

DESCRIPTION

TITLE OF THE INVENTION: LAMINATE AND METHOD FOR PRODUCING LAMINATE

TECHNICAL FIELD

[0001]

The present invention relates to a laminate and a method for producing a laminate. Specifically, the present invention relates to a laminate suitably used when an article such as a semiconductor chip is transferred by laser, a method for producing the laminate, a method for producing a display device using the laminate and the method for producing the laminate, and a method for producing a semiconductor device using the laminate and the method for producing the laminate.

BACKGROUND ART

[0002]

In recent years, electronic terminal devices have become more sophisticated, smaller, thinner, and lighter. These electronic terminal devices include a semiconductor device, and examples thereof include a processor and a memory. In these semiconductor manufacturing processes, a semiconductor chip incorporated into a semiconductor device is generally transferred and mounted onto a printed wiring

board or the like by a pick-and-place method using a flip chip bonder or the like. With higher performance and miniaturization of a semiconductor device, a semiconductor chip incorporated into a semiconductor device has also been miniaturized and thinned, and the number of mounted semiconductor chips has increased. Therefore, a method capable of mounting a large number of miniaturized semiconductor chips in a short time is required.

[0003]

In addition, technology related to an organic electroluminescence display, a quantum dot display, or a micro light emitting diode (hereinafter, referred to as LED) display has been actively studied in a thin display used in, for example, a smartphone or a television. Among them, the micro LED display has features such as high brightness, high contrast, high responsiveness, low power consumption, and a wide viewing angle, and thus is expected to be developed to new applications such as signage, AR, VR, and transparent displays. Since the micro LED display is a display in which an LED that is a semiconductor chip having a side length of several μm to several hundred μm is arranged in each pixel, a significant decrease in productivity becomes an issue in a conventional pick-and-place method. Therefore, a method capable of mounting a large number of LEDs in a short time is required to reduce

process time.

[0004]

Examples of a method for mounting a semiconductor chip at a high speed include a method using a laser transfer technique in which a semiconductor chip is mounted on a support substrate with a pressure-sensitive adhesive layer interposed therebetween, and then the pressure-sensitive adhesive layer is ablated by laser irradiation with laser from the support substrate side to transfer the semiconductor chip to another substrate (for example, Patent Documents 1 and 2). The transfer means that the semiconductor chip is transferred from the original substrate to another substrate. Ablation refers to a phenomenon in which a solid surface or a liquid surface of an object is irradiated with light such as a laser, and the surface of the object instantaneously melts and evaporates along with light absorption, a thermal process of light energy, and plasma generation, and ions, electrons, radicals, molecules, clusters, solid fragments, and the like are released, whereby constituent substances of the solid surface or the liquid surface are explosively released.

PRIOR ART DOCUMENTS

PATENT DOCUMENTS

[0005]

Patent Document 1: International Publication No.
2022/201767

Patent Document 2: Japanese Patent Laid-open
Publication No. 2020-188037

SUMMARY OF THE INVENTION

PROBLEMS TO BE SOLVED BY THE INVENTION

[0006]

However, in the method described in Patent Document 1, when a semiconductor chip is transferred by ablating the pressure-sensitive adhesive layer through laser irradiation, a residue derived from the pressure-sensitive adhesive layer is generated on the surface of the semiconductor chip after the transfer. In addition, there is a problem in that a residue adheres to the surface of the substrate at the transfer destination due to scattering of the pressure-sensitive adhesive layer during ablation. Furthermore, there is a problem in that positional accuracy during transfer of a semiconductor chip decreases due to displacement or variation in the laser irradiation position. Note that the residue of the pressure-sensitive adhesive layer on the surface of the semiconductor chip and the residue on the surface of the substrate as the transfer destination are referred to as debris. The method

described in Patent Document 2 employs a pressure-sensitive adhesive layer having a thickness of 0.1 to 0.5 μm as a thin film, and the pressure-sensitive adhesive layer is patterned by etching. Therefore, although the method is effective in debris suppression during transfer of a semiconductor chip, there is a problem in that positional accuracy during transfer of the semiconductor chip decreases.

[0007]

Therefore, the methods described in Patent Documents 1 and 2 do not provide both debris suppression and positional accuracy during transfer, and further improvement of characteristics has been desired. An object of the present invention is to achieve both debris suppression and excellent positional accuracy during transfer of an article such as a semiconductor chip and to obtain a display device and a semiconductor device with high accuracy.

SOLUTIONS TO THE PROBLEMS

[0008]

To solve the problems described above, the method for producing a laminate and the laminate of the present invention provide the following [1] to [20].

[1] A method for producing a laminate, comprising:

(10) preparing a laminate a1x including a first substrate and a light-absorbing layer in this order;

(12) tentatively fixing an article to the light-absorbing layer (hereinafter, referred to as step (12));

(13) patterning the light-absorbing layer (hereinafter, referred to as step (13));

(20) preparing a laminate a2 including a second substrate and a second pressure-sensitive adhesive layer in this order; and

(22) irradiating the light-absorbing layer with a chemical active ray from a first substrate side of the light-absorbing layer while a gap is present between an article provided on the first substrate and the second pressure-sensitive adhesive layer provided on the second substrate to transfer the article from the light-absorbing layer to the second pressure-sensitive adhesive layer (hereinafter referred to as step (22)),

wherein, in step (12), a plurality of articles are in contact with the light-absorbing layer, and, in step (13), a recess is formed in the light-absorbing layer.

[0009]

[2] The method for producing a laminate according to [1], wherein the light-absorbing layer has an indentation elastic modulus at 50°C of 1.0×10^3 to 2.0×10^9 Pa, and/or a glass transition temperature of -50 to 150°C in

step (13).

[0010]

[3] The method for producing a laminate according to [1] or [2], further comprising: (01) forming an article on a donor substrate,

wherein step (12) comprises (12a) irradiating the article with a chemical active ray from a donor substrate side of the article while the article provided on the donor substrate is in contact with the light-absorbing layer provided on the first substrate to transfer the article from the donor substrate to the light-absorbing layer (hereinafter, referred to as step (12a)), and

in step (12a), the light-absorbing layer is irradiated with a chemical active ray using the article as a mask, and at least a part of the light-absorbing layer irradiated with the chemical active ray is removed.

[0011]

[4] The method for producing a laminate according to any one of [1] to [3], wherein, in step (13), the light-absorbing layer is present, in a state of being in contact with the first substrate, as a plurality of convex-portion light-absorbing layers and a recess light-absorbing layer, a thickness of the light-absorbing layer in the recess is smaller than a thickness of the light-absorbing layer in the plurality of convex portions; and

wherein the plurality of articles each independently contact at least one of the plurality of convex-portion light-absorbing layers.

[0012]

[5] The method for producing a laminate according to any one of [1] to [3], wherein, in step (13), the light-absorbing layer is present in a state of being in contact with the first substrate as a plurality of island-shaped light-absorbing layers, and the plurality of articles each independently contact at least one of the plurality of island-shaped light-absorbing layers.

[0013]

[6] The method for producing a laminate according to any one of [1] to [5], wherein, in step (13), any one of the following conditions (a) to (c) is satisfied:

(a) the light-absorbing layer is a layer formed from a positive photosensitive composition, and step (13) comprises (13a) patterning the light-absorbing layer by photolithography (hereinafter, referred to as step (13a));

(b) the light-absorbing layer is a layer formed from a positive or negative photosensitive composition, and step (13) comprises (13b) patterning the light-absorbing layer by etching (hereinafter, referred to as step (13b)); and

(c) the light-absorbing layer is a layer formed from a non-photosensitive composition, and step (13) comprises

(13b) patterning the light-absorbing layer by etching, wherein the light-absorbing layer has an indentation elastic modulus at 50°C of 1.0×10^3 to 2.0×10^9 Pa and/or a glass transition temperature of -50 to 150°C.

[0014]

[7] The method for producing a laminate according to [6],

wherein condition (a) is satisfied in step (13), and step (13a) comprises (13a-1) irradiating the light-absorbing layer with a chemical active ray from an article side of the light-absorbing layer using the article as a mask; and (13a-2) developing the light-absorbing layer with a developer to pattern the light-absorbing layer.

[0015]

[8] The method for producing a laminate according to [6],

wherein condition (c) is satisfied in step (13), and step (13b) comprises (13b-1a) performing dry etching from an article side of the light-absorbing layer using the article as a mask to pattern the light-absorbing layer; or (13b-1b) performing wet etching from the article side of the light-absorbing layer using the article as a mask to pattern the light-absorbing layer.

[0016]

[9] The method for producing a laminate according to

any one of [1] to [8], further comprising, before or after step (13), (14) crosslinking a pattern of the light-absorbing layer (hereinafter, referred to as step (14)),

wherein step (14) comprises (14a) crosslinking the pattern of the light-absorbing layer by heating; or (14b-1) irradiating the light-absorbing layer with a chemical active ray from the first substrate side of the light-absorbing layer.

[0017]

[10] A method for producing a laminate, comprising:

(10) preparing a laminate a1x including a first substrate and a light-absorbing layer in this order;

(12z) tentatively fixing an article to the light-absorbing layer and ablating the light-absorbing layer (hereinafter, referred to as step (12z));

(20) preparing a laminate a2 including a second substrate and a second pressure-sensitive adhesive layer in this order; and

(22) irradiating the light-absorbing layer with a chemical active ray from a first substrate side of the light-absorbing layer while a gap is present between an article provided on the first substrate and the second pressure-sensitive adhesive layer provided on the second substrate to transfer the article from the light-absorbing layer to the second pressure-sensitive adhesive layer

(hereinafter referred to as step (22)),

wherein, in step (12z), a plurality of articles are in contact with the light-absorbing layer, and a recess is formed in the light-absorbing layer.

[0018]

[11] A laminate comprising, in this order, a first substrate, a light-absorbing layer, and an article, wherein a plurality of articles are in contact with the light-absorbing layer, the light-absorbing layer having a recess, and the light-absorbing layer has an indentation elastic modulus at 50°C of 1.0×10^3 to 2.0×10^9 Pa and/or a glass transition temperature of -50 to 150°C.

[0019]

[12] The laminate according to [11], wherein the light-absorbing layer is present, in a state of being in contact with the first substrate, as a plurality of convex-portion light-absorbing layers and a recess light-absorbing layer, and a thickness of the light-absorbing layer in the recess is smaller than a thickness of the light-absorbing layer in the plurality of convex portions; and

wherein the plurality of articles each independently contact at least one of the plurality of convex-portion light-absorbing layers.

[0020]

[13] The laminate according to [11], wherein the light-absorbing layer is present in a state of being in contact with the first substrate as a plurality of island-shaped light-absorbing layers, and the plurality of articles each independently contact at least one of the plurality of island-shaped light-absorbing layers.

[0021]

[14] The laminate according to any one of [11] to [13], wherein the light-absorbing layer has a thickness of less than 5.0 μm .

[0022]

[15] The laminate according to any one of [11] to [14], wherein the light-absorbing layer is a layer formed from a positive photosensitive composition.

[0023]

[16] the laminate according to any one of [11] to [15], wherein the laminate satisfies a relationship of formula (S-1), where (S_{1a}) is an area of surface 1a on a first substrate side of the light-absorbing layer, and (S_{2a}) is an area of surface 2a opposite to surface 1a of the light-absorbing layer.

$$(S_{1a}) \geq (S_{2a}) \quad (S-1).$$

[0024]

[17] The laminate according to [16], wherein (S_{1a})/(S_{2a}) is 1.10 or more and 3.00 or less, where

$(S_{1a})/(S_{2a})$ is a ratio of area (S_{1a}) of surface 1a to area (S_{2a}) of surface 2a.

[0025]

[18] The laminate according to any one of [11] to [17], wherein a maximum value of absorbance per 1.0 μm of thickness of the light-absorbing layer at wavelengths of 180 to 550 nm is 0.3 to 10.0.

[0026]

[19] The laminate according to any one of [11] to [18], wherein the light-absorbing layer contains ultraviolet absorber (XDa), the ultraviolet absorber (XDa) comprising a resin having a triazine structure and/or a benzotriazole structure in a structural unit of the resin.

[0027]

[20] The laminate according to any one of [11] to [19], wherein the light-absorbing layer satisfies any one of the following conditions (α) to (γ):

(α) the light-absorbing layer is a layer formed from a positive photosensitive composition, and the positive photosensitive composition satisfies at least one of conditions (1), (3), and (4);

(β) the light-absorbing layer is a layer formed from a negative photosensitive composition, and the negative photosensitive composition satisfies at least one of conditions (2) to (4);

(γ) the light-absorbing layer is a layer formed from a non-photosensitive composition, and the non-photosensitive composition satisfies condition (5) and/or condition (6);

(1) containing a naphthoquinonediazide compound (C1) and a crosslinking agent (F);

(2) containing a photopolymerization initiator (C2) and a radical polymerizable compound (B);

(3) containing a photoacid generator (C3) and a crosslinking agent (F);

(4) containing a photobase generator (C4) and a crosslinking agent (F);

(5) containing a crosslinking agent (F); and

(6) containing a radical polymerizable compound (B).

EFFECTS OF THE INVENTION

[0028]

The laminate of the present invention provides both debris suppression and excellent positional accuracy during transfer of an article such as a semiconductor chip and enables a display device or a semiconductor device to be obtained with high accuracy. According to the method for producing a laminate of the present invention, it is possible to provide both debris suppression and excellent positional accuracy during transfer of an article such as a

semiconductor chip and enable a display device or a semiconductor device to be obtained with high accuracy.

BRIEF DESCRIPTION OF THE DRAWINGS

[0029]

Fig. 1 is a process diagram showing a part of a production process of a micro LED display using a method for producing a laminate according to a third aspect and a fourth aspect of the present invention.

Fig. 2 is a process diagram showing a part of a production process of a micro LED display using a method for producing a laminate according to a fifth aspect and a sixth aspect of the present invention.

Fig. 3 is a process diagram showing a part of a production process of a micro LED display using a method for producing a laminate according to a seventh aspect and an eighth aspect of the present invention.

EMBODIMENTS OF THE INVENTION

[0030]

A method for producing a laminate of the present invention will be described below with a production process of a laminate in which a semiconductor micro light emitting diode (LED) is transferred as one embodiment. Figs. 1 to 3 are process diagrams showing a part of a production process

of a micro LED display using the method for producing a laminate. In the drawings, (1) is read as (Step 1). The laminate illustrated in (6) of Figs. 1 and 2 or (4) or (5) of Fig. 3 is a laminate including at least an article and having a recess in the light-absorbing layer, and is for transferring the article to another laminate. In one embodiment of the present invention, the first substrate includes a light-absorbing layer and an article in this order. This is a laminate according to the first aspect. In another embodiment of the present invention, the first substrate includes a light-absorbing layer, a first pressure-sensitive adhesive layer, and an article in this order. This is a laminate according to the second aspect. Aspects of the presence or absence of the first pressure-sensitive adhesive layer provided on the first substrate, a method of supplying an article, and a representative production method of a method of patterning the light-absorbing layer will be described below as a method for producing a laminate according to the third aspect to the eighth aspect. It is noted that the present invention is not limited to the following embodiments, and various modifications can naturally be made as long as the modifications can achieve the object of the invention and do not depart from the gist of the invention.

[0031]

In the present description, a silicone structure refers to any structure having an Si-O-Si bond as a main skeleton and having two organic groups on a silicon atom. That is, silicon atoms in the silicone structure are each bonded to two organic groups and two oxygen atoms. Further, a siloxane structure refers to a structure having a Si-O-Si bond as the main skeleton and having one organic group on a silicon atom. In other words, silicon atoms in the siloxane structure are each bonded to one organic group and three oxygen atoms.

[0032]

Laminates according to a first aspect and a second aspect of the present invention will be described. Note that the description of the laminate of the present invention is common to the laminates according to the first and second aspects of the present invention. On the other hand, when a laminate according to a specific aspect is described, the laminate is described as a laminate according to the first aspect of the present invention.

[0033]

<Laminate (Laminate 1X)>

The laminate corresponding to the first aspect of the present invention has the configuration of [11]. The first substrate 1 has the light-absorbing layer 2 and the article 4, and the light-absorbing layer 2 has a recess. With the

above configuration, the method for producing a laminate including a laminate according to the first aspect of the present invention can have both debris suppression and excellent position accuracy during transfer of an article such as a semiconductor chip, and a display device and a semiconductor device can be obtained with high accuracy. This means that since the light-absorbing layer portion has the recess, the volume of the light-absorbing layer is reduced as compared with the case where the light-absorbing layer portion does not have the recess. As a result, when the article is transferred from the light-absorbing layer, since the volume of the light-absorbing layer to be ablated is reduced, the scattering of the light-absorbing layer is also reduced, and it is estimated that the effect of debris suppression is achieved. Further, since the recess of the light-absorbing layer has deteriorated ablation characteristics and the opening portion of the light-absorbing layer is not ablated, it is estimated that the deviation of the irradiation position and the variation in the irradiation position of the laser are canceled, and the effect of excellent positional accuracy is achieved. For example, it is possible to reduce the volume of the light-absorbing layer by patterning a portion where no article is in contact with the light-absorbing layer as a recess or as an opening. The light-absorbing layer having the recess by

such pattern processing or the light-absorbing layer having the opening portion by pattern processing is more suitable for achieving the effect of debris suppression and the effect of excellent positional accuracy based on the estimation mechanism described above.

[0034]

Since the indentation elastic modulus of the light-absorbing layer is in a specific range and/or the glass transition temperature of the light-absorbing layer is in a specific range, it is considered that the light-absorbing layer can appropriately maintain a force for holding an article and suppress excessive adhesive force between the light-absorbing layer and the article. As a result, when the article is transferred from the light-absorbing layer, the transfer can be performed with less energy. It is therefore estimated that residuals of the light-absorbing layer on the surface of the article and scattering of the light-absorbing layer during ablation are suppressed and that the effect of debris suppression is achieved.

Furthermore, since transfer can be performed with less energy, the behavior of the article during transfer becomes stable, and the absolute value of variation in irradiation energy also becomes small, and it is estimated that the effect of excellent positional accuracy is achieved.

[0035]

<Laminate (Laminate 1Y)>

The laminate according to the second aspect of the present invention includes first substrate, a light-absorbing layer, and first pressure-sensitive adhesive layer, and an article in this order, wherein a plurality of articles are in contact with the first pressure-sensitive adhesive layer, the light-absorbing layer and first pressure-sensitive adhesive layer each have a recess, and the first pressure-sensitive adhesive layer has an indentation elastic modulus at 50°C of 1.0×10^3 to 2.0×10^9 Pa and/or a glass transition temperature of -50 to 150°C.

[0036]

With the above configuration, the laminate according to the second aspect of the present invention can provide both debris suppression and excellent positional accuracy during transfer of an article such as a semiconductor chip and enable a display device or a semiconductor device to be obtained with high accuracy. This means that, because the light-absorbing layer portion and the first pressure-sensitive adhesive layer each have a recess, the volume of the light-absorbing layer and the volume of the first pressure-sensitive adhesive layer are reduced as compared with a case where no recess is provided. As a result, it is estimated that the effects of debris suppression and

excellent positional accuracy are achieved for the same reasons as in the laminate according to the first aspect of the present invention. Since the indentation elastic modulus of the first pressure-sensitive adhesive layer is in a specific range and/or the glass transition temperature of the first pressure-sensitive adhesive layer is in a specific range, it is considered that the first pressure-sensitive adhesive layer can appropriately maintain a force for holding an article and suppress excessive adhesive force between the first pressure-sensitive adhesive layer and the article. As a result, it is estimated that the effects of debris suppression and excellent positional accuracy are achieved for the same reasons as in the laminate according to the first aspect of the present invention.

[0037]

Furthermore, it is considered that the laminate 1X and the laminate 1Y improve the light emission characteristics of the semiconductor chip and the like by achieving the above-described effects of debris suppression and excellent positional accuracy. That is, it is estimated that the light extraction efficiency from a semiconductor chip or the like is improved and that the effect of excellent light emission luminance is achieved.

[0038]

<Structure of Laminate>

A laminate according to the first aspect of the present invention includes a first substrate, a light-absorbing layer, and an article in this order. The laminate according to the first aspect of the present invention has a plurality of articles in contact with the light-absorbing layer, and the light-absorbing layer has a recess. The light-absorbing layer preferably has a plurality of recesses. The light-absorbing layer preferably satisfies any one of the following conditions (p) and (q):

(p) the light-absorbing layer has a recess, and the recess is formed by removing at least a part of the light-absorbing layer to reduce the thickness; and

(q) the light-absorbing layer has a recess, and the recess is an opening.

[0039]

In the laminate according to the first aspect of the present invention, the light-absorbing layer is preferably present, in a state of being in contact with the first substrate, as a plurality of convex-portion light-absorbing layers from the viewpoints of reduction in the energy of laser irradiation, debris suppression, and enhanced positional accuracy. In the laminate according to the first aspect of the present invention, the plurality of

articles preferably each independently contact at least one of the plurality of convex-portion light-absorbing layers. In the laminate according to the first aspect of the present invention, the plurality of convex-portion light-absorbing layers more preferably each independently contact at least one of the plurality of articles.

[0040]

In the laminate according to the first aspect of the present invention, the light-absorbing layer is preferably present as a layer having a plurality of island-shaped light-absorbing layers in a state of being in contact with the first substrate from the viewpoints of reduction in the energy of laser irradiation, debris suppression, and enhanced positional accuracy. In the laminate according to the first aspect of the present invention, the plurality of articles preferably each independently contact at least one of the plurality of island-shaped light-absorbing layers. In the laminate according to the first aspect of the present invention, the plurality of island-shaped light-absorbing layers more preferably each independently contact at least one of the plurality of articles.

[0041]

In the present invention, a laminate including the first substrate, the light-absorbing layer, and the article in this order may be referred to as a laminate 1X. In

addition, a laminate including the first substrate and the light-absorbing layer in this order may be referred to as a laminate 1x.

[0042]

A laminate according to the second aspect of the present invention includes a first substrate, a light-absorbing layer, a first pressure-sensitive adhesive layer, and an article in this order. The laminate according to the second aspect of the present invention has a plurality of articles in contact with the first pressure-sensitive adhesive layer, and the light-absorbing layer and the first pressure-sensitive adhesive layer each have a recess. The light-absorbing layer and the first pressure-sensitive adhesive layer each preferably have a plurality of recesses. The light-absorbing layer and the first pressure-sensitive adhesive layer preferably satisfy any one of the following conditions (py) and (qy):

(py) the light-absorbing layer and the first pressure-sensitive adhesive layer have a recess, the recess is an opening of the first pressure-sensitive adhesive layer, and the recess is formed by removing at least a part of the light-absorbing layer to reduce the thickness; and

(qy) the light-absorbing layer and the first pressure-sensitive adhesive layer have a recess, and the recess is an opening.

[0043]

In the laminate according to the second aspect of the present invention, it is preferable that the light-absorbing layer is present, in a state of being in contact with the first substrate, as a plurality of convex-portion light-absorbing layers and a recess light-absorbing layer, and the thickness of the light-absorbing layer in the recess is smaller than the thickness of the light-absorbing layer in the plurality of convex portions from the viewpoints of reduction in the energy of laser irradiation, debris suppression, and enhanced positional accuracy. In the laminate according to the second aspect of the present invention, the first pressure-sensitive adhesive layer is preferably present layer as a first pressure-sensitive adhesive having a plurality of convex-portion first pressure-sensitive adhesive layer in a state of being in contact with at least one of the plurality of convex-portion light-absorbing layers from the viewpoint of the same effect of the invention.. The first pressure-sensitive adhesive layer is also preferably present as a layer having a plurality of recess first pressure-sensitive adhesive layers in a state of being in contact with at least one of the plurality of recess light-absorbing layers. In the laminate according to the second aspect of the present invention, the plurality of articles preferably

each independently contact at least one of the plurality of convex-portion first pressure-sensitive adhesive layers.

In the laminate according to the second aspect of the present invention, it is preferable that the light-absorbing layer present, in a state of being in contact with the first substrate, as a plurality of convex-portion light-absorbing layers, the first pressure-sensitive adhesive layer is present as a plurality of convex-portion first pressure-sensitive adhesive layer in a state of being in contact with at least one of the plurality of convex-portion light-absorbing layers, and the plurality of articles are each independently in contact with at least one of the plurality of convex-portion first pressure-sensitive adhesive layers (hereinafter, referred to as specific configuration 1 of the laminate). In the laminate according to the second aspect of the present invention, the plurality of convex-portion first pressure-sensitive adhesive layers more preferably each independently contact at least one of the plurality of articles. In the laminate according to the second aspect of the present invention, the plurality of convex-portion light-absorbing layers more preferably each independently contact at least one of the plurality of convex-portion first pressure-sensitive adhesive layers.

[0044]

In the laminate according to the second aspect of the present invention, the light-absorbing layer is preferably present as a layer having a plurality of island-shaped light-absorbing layers in a state of being in contact with the first substrate from the viewpoints of reduction in the energy of laser irradiation, debris suppression, and enhanced positional accuracy. In the laminate according to the second aspect of the present invention, the first pressure-sensitive adhesive layer is preferably present as layer having a plurality of island-shaped first pressure-sensitive adhesive layers in a state of being in contact with at least one of the plurality of island-shaped light-absorbing layers from the viewpoint of the same effect of the invention.. In the laminate according to the second aspect of the present invention, the plurality of articles preferably each independently contact at least one of the plurality of island-shaped first pressure-sensitive adhesive layers. In the laminate according to the second aspect of the present invention, it is preferable that the light-absorbing layer is present as a layer having a plurality of island-shaped light-absorbing layers in a state of being in contact with the first substrate, the first pressure-sensitive adhesive later is present as a later having a plurality of island-shaped light-absorbing layers in a state of being in contact with at least one of

the plurality of island-shaped light-absorbing layers, and the plurality of articles are each independently in contact with at least one of the plurality of island-shaped first pressure-sensitive adhesive layers (hereinafter, referred to as specific configuration 2 of the laminate). In the laminate according to the second aspect of the present invention, the plurality of island-shaped first pressure-sensitive adhesive layers more preferably each independently contact at least one of the plurality of articles. In the laminate according to the second aspect of the present invention, the plurality of island-shaped light-absorbing layers more preferably each independently contact at least one of the plurality of island-shaped first pressure-sensitive adhesive layers.

[0045]

In the present invention, a laminate including the first substrate, the light-absorbing layer, the first pressure-sensitive adhesive layer, and the article in this order may be referred to as a laminate 1Y. In addition, a laminate including the first substrate, the light-absorbing layer, and the first pressure-sensitive adhesive layer in this order may be referred to as a laminate aly.

[0046]

<First Substrate>

The laminate of the present invention has a first

substrate. The first substrate is preferably a light-transmissive substrate from the viewpoint of reduction in the energy of laser irradiation and enhanced positional accuracy. The light-transmissive substrate refers to a substrate having a maximum transmittance of 60% or more at wavelengths of 180 to 1100 nm. The maximum transmittance of the light-transmissive substrate at wavelengths of 180 to 1100 nm is preferably 70% or more, more preferably 80% or more, and still more preferably 90% or more. In the light-transmissive substrate, the maximum transmittance at wavelengths of 180 to 550 nm is preferably in the above range from the viewpoints of reduction in the energy of laser irradiation and enhanced positional accuracy, and the maximum transmittance at a wavelength of 193 nm, a wavelength of 248 nm, a wavelength of 266 nm, a wavelength of 308 nm, a wavelength of 351 nm, a wavelength of 355 nm, or a wavelength of 532 nm is more preferably in the above range. When the first substrate has a multilayer structure, the first substrate refers to a substrate whose maximum transmittance is 60% or more at a wavelength of 180 to 1100 nm in the case of a multilayer structure. The transmittance at wavelengths of 180 to 1100 nm may be adjusted by adjusting the thickness of the first substrate.

[0047]

The light-transmissive substrate is preferably an

inorganic substrate from the viewpoint of improving impact resistance. The inorganic substrate as a light-transmissive substrate preferably has silicon dioxide or dialuminum trioxide, and is more preferably an alkali glass substrate, a alkali-free glass substrate, a borosilicate glass substrate, a quartz glass substrate, a crystal substrate, or a sapphire substrate. The thickness of the inorganic substrate as a light-transmissive substrate can be selected within a range in which the transmittance is not impaired, and is preferably 0.10 mm or more, more preferably 0.30 mm or more from the viewpoint of improving the handleability. On the other hand, the thickness is preferably 5.0 mm or less, and more preferably 3.0 mm or less from the viewpoint of easy availability.

[0048]

The light-transmissive substrate is preferably an organic substrate from the viewpoint of improving flexibility and handleability. The organic substrate as the light-transmissive substrate is preferably a polyethylene terephthalate substrate, an aramid substrate, a polyester substrate, a polypropylene substrate, a cycloolefin polymer substrate, a polycarbonate substrate, a cellulose triacetate substrate, or a polyimide substrate. The thickness of the organic substrate as a light-transmissive substrate can be selected within a range in

which the transmittance is not impaired, and is preferably 0.050 mm or more, more preferably 0.10 mm or more from the viewpoint of improving the handleability. On the other hand, the thickness is preferably 3.0 mm or less, and more preferably 1.0 mm or less from the viewpoint of suppressing light scattering during laser irradiation.

[0049]

The first substrate preferably has a maximum transmittance of 60% or more at wavelengths of chemical active rays to be applied in step (22), which will be described later, of irradiating the light-absorbing layer with a chemical active ray from a first substrate side of the light-absorbing layer while a gap is present between an article provided on the first substrate and the second pressure-sensitive adhesive layer provided on the second substrate to transfer the article from the light-absorbing layer to the second pressure-sensitive adhesive layer. Examples and preferred descriptions concerning the maximum transmittance are the same as the examples and preferred descriptions concerning the maximum transmittance at wavelengths of 180 to 1100 nm, respectively.

[0050]

The first substrate more preferably has a maximum transmittance of 60% or more at the wavelength of chemical active rays applied in the step of (14b-1) irradiating the

light-absorbing layer with a chemical active ray from the first substrate side of the light-absorbing layer, as described later. Examples and preferred descriptions concerning the maximum transmittance are the same as the examples and preferred descriptions concerning the maximum transmittance at wavelengths of 180 to 1100 nm, respectively.

[0051]

<Light-absorbing layer; Physical property value of light-absorbing layer>

The laminate according to the first aspect of the present invention includes a light-absorbing layer. In the laminate according to the first aspect of the present invention, the light-absorbing layer has a recess. in the laminate according to the first aspect of the present invention, the light-absorbing layer has an indentation elastic modulus of 1.0×10^3 to 2.0×10^9 pa at 50°C, and/or a glass transition temperature of -50 to 150°C. The shape of the light-absorbing layer is as described above.

[0052]

The laminate according to the second aspect of the present invention includes a light-absorbing layer. In the laminate according to the second aspect of the present invention, the light-absorbing layer has a recess. In the laminate according to the second aspect of the present

invention, the light-absorbing layer preferably has an indentation elastic modulus of 1.0×10^3 to 2.0×10^9 pa at 50°C, and/or a glass transition temperature of -50 to 150°C.

[0053]

The indentation elastic modulus of the light-absorbing layer at 50°C is preferably 1.0×10^3 Pa or more, more preferably 1.0×10^4 Pa or more, still more preferably 5.0×10^4 Pa or more, even more preferably 1.0×10^5 Pa or more, and particularly preferably 5.0×10^5 Pa or more from the viewpoints of reduction in the energy of laser irradiation, debris suppression, and enhanced positional accuracy. Meanwhile, the indentation elastic modulus at 50°C is preferably 2.0×10^9 Pa or less, more preferably 5.0×10^8 Pa or less, and still more preferably 2.0×10^8 Pa or less from the viewpoint of the same effect of the invention. Furthermore, the Indentation elastic modulus is preferably 5.0×10^7 Pa or less, more preferably 2.0×10^7 Pa or less, still more preferably 5.0×10^6 Pa or less, and particularly preferably 2.0×10^6 Pa or less.

[0054]

The glass transition temperature of the light-absorbing layer is preferably -50°C or more, more preferably -30°C or more, and still more preferably -10°C or more from the viewpoints of reduction in the energy of

laser irradiation, debris suppression, and enhanced positional accuracy. On the other hand, the glass transition temperature is preferably 150°C or less, more preferably 100°C or less, still more preferably 70°C or less, even more preferably 50°C or less, particularly preferably 30°C or less, and most preferably 10°C or less from the viewpoint of the same effect of the invention.

[0055]

In the laminate of the present invention, the ratio (hereinafter, referred to as an indentation elastic modulus ratio of the light-absorbing layer before and after the specific treatment) of the indentation elastic modulus at 50°C of the light-absorbing layer after treatment with any one of (x1), (x2) and (x3) below to the indentation elastic modulus at 50°C of the light-absorbing layer before treatment; (indentation elastic modulus after treatment)/(indentation elastic modulus before treatment)) is preferably 1.0×10^2 to 1.0×10^4 . In the laminate of the present invention, the difference (hereinafter, referred to as difference in glass transition temperature of the light-absorbing layer before and after the specific treatment) between the glass transition temperature of the light-absorbing layer after the treatment of any one of (x1), (x2) and (x3) below and the glass transition temperature of the light-absorbing layer before the

treatment is preferably 30 to 100°C.

(x1) The light-absorbing layer is heated at 150°C for 30 minutes.

(x2) the light-absorbing layer is irradiated with chemical active rays having a maximum wavelength in a range of 180 to 450 nm at 300 mJ/cm².

(x3) the light-absorbing layer is irradiated with chemical active rays having a maximum wavelength in a wavelength range of 180 to 450 nm at 300 mJ/cm², and then the light-absorbing layer is heated at 100°C for 30 minutes.

[0056]

As the indentation elastic modulus ratio of the light-absorbing layer before and after the specific treatment, at least one of the indentation elastic modulus ratios of the light-absorbing layer before and after the treatment of any one of (x1), (x2), and (x3) is preferably 1.0×10^2 to 1.0×10^4 . As the difference in glass transition temperature of the light-absorbing layer before and after the specific treatment, at least one of the glass transition temperature differences of the light-absorbing layer before and after the treatment of any one of (x1), (x2), and (x3) is preferably 30 to 100°C.

[0057]

The indentation elastic modulus ratio of the light-

absorbing layer before and after the specific treatment is preferably 1.0×10^2 or more, more preferably 3.0×10^2 or more, still more preferably 5.0×10^2 or more, even more preferably 7.0×10^2 or more, and still more preferably 1.0×10^3 or more from the viewpoints of reduction in the energy of laser irradiation, debris suppression, and enhanced positional accuracy. Meanwhile, the indentation elastic modulus ratio is preferably 1.0×10^4 or less, more preferably 7.0×10^3 or less, and still more preferably 5.0×10^3 or less from the viewpoint of the same effect of the invention.

[0058]

The difference in glass transition temperature of the light-absorbing layer before and after the specific treatment is preferably 30°C or more, more preferably 40°C or more, and still more preferably 50°C or more from the viewpoint of reduction in the energy of laser irradiation, debris suppression, and enhanced positional accuracy. On the other hand, the difference in glass transition temperature is preferably 100°C or less, more preferably 90°C or less, and still more preferably 80°C or less from the viewpoint of the same effect of the invention.

[0059]

The indentation elastic modulus at 50°C of the light-absorbing layer, the glass transition temperature of the

light-absorbing layer, the indentation elastic modulus ratio of the light-absorbing layer before and after the specific treatment, and the difference in glass transition temperature of the light-absorbing layer before and after the specific treatment can be adjusted to fall within the above ranges by using a binder resin (XA) in a suitable light-absorbing layer to be described later. In particular, the resin (XA1x) having a siloxane structure and/or a silicone structure in a structural unit of the resin, the resin (XA1x) having an oxyalkylene structure in a structural unit of the resin; the resin (XA2) that is an acrylic resin having a unit derived from a (meth)acrylate ester derivative containing an aliphatic group having 4 to 20 carbon atoms; and the resin (XA2) having a siloxane structure and/or a silicone structure in a structural unit of the resin or having an oxyalkylene structure in a structural unit of the resin are suitable for adjusting the physical property values of these light-absorbing layers within the above ranges. It is also preferable to adjust the physical property values of these light-absorbing layers within the above ranges by incorporating another structure into the structural units of the resin (XA1x) or resin (XA2) or by using two or more binder resins (XA) in the preferred light-absorbing layer described later.

[0060]

The thickness of the light-absorbing layer is preferably less than 5.0 μm , more preferably 4.0 μm or less, still more preferably 3.0 μm or less, still more preferably 2.0 μm or less, and particularly preferably 1.0 μm or less from the viewpoint of reduction in the energy of laser irradiation and debris suppression. On the other hand, the thickness of the light-absorbing layer is preferably 0.10 μm or more, more preferably 0.30 μm or more, and still more preferably 0.50 μm or more from the viewpoint of enhanced positional accuracy. The thickness of the light-absorbing layer corresponds to the thickness of the light-absorbing layer in the convex portion.

[0061]

On the other hand, the thickness of the light-absorbing layer in the recess is preferably 2.0 μm or less, more preferably 1.0 μm or less, still more preferably 0.50 μm or less, even more preferably 0.30 μm or less, and particularly preferably 0.10 μm or less. It is also preferable that there is no light-absorbing layer at a position corresponding to the recess.

[0062]

The maximum value of the absorbance of the light-absorbing layer per 1.0 μm of thickness at wavelengths of 180 to 550 nm and the absorbance of the light-absorbing layer per 1.0 μm of thickness at a wavelength of 193 nm, a

wavelength of 248 nm, a wavelength of 266 nm, a wavelength of 308 nm, a wavelength of 351 nm, a wavelength of 355 nm, or a wavelength of 532 nm are preferably 0.3 or more, more preferably 0.5 or more, and still more preferably 1.0 or more from the viewpoint of reduction in the energy of laser irradiation and enhanced positional accuracy. Furthermore, the maximum value of the absorbance and the absorbance are preferably 1.5 or more, more preferably 2.0 or more, still more preferably 2.5 or more, and particularly preferably 3.0 or more. On the other hand, from the viewpoint of debris suppression and enhanced positional accuracy, the maximum value of absorbance and the absorbance are preferably 10.0 or less, more preferably 8.0 or less, still more preferably 7.0 or less, and particularly preferably 6.0 or less. Furthermore, the maximum value of absorbance is preferably 5.0 or less, more preferably 4.5 or less, and still more preferably 4.0 or less.

[0063]

The maximum value of the absorbance per 1.0 μm of thickness of the light-absorbing layer at wavelengths of 180 to 550 nm can be adjusted within the above range by using an ultraviolet absorber (XDa) and/or a colorant (XDb) in a suitable light-absorbing layer to be described later. In particular, the ultraviolet absorber (XDa) having one or more selected from the group consisting of a triazine

structure, a benzotriazole structure, a benzophenone structure, an isocyanuric acid structure, and at least two benzene structures, which will be described later, and the ultraviolet absorber (XDa) having a specific structure are suitable for adjusting the absorbance of the light-absorbing layer within the above range. It is also preferable to adjust the absorbance of the light-absorbing layer within the above range by incorporating an ultraviolet absorber (XDa) different from the ultraviolet absorber (XDa) described above or a colorant (XDb), or by using two or more ultraviolet absorbers (XDa) and/or colorants (XDb) in the preferred light-absorbing layer described later.

[0064]

In the light-absorbing layer, in step (22), which will be described later, of irradiating the light-absorbing layer with a chemical active ray from a first substrate side of the light-absorbing layer while a gap is present between an article provided on the first substrate and the second pressure-sensitive adhesive layer provided on the second substrate to transfer the article from the light-absorbing layer to the second pressure-sensitive adhesive layer, the absorbance at the wavelength of the chemical active rays to be irradiated is more preferably in the above range.

[0065]

The light-absorbing layer more preferably has an absorbance of the transmittance in the above range at the wavelength of the chemical active rays irradiated in the step of (14b-1) irradiating the light-absorbing layer with a chemical active ray from the first substrate side of the light-absorbing layer, as described later.

[0066]

<Configuration of light-absorbing layer >

From the viewpoints of reduction in the energy of laser irradiation, debris suppression, and enhanced positional accuracy, the light-absorbing layer preferably satisfies the relationship of the formula (S-1), where (S_{1a}) is an area of the surface 1a of the light-absorbing layer on the first substrate side, and (S_{2a}) is an area of the surface 2a facing the surface 1a of the light-absorbing layer.

$$(S_{1a}) \geq (S_{2a}) \quad (S-1)$$

In a case where the relationship of the above formula (S-1) is satisfied, when the ratio of the area (S_{1a}) of the surface 1a to the area (S_{2a}) of the surface 2a is

$(S_{1a})/(S_{2a})$, $(S_{1a})/(S_{2a})$ is preferably 1.10 or more, more preferably 1.30 or more, still more preferably 1.50 or more, still more preferably 1.70 or more, and particularly preferably 2.00 or more from the viewpoint of debris

suppression and enhanced positional accuracy. On the other hand, $(S_{1a})/(S_{2a})$ is preferably 5.00 or less, more preferably 4.50 or less, still more preferably 4.00 or less, even more preferably 3.50 or less, and particularly preferably 3.00 or less from the viewpoints of reduction in the energy of laser irradiation.

[0067]

When the light-absorbing layer is present as a layer having a plurality of convex-portion light-absorbing layers or a plurality of island-shaped light-absorbing layers in a state of being in contact with the first substrate, the light-absorbing layer more preferably satisfies the relationship of the above formula (S-1) from the viewpoints of reduction in the energy of laser irradiation, debris suppression, and enhanced positional accuracy. In addition, when the laminate according to the first aspect of the present invention has the configuration of [12] or the configuration of [13], the light-absorbing layer particularly preferably satisfies the relationship of the above formula (S-1). When the laminate according to the second aspect of the present invention has the specific configuration 1 or 2 of the laminate, the light-absorbing layer particularly preferably satisfies the relationship of the above formula (S-1).

[0068]

When the light-absorbing layer is present as a layer having a plurality of convex-portion light-absorbing layers or a plurality of island-shaped light-absorbing layers in a state of being in contact with the first substrate and the relationship of the above formula (S-1) is satisfied, the taper angle of the inclined side in the cross section of the plurality of convex-portion light-absorbing layers or the plurality of island-shaped light-absorbing layers is 90° or less. The taper angle of the inclined side in a cross section of a plurality of convex-portion light-absorbing layers or a plurality of island-shaped light-absorbing layers is preferably 90° or less, more preferably 85° or less, still more preferably 80° or less, still more preferably 75° or less, and particularly preferably 70° or less from the viewpoint of debris suppression and enhanced positional accuracy. On the other hand, the taper angle of the inclined side is preferably 30° or more, more preferably 45° or more, and still more preferably 60° or more from the viewpoints of reduction in the energy of laser irradiation. The taper angle of the inclined side in the cross section of the light-absorbing layer refers to an angle formed by the side of the first substrate in contact with the surface 1a of the light-absorbing layer and the inclined side of the light-absorbing layer.

[0069]

It is considered that when the light-absorbing layer satisfies the relationship of the above formula (S-1), the area of contact between the light-absorbing layer and the article can be reduced, and excessive adhesive force between the light-absorbing layer and the article can be suppressed. As a result, when the article is transferred from the light-absorbing layer, the transfer can be performed with less energy. It is therefore estimated that residuals of the light-absorbing layer on the surface of the article and scattering of the light-absorbing layer during ablation are suppressed and that the effect of debris suppression becomes remarkable. Furthermore, since transfer can be performed with less energy, the behavior of the article during transfer becomes stable, and the absolute value of variation in irradiation energy also becomes small, and it is estimated that the effect of excellent positional accuracy becomes remarkable.

[0070]

From the viewpoints of reduction in the energy of laser irradiation, debris suppression, and enhanced positional accuracy, it is preferable that the plurality of convex-portion light-absorbing layers or a plurality of island-shaped light-absorbing layers satisfy the relationship of the formula (S-xy), where the area of each (hereinafter referred to as the area of the convex-portion

or island-shaped light-absorbing layer) is denoted by (S_x) , and the area of a plurality of articles in contact with each is denoted by (S_y) .

$$(S_x) \geq (S_y) \quad (S-xy)$$

In a case where the relationship of the above formula $(S-xy)$ is satisfied, when $(S_x)/(S_y)$ is a ratio of area (S_x) of the convex-portion or island-shaped light-absorbing layer to area (S_y) of the article, $(S_x)/(S_y)$ is preferably 1.10 or more, more preferably 1.30 or more, still more preferably 1.50 or more, even more preferably 1.65 or more, and particularly preferably 1.90 or more from the viewpoint of debris suppression and enhanced positional accuracy. On the other hand, $(S_x)/(S_y)$ is preferably 4.50 or less, more preferably 4.00 or less, still more preferably 3.50 or less, even more preferably 3.00 or less, and particularly preferably 2.70 or less from the viewpoints of reduction in the energy of laser irradiation.

[0071]

Of the area of the surface 1a of the light-absorbing layer on the first substrate side and the area of the surface 2a opposite to the surface 1a of the light-absorbing layer, the area of the island-shaped light-absorbing layer corresponds to the area of the surface 1a on the first substrate side.

[0072]

In addition, the area of the light-absorbing layer at the convex portion and the area of the light-absorbing layer at the recess are to be determined by determining the recess and the convex portion of the light-absorbing layer by the following methods (a1) to (a4).

(a1) In a plan view, an arbitrary article in contact with the light-absorbing layer and articles respectively adjacent to the arbitrary article (hereinafter referred to as "adjacent articles") are identified.

(a2) The thickness of the light-absorbing layer is measured at 10 points on each straight line connecting the shortest distance between an arbitrary article and each adjacent article.

(a3) Regarding the measured thicknesses of the light-absorbing layers at 10 points, the minimum value of the thickness of each light-absorbing layer is obtained, and the average value of the minimum values is calculated.

(a4) A region where the thickness of the light-absorbing layer is less than the average value obtained as described above +0.10 μm is defined as a recess of the light-absorbing layer, and a region where the thickness of the light-absorbing layer is the average value obtained as described above +0.10 μm or more is defined as a convex portion of the light-absorbing layer.

[0073]

The plane in the plan view refers to a plane horizontal to the article. In addition, in a case where a plane horizontal to an article is an xy-axis plane, and a direction orthogonal to the xy-axis plane is a z-axis direction, the plan view refers to a plan view on an article side in the xy-axis plane viewed from the z-axis direction. When focusing on a specific member in a plan view, it is assumed that another member overlapping the specific member is seen through. When the article is not a plane, a plane horizontal to the light-absorbing layer in contact with the article is an xy plane.

[0074]

In addition, from the viewpoints of reduction in the energy of laser irradiation, debris suppression, and enhanced positional accuracy, it is preferable that a plurality of convex-portion first pressure-sensitive adhesive layers to be described later or a plurality of island-shaped first pressure-sensitive adhesive layers to be described later satisfy the relationship of the formula (S-pq) when the area of each (hereinafter referred to as the area of the convex-portion or island-shaped first pressure-sensitive adhesive layer) is denoted by (S_p) and the area of a plurality of articles in contact with each is denoted by (S_q).

$$(S_p) \geq (S_q) \quad (S-pq)$$

In a case where the relationship of the above formula (S-pq) is satisfied, when $(S_p)/(S_q)$ is a ratio of area (S_p) of the convex-portion or island-shaped first pressure-sensitive adhesive layer to area (S_q) of the article, $(S_p)/(S_q)$ is preferably 1.10 or more, more preferably 1.30 or more, still more preferably 1.50 or more, even more preferably 1.65 or more, and particularly preferably 1.90 or more from the viewpoints of debris suppression and enhanced positional accuracy. On the other hand, $(S_p)/(S_q)$ is preferably 4.50 or less, more preferably 4.00 or less, still more preferably 3.50 or less, still more preferably 3.00 or less, and particularly preferably 2.70 or less from the viewpoints of reduction in the energy of laser irradiation.

[0075]

Of the area of the surface of the first pressure-sensitive adhesive layer on the light-absorbing layer side and the area of the surface opposite to the surface, the area of the island-shaped first pressure-sensitive adhesive layer corresponds to the area of the surface on the light-absorbing layer side.

[0076]

In addition, the area of the first pressure-sensitive adhesive layer at the convex portion and the area of the first pressure-sensitive adhesive layer at the recess are

to be determined by determining the recess and the convex portion of the first pressure-sensitive adhesive layer by the following methods (b1) to (b4).

(b1) In plan view, an arbitrary article in contact with the first pressure-sensitive adhesive layer and an article adjacent to the arbitrary article (hereinafter, referred to as "each adjacent article") are obtained.

(b2) The thickness of the first pressure-sensitive adhesive layer is measured at 10 points on each straight line representing the shortest distance between any article and each adjacent article.

(b3) Regarding the measured thicknesses of the first pressure-sensitive adhesive layer at 10 points, the minimum value of the thickness of the first pressure-sensitive adhesive layer at each of the 10 points is obtained, and the average value of these minimum values is calculated.

(b4) A region where the thickness of the first pressure-sensitive adhesive layer is less than the average value obtained above +0.10 μm is defined as a recess of the first pressure-sensitive adhesive, and a region where the thickness of the first pressure-sensitive adhesive layer is the average value obtained above +0.10 μm or more is defined as a convex portion of the first pressure-sensitive adhesive layer.

[0077]

The plane in the plan view refers to a plane horizontal to the article. In addition, in a case where a plane horizontal to an article is an xy-axis plane, and a direction orthogonal to the xy-axis plane is a z-axis direction, the plan view refers to a plan view on an article side in the xy-axis plane viewed from the z-axis direction. When focusing on a specific member in a plan view, it is assumed that another member overlapping the specific member is seen through. When the article is not planar, a plane horizontal to the first pressure-sensitive adhesive layer in contact with the article is defined as an xy-plane.

[0078]

from the viewpoint of enhanced positional accuracy, the light-absorbing layer also preferably satisfies the relationship of the formula (S-2), where (S_{1a}) is an area of the surface 1a on the first substrate side of the light-absorbing layer, and (S_{2a}) is an area of the surface 2a opposite to the surface 1a of the light-absorbing layer.

$$(S_{1a}) < (S_{2a}) \quad (S-2)$$

In a case where the relationship of the above formula (S-2) is satisfied, (S_{2a})/(S_{1a}) is preferably 1.10 or more, more preferably 1.30 or more, still more preferably 1.50 or more, even more preferably 1.70 or more, and particularly preferably 2.00 or more from the viewpoint of enhanced

positional accuracy. On the other hand, $(S_{2a})/(S_{1a})$ is preferably 5.00 or less, more preferably 4.50 or less, still more preferably 4.00 or less, even more preferably 3.50 or less, and particularly preferably 3.00 or less from the viewpoint of enhanced positional accuracy.

[0079]

When the light-absorbing layer is present as a plurality of convex-portion light-absorbing layers or a plurality of island-shaped light-absorbing layers in a state of being in contact with the first substrate, the light-absorbing layer also more preferably satisfies the relationship of the above formula (S-2) from the viewpoint of enhanced positional accuracy. In addition, when the laminate according to the first aspect of the present invention has the configuration of [12] or the configuration of [13], the light-absorbing layer also more preferably satisfies the relationship of the above formula (S-2). When the laminate according to the second aspect of the present invention has the specific configuration 1 or 2 of the laminate, the light-absorbing layer also more preferably satisfies the relationship of the above formula (S-2).

[0080]

When the light-absorbing layer is present as a layer having a plurality of convex-portion light-absorbing layers

or a plurality of island-shaped light-absorbing layers in a state of being in contact with the first substrate and satisfies the relationship of the above formula (S-2), the taper angle of the inclined side in the cross section of the plurality of convex-portion light-absorbing layers or a plurality of island-shaped light-absorbing layers is more than 90° . The taper angle of the inclined side in a cross section of a plurality of convex-portion light-absorbing layers or a plurality of island-shaped light-absorbing layers is preferably more than 90° , more preferably 95° or more, still more preferably 100° or more, even more preferably 105° or more, and particularly preferably 110° or more from the viewpoint of enhanced positional accuracy. On the other hand, the taper angle of the inclined side is preferably 150° or less, more preferably 135° or less, still more preferably 120° or less from the viewpoint of enhanced positional accuracy. The taper angle of the inclined side in the cross section of the light-absorbing layer refers to an angle formed by the side of the first substrate in contact with the surface 1a of the light-absorbing layer and the inclined side of the light-absorbing layer.

[0081]

It is considered that when the light-absorbing layer satisfies the relationship of the above formula (S-2), the

area where the light-absorbing layer and the first substrate are in contact with each other can be reduced, and the reactive force that the light-absorbing layer receives from the first substrate during ablation can be suppressed. As a result, it is estimated that excessive energy transmitted from the light-absorbing layer to the article by the reactive force can be suppressed, and the behavior of the article at the time of transfer is stabilized, and thus the effect of excellent positional accuracy becomes remarkable.

[0082]

The light-absorbing layer is preferably a layer formed from a photosensitive composition or a layer formed from a non-photosensitive composition. That is, the light-absorbing layer is preferably a layer formed from a photosensitive composition or a layer formed from a non-photosensitive composition. Note that the photosensitive composition is a positive photosensitive composition or a negative photosensitive composition.

[0083]

<Binder resin (XA) in light-absorbing layer >

The light-absorbing layer preferably contains a binder resin (XA). The binder resin (XA) in the light-absorbing layer is preferably the binder resin (A) in the composition described later and also preferably a resin

having a structure derived from the binder resin (A) in the composition. The binder resin (XA) preferably has an acidic group, and more preferably has an acidic group in the structural unit of the resin, from the viewpoints of reduction in the energy of laser irradiation, debris suppression, and enhanced positional accuracy. The acidic group is preferably one or more groups selected from the group consisting of a phenolic hydroxyl group, a hydroxyimide group, a hydroxyamide group, a silanol group, a mercapto group, a carboxy group, a carboxylic anhydride group, and a sulfonic acid group, and more preferably one or more groups selected from the group consisting of weakly acidic groups (WA): a phenolic hydroxyl group, a hydroxyimide group, a hydroxyamide group, a silanol group, and a mercapto group. The binder resin (XA) having a (WA) weakly acidic group may be referred to as a (XA1) weakly acidic group-containing resin.

[0084]

The binder resin (XA) preferably has a radical polymerizable group, and more preferably has a radical polymerizable group in the structural unit of the resin, from the viewpoints of reduction in the energy of laser irradiation, debris suppression, and enhanced positional accuracy. The radical polymerizable group preferably has an ethylenically unsaturated double bond group, and more

preferably has a photoreactive group, an alkenyl group having 2 to 5 carbon atoms, or an alkynyl group having 2 to 5 carbon atoms. The photoreactive group is preferably a styryl group, a cinnamoyl group, a maleimide group, a nadimide group, or a (meth)acryloyl group, and more preferably a (meth)acryloyl group from the viewpoint of debris suppression and enhanced positional accuracy. On the other hand, the alkenyl group having 2 to 5 carbon atoms or the alkynyl group having 2 to 5 carbon atoms is preferably a vinyl group, an allyl group, a 2-methyl-2-propenyl group, a crotonyl group, a 2-methyl-2-butenyl group, a 3-methyl-2-butenyl group, a 2,3-dimethyl-2-butenyl group, an ethynyl group, or a 2-propargyl group, and is more preferably a vinyl group or an allyl group from the viewpoints of debris suppression and enhanced positional accuracy.

[0085]

The binder resin (XA) preferably includes one or more resins selected from the group consisting of a polyimide, a polyimide precursor, a polybenzoxazole, a polybenzoxazole precursor, a polyamide-imide, a polyamide-imide precursor, a polyamide, a polysiloxane, a silicone resin, a maleimide resin, a maleimide-styrene resin, a maleimide-triazine resin, a maleimide-oxazine resin, a phenolic resin, polyhydroxystyrene, a phenolic-group-containing epoxy

resin, a phenolic-group-containing acrylic resin, an acrylic resin, a resin having a polycyclic side chain, an acid-modified epoxy resin, a urethane resin, an epoxy resin, and copolymers thereof.

[0086]

The binder resin (XA) preferably contains a weakly acidic group-containing resin (XA1) (hereinafter, referred to as resin (XA1)) from the viewpoint of the effect of the invention,. The resin (XA1) preferably contains resin (XA1x): resin having one or more structures selected from the group consisting of an imide structure, an amide structure, an oxazole structure, a siloxane structure, and a silicone structure (hereinafter, referred to as imide structure and the like) in the structural unit of the resin, and/or resin (XA1y): resin having a phenolic hydroxyl group in the structural unit of the resin.

[0087]

From the viewpoint of the effect of the above invention, the resin (XA1x) more preferably has one or more selected from the group consisting of an imide structure, an amide structure, and an oxazole structure in the structural unit of the resin, and still more preferably has a siloxane structure and/or a silicone structure in the structural unit of the resin. From the viewpoint of the effect of the invention, the resin (XA1x) also more

preferably has an oxyalkylene structure in the structural unit of the resin. It is still more preferable that the resin (XA1x) has one or more structures selected from the group consisting of an imide structure, an amide structure, and an oxazole structure in the structural unit of the resin, and has an oxyalkylene structure in the structural unit of the resin.

[0088]

Among the resins (XA1x) having one or more selected from the group consisting of an imide structure and the like in the structural unit of the resin, the resin having a siloxane structure and/or silicone structure in the structural unit of the resin and the resin having an oxyalkylene structure in the structural unit of the resin are particularly suitable from at least one of the viewpoints of adjusting the indentation elastic modulus of the light-absorbing layer at 50°C to be in the range of 1.0×10^3 to 2.0×10^9 Pa and adjusting the glass transition temperature of the light-absorbing layer to be in the range of -50 to 150°C by improving mechanical properties with an imide structure, an amide structure, or an oxazole structure in addition to a flexible skeleton derived from a siloxane structure, a silicone structure, or an oxyalkylene structure. in addition, resin (XA1x) is particularly suitable in at least one of the following: adjusting the

indentation elastic modulus ratio of the light-absorbing layer before and after the above-described specific treatment to a range of 1.0×10^2 to 1.0×10^4 ; and adjusting the difference in glass transition temperature of the light-absorbing layer before and after the above-described specific treatment to a range of 30 to 100 °C.

[0089]

The siloxane structure and the silicone structure of the resin (XA1x) are each preferably a divalent or more structure which is bonded to at least two alkylene groups and in which these alkylene groups are interposed. The divalent or more structure is more preferably trivalent or more, and still more preferably tetravalent or more. On the other hand, the divalent or more structure is preferably hexavalent or less. The number of the silicon atoms of the siloxane structure and/or the silicone structure is preferably 5 or more, more preferably 10 or more, still more preferably 15 or more, and particularly preferably 20 or more. On the other hand, the number of silicon atoms is preferably 50 or less, more preferably 40 or less, still more preferably 30 or less, even more preferably 27 or less, and particularly preferably 25 or less.

[0090]

The siloxane structure in the resin (XA1x) is

preferably a monoalkylsiloxane structure. The number of the carbon atoms of the alkyl group of the monoalkylsiloxane structure is preferably 1 or more, more preferably 2 or more, and still more preferably 3 or more. On the other hand, the number of the carbon atoms in the alkyl group is preferably 10 or less, more preferably 8 or less, and still more preferably 6 or less. The silicone structure in the resin (XA1x) is preferably a dialkylsilicone structure and/or a monoalkylsilicone structure. The number of the carbon atoms of an alkyl group of the dialkylsilicone structure and the monoalkylsilicone structure is preferably 1 or more, more preferably 2 or more, and still more preferably 3 or more. On the other hand, the number of the carbon atoms in the alkyl group is preferably 10 or less, more preferably 8 or less, and still more preferably 6 or less.

[0091]

The oxyalkylene structure in the resin (XA1x) is preferably a divalent or higher structure, more preferably a trivalent or higher structure, and still more preferably a tetravalent or higher structure. On the other hand, the oxyalkylene structure is preferably a hexavalent or less structure. The number of oxyalkylene groups of the oxyalkylene structure in the resin (XA1x) is preferably 2 or more, more preferably 4 or more, still more preferably 8

or more, particularly preferably 10 or more. Meanwhile, the number of oxyalkylene groups is preferably 30 or less, more preferably 25 or less, still more preferably 20 or less, and particularly preferably 15 or less. The number of carbon atoms of the oxyalkylene group of the oxyalkylene structure is preferably 1 or more, more preferably 2 or more, and still more preferably 3 or more. Meanwhile, the number of the carbon atoms of the oxyalkylene group is preferably 6 or less, more preferably 4 or less. The oxyalkylene group is more preferably an oxyethylene group, an oxypropylene group, or an oxybutylene group.

[0092]

The oxyalkylene structure in the resin (XA1x) preferably has two or more different oxyalkylene groups, and more preferably has three or more different oxyalkylene groups. The two or more different oxyalkylene groups may have different numbers of carbon atoms. The oxyalkylene structure more preferably has two or more groups selected from the group consisting of an oxyethylene group, an oxypropylene group, and an oxybutylene group, and still more preferably has an oxyethylene group, an oxypropylene group, and an oxybutylene group.

[0093]

Both the structural unit having an imide structure and the like and the structural unit having a phenolic

hydroxyl group are structural units constituting a resin, and are repeating units having two or more repeating units. The number of repetitions of these units is preferably 2 or more, more preferably 5 or more, and still more preferably 10 or more. On the other hand, the number of repetitions is preferably 1,000 or less.

[0094]

The resin (XA1) preferably includes resin (XA1x). The resin (XA1x) preferably includes one or more resins selected from the group consisting of a polyimide, a polyimide precursor, a polybenzoxazole, a polybenzoxazole precursor, a polyamideimide, a polyamideimide precursor, a polyamide, a polysiloxane, a silicone resin, a maleimide resin, a maleimide-styrene resin, a maleimide-triazine resin, a maleimide-oxazine resin, and copolymers thereof, and more preferably includes one or more resins selected from the group consisting of a polyimide, a polyimide precursor, a polybenzoxazole, a polybenzoxazole precursor, a polyamideimide, a polyamideimide precursor, a polyamide, and copolymers thereof (hereinafter, referred to as polyimide-based resin having a weakly acidic group). The resin (XA1x) may be either a single resin or a copolymer thereof. The polyimide-based resin having a weakly acidic group preferably has an amine residue having a phenolic hydroxyl group, and the amine residue having a phenolic

hydroxyl group more preferably has at least two cyclic structures having a phenolic hydroxyl group. The phenolic hydroxyl group in the amine residue having a phenolic hydroxyl group may react with a structure and/or a group in the resin to form a benzoxazole ring. That is, in the resin having a benzoxazole ring in the structural unit of the resin, the benzoxazole ring may have an amine residue having a phenolic hydroxyl group.

[0095]

Since the resin (XA1x) has a weakly acidic group (WA) and has an imide structure or the like in the structural unit of the resin, it is considered that internal stress is generated due to an increase in hydrogen bond formation and intermolecular interaction in the light-absorbing layer, and excessive adhesive force between the light-absorbing layer and the article is suppressed. As a result, since the transfer can be performed with less energy, it is estimated that the effects of debris suppression and enhanced positional accuracy become remarkable.

[0096]

The resin (XA1) also preferably includes resin (XA1y). The resin (XA1y) preferably includes one or more resins selected from the group consisting of a phenolic resin, polyhydroxystyrene, a phenol group-containing epoxy resin, and a phenol group-containing acrylic resin. The

resin (XA1y) may be either a single resin or a copolymer thereof. The phenol resin is preferably a novolac resin, a resol resin, or a phenol aralkyl resin. The polyhydroxystyrene may have a unit derived from a styrene derivative or a unit derived from a (meth)acrylic acid ester derivative. The phenol group-containing epoxy resin is preferably a phenol group-containing cardo resin or a phenol group-containing epoxy ester resin. The phenol group-containing acrylic resin may have a unit derived from a styrene derivative. Note that the phenol group-containing acrylic resin is a resin different from polyhydroxystyrene.

[0097]

Since the resin (XA1y) has a weakly acidic group (WA), it is considered that internal stress is generated due to an increase in hydrogen bond formation and intermolecular interaction in the light-absorbing layer, and excessive adhesive force between the light-absorbing layer and the article is suppressed. As a result, since the transfer can be performed with less energy, it is estimated that the effects of debris suppression and enhanced positional accuracy become remarkable.

[0098]

From the viewpoint of the effect of the invention, the binder resin (XA) also preferably includes a resin

(XA2) having no weakly acidic group (hereinafter, referred to as resin (XA2)), and preferably has a carboxy group, a carboxylic anhydride group, or a sulfonic acid group. The resin (XA2) may be a resin having no acidic group. The resin (XA2) preferably includes one or more resins selected from the group consisting of an acrylic resin, a polycyclic side chain-containing resin, an acid-modified epoxy resin, a urethane resin, and an epoxy resin. The resin (XA2) may be either a single resin or a copolymer thereof. The acrylic resin may have a unit derived from a styrene derivative. The polycyclic side chain-containing resin is preferably a cardo-based resin. The acid-modified epoxy resin is preferably an epoxy (meth)acrylate resin.

[0099]

Since the resin (XA2) has a carboxy group, a carboxylic anhydride group, or a sulfonic acid group, it is considered that an internal stress is generated due to an increase in hydrogen bond formation or intermolecular interaction in the light-absorbing layer. In addition, it is considered that the structural units of the resins included in the acrylic resin, the polycyclic side chain-containing resin, the acid-modified epoxy resin, the urethane resin, and the epoxy resin can appropriately maintain the force for holding an article, and suppress excessive adhesive force between the light-absorbing layer

and the article. As a result, since the transfer can be performed with less energy, it is estimated that the effects of debris suppression and enhanced positional accuracy become remarkable.

[0100]

From the viewpoint of the effect of the above invention, the resin (XA2) preferably contains an acrylic resin and has a unit derived from a (meth)acrylic acid ester derivative containing an aliphatic group having 4 to 20 carbon atoms. The number of carbon atoms of the aliphatic group in the resin (XA2) is preferably 4 or more, more preferably 6 or more, still more preferably 8 or more, and particularly preferably 10 or more. Meanwhile, the number of the carbon atoms in the aliphatic group is preferably 20 or less, more preferably 15 or less, and still more preferably 12 or less. The aliphatic group is preferably a linear or branched alkyl group, alkenyl group, or alkynyl group. The aliphatic group in the resin (XA2) preferably has two or more different aliphatic groups. The two or more different aliphatic groups may have different numbers of carbon atoms.

[0101]

Among the resins (XA2), an acrylic resin having a unit derived from a (meth)acrylic acid ester derivative containing an aliphatic group having 4 to 20 carbon atoms

is particularly suitable, in at least one respect of adjusting the indentation elastic modulus of the light-absorbing layer at 50°C to be within a range of 1.0×10^3 to 2.0×10^9 Pa and adjusting the glass transition temperature of the light-absorbing layer to be within a range of -50 to 150°C, due to improved flexibility and improved mechanical properties derived from the unit derived from the (meth)acrylic acid ester derivative containing an aliphatic group. In addition, resin (XA2) is particularly suitable in at least one of the following: adjusting the indentation elastic modulus ratio of the light-absorbing layer before and after the above-described specific treatment to a range of 1.0×10^2 to 1.0×10^4 ; and adjusting the difference in glass transition temperature of the light-absorbing layer before and after the above-described specific treatment to a range of 30 to 100 °C.

[0102]

When the light-absorbing layer is a layer formed from a positive photosensitive composition, the resin (XA2) preferably contains an acrylic resin and has a unit derived from a (meth)acrylic acid ester derivative containing an aromatic group having 6 to 15 carbon atoms or a unit derived from a styrene derivative having 6 to 15 carbon atoms from the viewpoint of the effect of the above invention. The number of carbon atoms of the aromatic

group in the resin (XA2) is preferably 6 or more, more preferably 10 or more. Meanwhile, the number of carbon atoms of the aromatic group is preferably 15 or less, and more preferably 14 or less. The aromatic group may have a fused polycyclic structure.

[0103]

From the viewpoint of the effect of the invention, the resin (XA2) preferably contains a resin having one or more structures selected from the group consisting of an imide structure, an amide structure, an oxazole structure, a siloxane structure, and a silicone structure (hereinafter, referred to as imide structure or the like) in the structural unit of the resin.

[0104]

From the viewpoint of the effect of the invention, the resin (XA2) more preferably has one or more structures selected from the group consisting of an imide structure, an amide structure, and an oxazole structure in the structural unit of the resin, and still more preferably has a siloxane structure and/or a silicone structure in the structural unit of the resin. From the viewpoint of the effect of the invention, the resin (XA2) also more preferably has an oxyalkylene structure in the structural unit of the resin. It is still more preferable that the resin (XA2) has one or more structures selected from the

group consisting of an imide structure, an amide structure, and an oxazole structure in the structural unit of the resin, and has an oxyalkylene structure in the structural unit of the resin.

[0105]

Examples and preferred descriptions concerning the siloxane structure, the silicone structure, and the oxyalkylene structure in the resin (XA2) are the same as the examples and preferred descriptions in the resin (XA1x), respectively.

[0106]

Among the resins (XA2) having one or more selected from the group consisting of an imide structure and the like in the structural unit of the resin, the resin having a siloxane structure and/or silicone structure in the structural unit of the resin and the resin having an oxyalkylene structure in the structural unit of the resin are particularly suitable from at least one of the viewpoints of adjusting the indentation elastic modulus of the light-absorbing layer at 50°C to be in the range of 1.0×10^3 to 2.0×10^9 Pa and adjusting the glass transition temperature of the light-absorbing layer to be in the range of -50 to 150°C by improving mechanical properties with an imide structure, an amide structure, or an oxazole structure in addition to a flexible skeleton derived from a

siloxane structure, a silicone structure, or an oxyalkylene structure. In addition, resin (XA2) is particularly suitable in at least one of the following: adjusting the indentation elastic modulus ratio of the light-absorbing layer before and after the above-described specific treatment to a range of 1.0×10^2 to 1.0×10^4 ; and adjusting the difference in glass transition temperature of the light-absorbing layer before and after the above-described specific treatment to a range of 30 to 100 °C.

[0107]

The resin (XA2) preferably includes one or more resins selected from the group consisting of a polyimide, a polyimide precursor, a polybenzoxazole, a polybenzoxazole precursor, a polyamideimide, a polyamideimide precursor, a polyamide, a polysiloxane, a silicone resin, a maleimide resin, a maleimide-styrene resin, a maleimide-triazine resin, a maleimide-oxazine resin, and copolymers thereof, and more preferably includes one or more resins selected from the group consisting of a polyimide, a polyimide precursor, a polybenzoxazole, a polybenzoxazole precursor, a polyamideimide, a polyamideimide precursor, a polyamide, and copolymers thereof (hereinafter, referred to as polyimide-based resin having no weakly acidic group). The resin (XA2) may be either a single resin or a copolymer thereof.

[0108]

Since the resin (XA2) has an imide structure or the like in the structural unit of the resin, it is considered that internal stress is generated due to an increase in hydrogen bond formation and intermolecular interaction in the light-absorbing layer, and excessive adhesive force between the light-absorbing layer and the article is suppressed. As a result, since the transfer can be performed with less energy, it is estimated that the effects of debris suppression and enhanced positional accuracy become remarkable.

[0109]

Examples of the polyimide precursor include a polyamide acid, a polyamide acid ester, a polyamide acid amide, and a polyisoimide. Examples of the polyimide include a resin obtained by dehydrating and cyclizing a polyimide precursor. Examples of the polybenzoxazole precursor include polyhydroxyamides. Examples of the polybenzoxazole include a resin obtained by dehydrating and cyclizing a polybenzoxazole precursor. Examples of the polyamideimide precursor include a resin obtained by reacting a tricarboxylic anhydride or the like with a diamine or the like. Examples of the polyamideimide include a resin obtained by dehydrating and cyclizing a polyamideimide precursor. Examples of the polyamide

include a resin obtained by reacting a dicarboxylic acid chloride or the like with a diamine or the like.

[0110]

When each of the resins (XA1x), (XA1y), and (XA2) has a structure or a group constituting another resin among these resins, these resins are classified into any of the resins by the classification method shown in Table 1-1 below. When a resin can be classified as two or more of resins (XA1x), (XA1y), and (XA2), the classification method determines which resin the resin falls into.

[0111]

[Table 1-1]

	(WA) Weakly acidic group	Structural unit having imide structure or the like	Structural unit including phenolic hydroxyl group	Radical polymerizable group	Classification of resin
Resin 1	Present	Present	Present	Present	Resin (XA1x)
Resin 2	Present	Present	Present	Absent	Resin (XA1x)
Resin 3	Present	Present	Absent	Present	Resin (XA1x)
Resin 4	Present	Present	Absent	Absent	Resin (XA1x)
Resin 5	Present	Absent	Present	Present	Resin (XA1y)
Resin 6	Present	Absent	Present	Absent	Resin (XA1y)
Resin 7	Absent	Present	Absent	Present	Resin (XA2)
Resin 8	Absent	Present	Absent	Absent	Resin (XA2)
Resin 9	Absent	Absent	Absent	Present	Resin (XA2)
Resin 10	Absent	Absent	Absent	Absent	Resin (XA2)

[0112]

<Ultraviolet Absorber (XD_a) and Colorant (XD_b) in light-absorbing layer >

The light-absorbing layer preferably contains an ultraviolet absorber (XD_a) and/or a colorant (XD_b). The

ultraviolet absorber (XDa) in the light-absorbing layer is preferably the ultraviolet absorber (Da) in the composition described later, and also preferably a compound having a structure derived from the ultraviolet absorber (Da) in the composition. The colorant (XDb) in the absorption layer is preferably the colorant (Db) in the composition described later, and also preferably a compound having a structure derived from the colorant (Db) in the composition.

[0113]

The ultraviolet absorber (XDa) refers to a compound that absorbs light having a wavelength in the ultraviolet region (less than 380 nm). The ultraviolet absorber (XDa) preferably has a phenolic hydroxyl group, and more preferably has at least two phenolic hydroxyl groups from the viewpoints of reduction in the energy of laser irradiation, debris suppression, and enhanced positional accuracy. The number of phenolic hydroxyl groups in the ultraviolet absorber (XDa) is preferably 1 or more, more preferably 2 or more, still more preferably 3 or more, and particularly preferably 4 or more. On the other hand, the number of phenolic hydroxyl groups is preferably 8 or less, more preferably 6 or less.

[0114]

The ultraviolet absorber (XDa) preferably contains a compound having one or more selected from the group

consisting of a triazine structure, a benzotriazole structure, a benzophenone structure, an isocyanuric acid structure, and at least two benzene structures from the viewpoints of reduction in the energy of laser irradiation, debris suppression, and enhanced positional accuracy. The ultraviolet absorber (XDa) more preferably contains a compound having at least two triazine structures, at least two benzotriazole structures, at least two benzophenone structures, or at least two isocyanuric acid structures.

[0115]

The number of triazine structures, the number of benzotriazole structures, the number of benzophenone structures, or the number of isocyanuric acid structures included in the ultraviolet absorber (XDa) is preferably two or more, more preferably three or more. On the other hand, the number of triazine structures, the number of benzotriazole structures, the number of benzophenone structures, or the number of isocyanuric acid structures is preferably 4 or less. The number of benzene structures in the ultraviolet absorber (XDa) is preferably two or more, more preferably three or more, still more preferably four or more. On the other hand, the number of benzene structures is preferably 8 or less, and more preferably 6 or less.

[0116]

When the light-absorbing layer contains the ultraviolet absorber (XDa), the ultraviolet absorber (XDa) preferably contains a resin (hereinafter referred to as an ultraviolet absorber (XDa) having a specific structure) having a triazine structure, a benzotriazole structure, a benzophenone structure, or an isocyanuric acid structure in the structural unit of the resin, and more preferably contains a resin having a triazine structure and/or a benzotriazole structure in the structural unit of the resin, from the viewpoints of reduction in the energy of laser irradiation, debris suppression, and enhanced positional accuracy. The ultraviolet absorber (XDa) having a specific structure is a resin different from the above-described binder resin (XA), but the ultraviolet absorber (XDa) having a specific structure corresponds to both the ultraviolet absorber (XDa) and the binder resin (XA). That is, when the light-absorbing layer contains the ultraviolet absorber (XDa) having a specific structure, the light-absorbing layer contains the ultraviolet absorber (XDa) and the binder resin (XA).

[0117]

From the viewpoints of reduction in the energy of laser irradiation, debris suppression, and enhanced positional accuracy, the ultraviolet absorber (XDa) having a specific structure preferably contains one or more resins

selected from the group consisting of polysiloxane, silicone resin, maleimide resin, maleimide-styrene resin, maleimide-triazine resin, maleimide-oxazine resin, phenol resin, polyhydroxystyrene, phenol group-containing epoxy resin, phenol group-containing acrylic resin, acrylic resin, polycyclic side chain-containing resin, acid-modified epoxy resin, urethane resin, epoxy resin, and copolymers thereof, and more preferably contains one or more resins selected from the group consisting of phenol group-containing acrylic resin, acrylic resin, maleimide-styrene resin, polyhydroxystyrene, and copolymers thereof.

[0118]

Among the ultraviolet absorbers (XDa), a compound having one or more structures selected from the group consisting of a triazine structure, a benzotriazole structure, a benzophenone structure, an isocyanuric acid structure, and at least two benzene structures, and an ultraviolet absorber (XDa) having a specific structure are particularly suitable for adjusting the maximum value of absorbance per 1.0 μm of thickness of the light-absorbing layer at wavelengths of 180 to 550 nm within a range of 0.3 to 10.0.

[0119]

The colorant (XDb) refers to a compound that colors by absorbing light having a wavelength of visible light

(380 to 780nm). Coloring means being red, orange, yellow, green, blue, or purple. The colorant (XDb) preferably contains a pigment and/or a dye. The colorant (XDb) preferably contains one or more selected from the group consisting of a blackening agent, a colorant mixture of two or more colors, and a non-black colorant. The blackening agent preferably contains an organic black pigment and/or an inorganic black pigment from the viewpoints of reduction in the energy of laser irradiation and enhanced positional accuracy. The blackening agent preferably contains a black dye from the viewpoint of debris suppression and enhanced positional accuracy. The black color in the colorant (XDb) is as described in paragraphs[0284] to[0285] of International Publication No. 2019/087985.

[0120]

The organic black pigment preferably includes one or more pigments selected from the group consisting of a benzofuranone-based black pigment, a perylene-based black pigment, an azo-based black pigment, an anthraquinone-based black pigment, an aniline-based black pigment, an azo-based black pigment, and carbon black. The carbon black is preferably subjected to resin coating, dye coating, oxidation treatment, surface modification with an organic group having an ionic group, or surface treatment with a sulfonic acid group.

[0121]

The inorganic black pigment preferably contains one or more selected from the group consisting of nitrides, carbides, oxynitrides, fine particles, oxides, composite oxides, sulfides, sulfates, nitrates, and carbonates, and contains one or more metal elements selected from the group consisting of zirconium, vanadium, niobium, hafnium, tantalum, titanium, copper, iron, manganese, cobalt, chromium, nickel, zinc, calcium, and silver. The inorganic black pigment preferably contains graphite or a silver-tin alloy.

[0122]

The black dye preferably contains a black dye containing a metal element or a black dye not containing a metal element, and more preferably contains a black dye not containing a metal element. The black dye preferably includes an azo-based black dye.

[0123]

The colorant mixture of two or more colors preferably includes a coloring pigment mixture of two or more colors and/or a coloring dye mixture of two or more colors, and it is more preferable that the two or more colors include blue and/or purple, and red and orange. The non-black colorant preferably contains a coloring pigment and/or a coloring dye. The coloring pigment preferably includes an

anthraquinone-based pigment, a diketopyrrolopyrrole-based pigment, a perylene-based pigment, an isoindoline-based pigment, an isoindolinone-based pigment, an imidazolone-based pigment, a quinacridone-based pigment, a pyranthrone-based pigment, a phthalocyanine-based pigment, an indantrone-based pigment, or a dioxazine-based pigment. The coloring dye preferably includes a squarylium-based dye, a xanthene-based dye, a triarylmethane-based dye, or a phthalocyanine-based dye.

[0124]

The absorbance of the binder resin (XA), the ultraviolet absorber (XDa), or the colorant (XDb) per 1.0 μm of thickness at a wavelength of 193 nm, a wavelength of 248 nm, a wavelength of 266 nm, a wavelength of 308 nm, a wavelength of 351 nm, a wavelength of 355 nm, or a wavelength of 532 nm is preferably 0.3 or more, more preferably 0.5 or more, and still more preferably 1.0 or more from the viewpoint of reduction in the energy of laser irradiation and enhanced positional accuracy. Furthermore, the maximum value of the absorbance is preferably 1.5 or more, more preferably 2.0 or more, still more preferably 2.5 or more, and particularly preferably 3.0 or more. On the other hand, from the viewpoint of debris suppression and enhanced positional accuracy, the maximum value of absorbance is preferably 10.0 or less, more preferably 8.0

or less, still more preferably 7.0 or less, and particularly preferably 6.0 or less. Furthermore, the maximum value of absorbance is preferably 5.0 or less, more preferably 4.5 or less, and still more preferably 4.0 or less.

[0125]

The absorbance of the binder resin (XA), the ultraviolet absorber (XDa), or the colorant (XDb) per 1.0 μm of thickness at a wavelength of 193 nm, a wavelength of 248 nm, a wavelength of 266 nm, a wavelength of 308 nm, a wavelength of 351 nm, a wavelength of 355 nm, or a wavelength of 532 nm are preferably 0.3 or more, more preferably 0.5 or more, and still more preferably 1.0 or more from the viewpoint of reduction in the energy of laser irradiation and enhanced positional accuracy.

Furthermore, the absorbance is preferably 1.5 or more, more preferably 2.0 or more, still more preferably 2.5 or more, and particularly preferably 3.0 or more. On the other hand, from the viewpoint of debris suppression and enhanced positional accuracy, the absorbance is preferably 10.0 or less, more preferably 8.0 or less, still more preferably 7.0 or less, and particularly preferably 6.0 or less.

Furthermore, the maximum value of absorbance is preferably 5.0 or less, more preferably 4.5 or less, and still more preferably 4.0 or less.

[0126]

The binder resin (XA), the ultraviolet absorber (XDa), or the colorant (XDb) more preferably has an absorbance in the above range at the wavelength of the chemical active rays applied in the step of (22) irradiating the light-absorbing layer with a chemical active ray from a first substrate side of the light-absorbing layer while a gap is present between an article provided on the first substrate and the second pressure-sensitive adhesive layer provided on the second substrate to transfer the article from the light-absorbing layer to the second pressure-sensitive adhesive layer.

[0127]

In step (14b-1), which will be described later, of irradiating the light-absorbing layer with a chemical active ray from the first substrate side of the light-absorbing layer, the absorbance of the transmittance at the wavelength of the chemical active rays with the binder resin (XA), the ultraviolet absorber (XDa), or the colorant (XDb) is more preferably in the above range.

[0128]

<Light-absorbing Layer Formed from Photosensitive Composition or Non-photosensitive Composition>

The light-absorbing layer is preferably a layer formed from a positive photosensitive composition from the

viewpoints of reduction in the energy of laser irradiation, debris suppression, and enhanced positional accuracy. In addition, when the laminate according to the first aspect of the present invention has the configuration of [12] or the configuration of [13], the light-absorbing layer is particularly preferably a layer formed from a positive photosensitive composition. When the laminate according to the second aspect of the present invention has the specific configuration 1 or 2 of the laminate, the light-absorbing layer is particularly preferably a layer formed from a positive photosensitive composition. When the light-absorbing layer is a layer formed from a positive photosensitive composition, the light-absorbing layer preferably contains one or more selected from the group consisting of the naphthoquinone diazide compound (C1), photoacid generator (C3), and the photobase generator (C4) in the composition described later, and also preferably contains a compound having a structure derived from these compounds in the composition.

[0129]

When the light-absorbing layer is a layer formed from a positive photosensitive composition, the laminate according to the first aspect of the present invention more preferably satisfies the relationship of the above formula (S-1), particularly preferably has the configuration of

[12] or [13] and satisfies the relationship of the above formula (S-1) from the viewpoints of reduction in the energy of laser irradiation, debris suppression, and enhanced positional accuracy. When the light-absorbing layer is a layer formed from a positive photosensitive composition, the laminate according to the second aspect of the present invention more preferably satisfies the relationship of the above formula (S-1), and particularly preferably has the specific configuration 1 or 2 of the laminate and satisfies the relationship of the above formula (S-1) from the viewpoint of the same effect of the invention. Examples and preferred descriptions concerning the relationship of the above formula (S-1) are as described above.

[0130]

When the light-absorbing layer is a layer formed from a positive photosensitive composition, the thickness of the light-absorbing layer is more preferably less than 5.0 μm . Examples and preferred descriptions concerning the thickness of the light-absorbing layer are as described above.

[0131]

The light-absorbing layer is preferably a layer formed from a negative photosensitive composition from the viewpoints of reduction in the energy of laser irradiation,

debris suppression, and enhanced positional accuracy. In addition, when the laminate according to the first aspect of the present invention has the configuration of [12] or the configuration of [13], the light-absorbing layer is more preferably a layer formed from a negative photosensitive composition. When the laminate according to the second aspect of the present invention has the specific configuration 1 or 2 of the laminate, the light-absorbing layer is more preferably a layer formed from a negative photosensitive composition. When the light-absorbing layer is a layer formed from a negative photosensitive composition, the light-absorbing layer preferably contains one or more selected from the group consisting of the photopolymerization initiator (C2), the photoacid generator (C3), and the photobase generator (C4) in the composition described later, and also preferably contains a compound having a structure derived from these compounds in the composition.

[0132]

When the light-absorbing layer is a layer formed from a negative photosensitive composition, the laminate according to the first aspect of the present invention more preferably satisfies the relationship of the above formula (S-1), more preferably has the configuration of [12] or [13], and still more preferably satisfies the relationship

of the above formula (S-1) from the viewpoints of reduction in the energy of laser irradiation, debris suppression, and enhanced positional accuracy. When the light-absorbing layer is a layer formed from a negative photosensitive composition, the laminate according to the second aspect of the present invention more preferably satisfies the relationship of the above formula (S-1), and still more preferably has the specific configuration 1 or 2 of the laminate and satisfies the relationship of the above formula (S-1) from the viewpoint of the same effect of the invention. Examples and preferred descriptions concerning the relationship of the above formula (S-1) are as described above.

[0133]

When the light-absorbing layer is a layer formed from a negative photosensitive composition, the thickness of the light-absorbing layer is more preferably less than 5.0 μm . Examples and preferred descriptions concerning the thickness of the light-absorbing layer are as described above.

[0134]

The light-absorbing layer is preferably a layer formed from a non-photosensitive composition from the viewpoint of enhanced positional accuracy. In addition, when the laminate according to the first aspect of the

present invention has the configuration of [12] or the configuration of [13], the light-absorbing layer is more preferably a layer formed from a non-photosensitive composition. When the laminate according to the second aspect of the present invention has the specific configuration 1 or 2 of the laminate, the light-absorbing layer is more preferably a layer formed from a non-photosensitive composition. When the light-absorbing layer is a layer formed from a non-photosensitive composition, the light-absorbing layer preferably contains the crosslinking agent (F) and/or the radical polymerizable compound (B) in the composition described later, and also preferably contains a compound having a structure derived from these compounds in the composition.

[0135]

When the light-absorbing layer is a layer formed from a non-photosensitive composition, the laminate according to the first aspect of the present invention more preferably satisfies the relationship of the formula (S-1) from the viewpoint of enhanced positional accuracy, and still more preferably has the configuration of [12] or [13] and satisfies the relationship of the formula (S-1). When the light-absorbing layer is a layer formed from a non-photosensitive composition, the laminate according to the second aspect of the present invention more preferably

satisfies the relationship of the formula (S-1) from the viewpoint of enhanced positional accuracy, and it is still more preferable that the laminate has the specific configuration 1 or 2 of the laminate and satisfies the relationship of the formula (S-1). Examples and preferred descriptions concerning the relationship of the above formula (S-1) are as described above.

[0136]

When the light-absorbing layer is a layer formed from a non-photosensitive composition, the thickness of the light-absorbing layer is more preferably less than 5.0 μm . Examples and preferred descriptions concerning the thickness of the light-absorbing layer are as described above.

[0137]

From the viewpoint of enhanced positional accuracy, the laminate according to the first aspect of the present invention preferably satisfies the relationship of the formula (S-2), more preferably has the configuration of [12] or [13], and satisfies the relationship of the formula (S-2). From the viewpoint of enhanced positional accuracy, the laminate according to the second aspect of the present invention preferably satisfies the relationship of the formula (S-2), and more preferably has the specific configuration 1 or 2 of the laminate and satisfies the

relationship of the formula (S-2). Examples and preferred descriptions concerning the relationship of the above formula (S-2) are as described above.

[0138]

The light-absorbing layer preferably satisfies any one of the following conditions (α) to (γ) from the viewpoints of reduction in the energy of laser irradiation, debris suppression, and enhanced positional accuracy:

(α) the light-absorbing layer is a layer formed from a positive photosensitive composition, and the positive photosensitive composition satisfies at least one of conditions (1), (3), and (4);

(β) the light-absorbing layer is a layer formed from a negative photosensitive composition, and the negative photosensitive composition satisfies at least one of conditions (2) to (4); and

(γ) the light-absorbing layer is a layer formed from a non-photosensitive composition, and the non-photosensitive composition satisfies condition (5) and/or condition (6):

(1) containing a naphthoquinonediazide compound (C1) and a crosslinking agent (F);

(2) containing a photopolymerization initiator (C2) and a radical polymerizable compound (B);

(3) containing a photoacid generator (C3) and a

crosslinking agent (F);

(4) containing a photobase generator (C4) and a crosslinking agent (F);

(5) containing a crosslinking agent (F); and

(6) containing a radical polymerizable compound (B).

[0139]

When the light-absorbing layer satisfies the condition (α), the positive photosensitive composition preferably further satisfies at least one of the conditions (2) and (6). When the light-absorbing layer satisfies the condition (β), the negative photosensitive composition preferably further satisfies at least one of the conditions (1), (5) and (6).

[0140]

<First pressure-sensitive adhesive layer>

The laminate according to the second aspect of the present invention includes a first pressure-sensitive adhesive layer. In the laminate according to the second aspect of the present invention, the first pressure-sensitive adhesive layer has a recess. In the laminate according to the second aspect of the present invention, the first pressure-sensitive adhesive layer has an indentation elastic modulus of 1.0×10^3 to 2.0×10^9 Pa at 50°C, and/or a glass transition temperature of -50 to 150°C. The above-described light-absorbing layer and first

pressure-sensitive adhesive layer preferably satisfy any one of the following conditions (py) and (qy):

(py) the light-absorbing layer and the first pressure-sensitive adhesive layer have a recess, the recess is an opening of the first pressure-sensitive adhesive layer, and the recess is formed by removing at least a part of the light-absorbing layer to reduce the thickness; and

(qy) the light-absorbing layer and the first pressure-sensitive adhesive layer have a recess, and the recess is an opening.

[0141]

Examples and preferred descriptions regarding the indentation elastic modulus of the first pressure-sensitive adhesive layer at 50°C and the glass transition temperature of the first pressure-sensitive adhesive layer are the same as the examples and preferred descriptions regarding the indentation elastic modulus of the light-absorbing layer at 50°C and the glass transition temperature of the light-absorbing layer, respectively.

[0142]

In the laminate according to the second aspect of the present invention, examples and preferred descriptions regarding the difference between the indentation elastic modulus at 50°C of the first pressure-sensitive adhesive layer after any one of the treatments (x1), (x2), and (x3)

and the indentation elastic modulus at 50°C of the first pressure-sensitive adhesive layer before the treatment, and the difference between the glass transition temperature of the first pressure-sensitive adhesive layer after any one of the treatments (x1), (x2), and (x3) and the glass transition temperature of the first pressure-sensitive adhesive layer before the treatment are the same as the examples and preferred descriptions regarding the indentation elastic modulus ratio of the light-absorbing layer before and after the specific treatment and the glass transition temperature of the light-absorbing layer before and after the specific treatment, respectively.

[0143]

The thickness of the first pressure-sensitive adhesive layer is preferably less than 5.0 μm , more preferably 4.0 μm or less, still more preferably 3.0 μm or less, still more preferably 2.0 μm or less, and particularly preferably 1.0 μm or less from the viewpoint of reduction in the energy of laser irradiation and debris suppression. On the other hand, the thickness of the first pressure-sensitive adhesive layer is preferably 0.10 μm or more, more preferably 0.30 μm or more, and still more preferably 0.50 μm or more from the viewpoint of enhanced positional accuracy.

[0144]

The thickness of the first pressure-sensitive adhesive layer in the recess is preferably 2.0 μm or less, more preferably 1.0 μm or less, still more preferably 0.50 μm or less, still more preferably 0.30 μm or less, and particularly preferably 0.10 μm or less. It is also preferable that there is no first pressure-sensitive adhesive layer at a position corresponding to the recess.

[0145]

Examples and preferred descriptions concerning other physical property values and other configurations of the first pressure-sensitive adhesive layer are the same as the examples and preferred descriptions in the light-absorbing layer, respectively. Examples and preferred descriptions concerning the binder resin (XA), the ultraviolet absorber (XDa), and the colorant (XDb) in the first pressure-sensitive adhesive layer are the same as the examples and preferred descriptions in the light-absorbing layer, respectively. The first pressure-sensitive adhesive layer is preferably a layer formed from a positive photosensitive composition, a layer formed from a negative photosensitive composition, or a layer formed from a non-photosensitive composition. The first pressure-sensitive adhesive layer may be a layer formed from the same composition as that of the light-absorbing layer.

[0146]

The first pressure-sensitive adhesive layer is also preferably a layer containing a resin having a polydialkylsilicone structure in a structural unit of the resin, more preferably a layer containing a resin in which a unit having a polydialkylsilicone structure is a main component, and still more preferably a layer containing these resins as a main component. The unit of the main component in the resin refers to a unit contained most in the structural unit of the resin on a molar ratio basis. The main component in the first pressure-sensitive adhesive layer refers to a component that is contained most on a mass basis in the constituent components of the first pressure-sensitive adhesive layer. The polydialkylsilicone structure is more preferably a polydimethylsilicone structure. These resins may further have a polymonoalkyl monoaryl silicone structure in the structural unit of the resin.

[0147]

<Article>

The laminate according to the first aspect of the present invention includes an article. The laminate according to the first aspect of the present invention includes a plurality of articles in contact with the light-absorbing layer. A laminate according to a second aspect of the present invention includes an article. The laminate

according to the second aspect of the present invention includes a plurality of articles in contact with the first pressure-sensitive adhesive layer.

[0148]

The article in the laminate of the present invention is preferably provided in an electronic component, an electronic device, a moving body, a building, or a window after being transferred to another laminate. Examples of the electronic component include a semiconductor device, an antenna, a display device, an optical device, a printed wiring board, a semiconductor package, an active component including a semiconductor device, and a passive component. The laminate of the present invention is preferably used for producing the electronic component, the electronic device, the moving body, the building, or the window.

[0149]

Examples of the semiconductor device include a semiconductor device having a fan-out wafer level package structure, a fan-out panel level package structure, or an antenna-in-package structure. Examples of the antenna include a microstrip line antenna and a strip line antenna. Examples of the display device include an organic EL display, a quantum dot display, a micro LED display, a mini LED display, and a liquid crystal display. Examples of the metal-clad laminate include a printed wiring board. The

electronic component preferably also has a hollow structure. The hollow structure includes a hollow structure support member and a hollow structure roof member. Examples of the electronic component having a hollow structure include micro electro mechanical systems (MEMS). The package structures in the semiconductor device may be either of structures including a single die or a multi-die, and a structure including a multi-die is preferable from the viewpoint of improving the integration density and suppressing transmission loss between wirings. The structure including the multi-die preferably has a chiplet structure, more preferably includes one or more types of dies selected from the group consisting of a logic, a memory, an analog IC (analog integrated circuit), an RF circuit (radio frequency circuit), and a power semiconductor, and still more preferably includes two or more dies.

[0150]

The laminate of the present invention is preferably used for producing a semiconductor device, an antenna, a display device, an optical device, a printed wiring board, a semiconductor package, an active component including a semiconductor device, or a passive component having the above configuration.

[0151]

<Article; semiconductor chip>

The article is preferably a semiconductor chip. The semiconductor layer preferably contains silicon, silicon carbide, gallium nitride, indium gallium nitride, aluminum gallium nitride, digallium trioxide, gallium arsenide, aluminum gallium arsenide, gallium arsenide phosphide, indium phosphide, gallium phosphide, zinc selenide, aluminum indium gallium phosphide, indium tin oxide, indium zinc oxide, indium gallium zinc oxide, diamond, aluminum zinc oxide, or zinc oxide as a main component. The main component in the semiconductor layer refers to a component that is contained most on a mass basis in the constituent components of the semiconductor layer.

[0152]

The semiconductor chip preferably has a flip-chip type structure having a plurality of electrode terminals on one surface. In a case where the article has a plurality of electrode terminals on one surface, when a surface on the light-absorbing layer side of the article is defined as a surface 1b and a surface facing the surface 1b of the article is defined as a surface 2b, the article preferably has a plurality of electrode terminals on the surface 1b. When the recess of the light-absorbing layer or the opening of the light-absorbing layer in the laminate according to the first aspect of the present invention is formed by

alkali development or etching, the above configuration is preferable from the viewpoint of suppressing corrosion of the electrode terminal and improving reliability. In addition, the above configuration is suitable from the viewpoint of suppressing corrosion of the electrode terminal and improving reliability when the recess of the light-absorbing layer or the opening of the light-absorbing layer and the recess of the first pressure-sensitive adhesive layer or the opening of the first pressure-sensitive adhesive layer in the laminate according to the second aspect of the present invention are formed by alkali development or etching.

[0153]

In addition, the semiconductor chip preferably has a vertical type having a plurality of electrode terminals on one surface and a surface different from the surface. The vertical structure is more preferably a structure having a plurality of electrode terminals on one surface and a surface facing the surface. The above configuration is suitable from the viewpoint of high integration of a semiconductor device and improvement in resolution of a display device in producing an electronic component or the like using the laminate of the present invention.

[0154]

The electrode terminal is preferably a conductive

layer. The conductive layer refers to a layer having a volume resistivity of 1.0×10^{-8} to $1.0 \times 10^{-4} \Omega \cdot \text{cm}$. The electrode terminal preferably contains Ag, Cu, Au, In, Sb, Sn, Pb, Ti, Al, Ni, Mo, or Cr as a main component element. The main component element in the electrode terminal refers to an element that is included most on a mass basis in the constituent elements of the electrode terminal. The length of one side of the electrode terminal is preferably $0.20 \mu\text{m}$ or more and $100 \mu\text{m}$ or less. The height of the electrode terminal is preferably $0.10 \mu\text{m}$ or more and $50 \mu\text{m}$ or less.

[0155]

The article is preferably a semiconductor chip, and the semiconductor chip is preferably a light-emitting element. The semiconductor chip as a light-emitting element is preferably included in the display device. The display device having the above configuration is preferably a micro LED display or a mini LED display. The display device preferably includes a semiconductor chip as a light-emitting element, a wiring layer, a rewiring layer, and an interlayer insulating layer of the rewiring layer, and the semiconductor chip and the wiring layer and/or the semiconductor chip and the rewiring layer are preferably electrically connected. The display device preferably further includes a barrier layer and/or a planarization layer. The semiconductor chip as a light-emitting element

is preferably a PN junction diode in which a P-type semiconductor and an N-type semiconductor are joined.

[0156]

The length of one side of the semiconductor chip as a light-emitting element is preferably 0.50 μm or more, more preferably 5.0 μm or more, and still more preferably 10 μm or more. On the other hand, the length of one side is preferably 200 μm or less, more preferably 100 μm or less, and still more preferably 50 μm or less. The thickness of one side of the semiconductor chip as a light-emitting element is preferably 0.50 μm or more, more preferably 1.0 μm or more, and still more preferably 5.0 μm or more. On the other hand, the thickness of one side is preferably 100 μm or less, more preferably 50 μm or less, and still more preferably 20 μm or less. The laminate of the present invention is preferably used for producing a display device having the above configuration.

[0157]

Preferably, the article is a semiconductor chip, and the semiconductor chip is a light-emitting element, a light-receiving element, an optical coupling element, an optical filter element, an optical modulation element, or an optical amplification element (hereinafter, referred to as an optical communication element or the like). The semiconductor chip as an optical communication element or

the like is preferably included in the optical device. The optical device having the above configuration preferably includes a semiconductor chip such as an optical communication element or the like, a logic semiconductor chip, a package substrate, and a printed wiring board.

[0158]

In the optical device, a semiconductor chip such as an optical communication element or the like sealed on a package substrate and a logic semiconductor chip sealed on the package substrate are preferably electrically connected on a printed wiring board. Further, in the optical device, it is more preferable that a semiconductor chip such as an optical communication element or the like and a logic semiconductor chip are sealed on a package substrate, and the semiconductor chip such as an optical communication element or the like and the logic semiconductor chip are electrically connected via the package substrate. Further, it is more preferable that the optical device further includes an interposer, a semiconductor chip as an optical communication element or the like and a logic semiconductor chip are electrically connected via the interposer, and the semiconductor chip as the optical communication element or the like and the logic semiconductor chip are sealed on a package substrate. In addition, in the optical device, it is particularly preferable that a semiconductor chip such

as an optical communication element or the like and a logic semiconductor chip are laminated on and electrically connected to each other, and the semiconductor chip such as an optical communication element or the like and the logic semiconductor chip are sealed on a package substrate. When a semiconductor chip as an optical communication element or the like and a logic semiconductor chip are stacked on top of each other and electrically connected to each other, it is preferable that the electrodes are electrically connected to each other by bump bonding, and it is more preferable that the electrodes are electrically directly connected to each other without using bumps. It is also preferable that, in the optical device, a semiconductor chip such as an optical communication element and a logic semiconductor chip are formed on the same substrate and are electrically connected.

[0159]

The length of one side of the semiconductor chip such as an optical communication element is preferably 10 μm or more, more preferably 30 μm or more, and still more preferably 50 μm or more. On the other hand, the length of one side is preferably 2000 μm or less, more preferably 1500 μm or less, and still more preferably 1000 μm or less. The ratio of the length of the long side to the length of the short side of the semiconductor chip such as an optical

communication element is preferably 2.0 or more, more preferably 3.0 or more, still more preferably 5.0 or more, even more preferably 7.0 or more, and particularly preferably 10 or more. On the other hand, the ratio of the length of the long side to the length of the short side is preferably 200 or less, more preferably 150 or less, and still more preferably 100 or less. On the other hand, the ratio of the length of the long side to the length of the short side is preferably 70 or less, more preferably 50 or less, still more preferably 40 or less, even more preferably 30 or less, and particularly preferably 20 or less. The thickness of one side of a semiconductor chip such as an optical communication element is preferably 0.10 μm or more, more preferably 0.50 μm or more, and even more preferably 1.0 μm or more. On the other hand, the thickness of one side is preferably 20 μm or less, more preferably 10 μm or less, and still more preferably 5.0 μm or less. The laminate of the present invention is preferably used for producing an optical device having the above configuration.

[0160]

<Laminate 0A; Donor substrate and article>

A laminate including the donor substrate and the article in this order may be referred to as a laminate 0A. The article in the laminate according to the first aspect

of the present invention is preferably transferred from the laminate 0A to the light-absorbing layer of the laminate alx. The article in the laminate according to the second aspect of the present invention is preferably transferred from the laminate 0A to the first pressure-sensitive adhesive layer of the laminate aly.

[0161]

From the viewpoint of conductivity control and insulation control, the donor substrate is preferably a substrate having a semiconductive layer, and more preferably a substrate having a semiconductor layer. The semiconductive layer refers to a layer having a volume resistivity of 1.0×10^{-4} to $1.0 \times 10^8 \Omega \cdot \text{cm}$. The semiconductor layer preferably contains, as an element whose main component is a semiconductor, Ga, As, Al, In, Zn, Se, Si, Sn, nitrogen, phosphorus, carbon, or oxygen. The main component element in the semiconductor layer refers to an element that is included most on a mass basis in the constituent elements of the semiconductor layer. In addition, the semiconductor layer preferably contains silicon, silicon carbide, gallium nitride, indium gallium nitride, aluminum gallium nitride, digallium trioxide, gallium arsenide, aluminum gallium arsenide, gallium arsenide phosphide, indium phosphide, gallium phosphide, zinc selenide, aluminum indium gallium phosphide, indium

tin oxide, indium zinc oxide, indium gallium zinc oxide, diamond, aluminum zinc oxide, or zinc oxide as a main component. The main component in the semiconductor layer refers to a component that is contained most on a mass basis in the constituent components of the semiconductor layer. The donor substrate is a substrate formed from a plurality of layers including a semiconductor layer, and the semiconductor layer is preferably a main component layer. The layer of the main component in the donor substrate refers to a layer that occupies the largest mass among the plurality of layers constituting the donor substrate. The donor substrate is also preferably a semiconductor layer. The donor substrate is a substrate formed from a plurality of layers including an insulating layer and a semiconductor layer, and the insulating layer is preferably an alkali glass substrate, an alkali-free glass substrate, a borosilicate glass substrate, a quartz glass substrate, a crystal substrate, or a sapphire substrate.

[0162]

The donor substrate preferably has a photolytic layer. That is, at least one of the plurality of layers constituting the donor substrate is preferably a photolytic layer. The laminate 0A is preferably a laminate including a donor substrate, a photolytic layer, and an article in

this order.

[0163]

<Laminate 0B and laminate a0; base substrate, base pressure-sensitive adhesive layer, and article>

A laminate including the base substrate, the base pressure-sensitive adhesive layer to be described later, and the article in this order may also be referred to as laminate 0B. In addition, a laminate including the base substrate and the base pressure-sensitive adhesive layer to be described later in this order may also be referred to as laminate a0. The article in the laminate according to the first aspect of the present invention is preferably transferred from the laminate 0A to the base pressure-sensitive adhesive layer of the laminate a0, and subsequently transferred from the laminate 0B to the light-absorbing layer of the laminate a1x. The article in the laminate according to the second aspect of the present invention is preferably transferred from the laminate 0A to the base pressure-sensitive adhesive layer of the laminate a0, and subsequently transferred from the laminate 0B to the first pressure-sensitive adhesive layer of the laminate a1y.

[0164]

The base substrate is preferably an inorganic substrate from the viewpoint of improving impact

resistance. The base substrate is preferably an organic substrate from the viewpoint of improving flexibility and handleability. Note that the inorganic substrate is preferably a substrate having a semiconductor layer.

[0165]

The base substrate is preferably a light-transmissive substrate from the viewpoints of reduction in the energy of laser irradiation and enhanced positional accuracy. The light-transmissive substrate is preferably an inorganic substrate from the viewpoint of improving impact resistance. The light-transmissive substrate is preferably an organic substrate from the viewpoint of improving flexibility and handleability.

[0166]

Examples and preferred descriptions concerning the light-transmissive substrate, the inorganic substrate, the organic substrate, the substrate having a semiconductive layer, and the substrate having a semiconductor layer are the same as the examples and preferred descriptions in the first substrate and the donor substrate, respectively.

[0167]

The base pressure-sensitive adhesive layer is also preferably a layer containing a resin having a polydialkylsilicone structure in the structural unit of the resin. Examples and preferred descriptions concerning the

polydialkylsilicone structure are the same as the examples and preferred descriptions in the first pressure-sensitive adhesive layer, respectively. As the base pressure-sensitive adhesive layer, a known material such as a known adhesive layer may be used. The base pressure-sensitive adhesive layer may be a layer formed from a known composition. Note that the base pressure-sensitive adhesive layer may be a layer formed from the same composition as that of the first pressure-sensitive adhesive layer.

[0168]

<Laminate 2 and laminate a2; second substrate, second pressure-sensitive adhesive layer, and article>

A laminate including the second substrate, the second pressure-sensitive adhesive layer to be described later, and the article in this order may also be referred to as laminate 2. In addition, a laminate including the second substrate and the second pressure-sensitive adhesive layer to be described later in this order may also be referred to as laminate a2. The article in the laminate according to the first aspect of the present invention is preferably transferred from the laminate 1X to the second pressure-sensitive adhesive layer of the laminate a2. The article in the laminate according to the second aspect of the present invention is preferably transferred from the

laminate 1Y to the second pressure-sensitive adhesive layer of the laminate a2.

[0169]

The second substrate is preferably an inorganic substrate from the viewpoint of improving impact resistance. The second substrate is preferably an organic substrate from the viewpoint of improving flexibility and handleability. Note that the inorganic substrate is preferably a substrate having a semiconductor layer.

[0170]

The second substrate is preferably a light-transmissive substrate from the viewpoints of reduction in the energy of laser irradiation and enhanced positional accuracy. The light-transmissive substrate is preferably an inorganic substrate from the viewpoint of improving impact resistance. The light-transmissive substrate is preferably an organic substrate from the viewpoint of improving flexibility and handleability.

[0171]

In a case where the article in the laminate of the first aspect of the present invention, after being transferred from the laminate 1X to the second pressure-sensitive adhesive layer of the laminate a2, is in a state in which an electrode terminal or the like included in the article and wiring included in the laminate 2 are

electrically connected, the second substrate is preferably a substrate having a semiconductive layer, and more preferably a substrate having a semiconductor layer, from the viewpoint of conductivity control and insulation control. In a case where the article in the laminate of the second aspect of the present invention, after being transferred from the laminate 1Y to the second pressure-sensitive adhesive layer of the laminate a2, is in a state in which an electrode terminal or the like included in the article and wiring included in the laminate 2 are electrically connected, the second substrate is preferably a substrate having a semiconductive layer, and more preferably a substrate having a semiconductor layer, from the viewpoint of conductivity control and insulation control. In the laminate 2, when the electrode terminal or the like included in the article transferred from the laminate of the present invention is electrically connected to the wiring included in the laminate 2, the laminate 2 preferably has an insulating layer. The insulating layer refers to a layer having a volume resistivity of 1.0×10^8 to $1.0 \times 10^{18} \Omega \cdot \text{cm}$.

[0172]

Examples and preferred descriptions concerning the light-transmissive substrate, the inorganic substrate, the organic substrate, the substrate having a semiconductive

layer, and the substrate having a semiconductor layer are the same as the examples and preferred descriptions in the first substrate and the donor substrate, respectively.

[0173]

The second pressure-sensitive adhesive layer is also preferably a layer containing a resin having a polydialkylsilicone structure in the structural unit of the resin. Examples and preferred descriptions concerning the polydialkylsilicone structure are the same as the examples and preferred descriptions in the first pressure-sensitive adhesive layer, respectively. As the second pressure-sensitive adhesive layer, a known material such as a known adhesive layer may be used. The second pressure-sensitive adhesive layer may be a layer formed from a known composition. Note that the second pressure-sensitive adhesive layer may be a layer formed from the same composition as that of the first pressure-sensitive adhesive layer.

[0174]

When the article transferred from the laminate of the present invention is a semiconductor chip and the semiconductor chip is the above-described optical communication element or the like, the maximum transmittance of the second pressure-sensitive adhesive layer at wavelengths of 1300 to 1600 nm is preferably 60%

or more, more preferably 70% or more, still more preferably 80% or more, particularly preferably 90% or more.

[0175]

<Laminate 3J, laminate 3, and laminate a3; element substrate, third pressure-sensitive adhesive layer, and article>

A laminate including the element substrate, the third pressure-sensitive adhesive layer to be described later, and the article in this order may also be referred to as laminate 3. In addition, a laminate including the element substrate and the third pressure-sensitive adhesive layer to be described later in this order may also be referred to as laminate a3. A laminate including the element substrate and the article in this order may be referred to as a laminate 3J. The article in the laminate according to the present invention is preferably one that has been transferred from the laminate 2 to the third pressure-sensitive adhesive layer of the laminate a3. The laminate 2 is a laminate in which an article is transferred onto a second substrate and a second pressure-sensitive adhesive layer according to the present invention. The article in the laminate of the present invention is preferably transferred from the laminate 2 to the element substrate. The element substrate preferably has wiring provided on the element substrate.

[0176]

When the article in the laminate of the present invention, after being transferred from the laminate 2 to the third pressure-sensitive adhesive layer of the laminate a3, is in a state in which an electrode terminal or the like included in the article and wiring included in the laminate 3 are electrically connected, the element substrate is preferably a substrate having a semiconductive layer, and more preferably a substrate having a semiconductor layer, from the viewpoint of conductivity control and insulation control. In the laminate 3, when the electrode terminal or the like included in the article transferred from the laminate of the present invention is electrically connected to the wiring included in the laminate 3, the laminate 3 preferably has an insulating layer. The insulating layer refers to a layer having a volume resistivity of 1.0×10^8 to $1.0 \times 10^{18} \Omega \cdot \text{cm}$.

[0177]

In a case where the article in the laminate of the present invention, after being transferred from the laminate 2 to the element substrate, is in a state in which an electrode terminal or the like included in the article and wiring included in the element substrate are electrically connected, the element substrate is preferably a substrate having a semiconductive layer, and more

preferably a substrate having a semiconductor layer, from the viewpoint of conductivity control and insulation control. In the element substrate, when the electrode terminal or the like included in the article transferred from the laminate of the present invention is electrically connected to the wiring included in the element substrate, the element substrate preferably has an insulating layer. The insulating layer refers to a layer having a volume resistivity of 1.0×10^8 to $1.0 \times 10^{18} \Omega \cdot \text{cm}$.

[0178]

It is also preferable that the element substrate is used as a support substrate, and some or all of the layers of the element substrate are peeled off. It is suitable for use in a chip-first (RDL-last) production process in which an article such as a semiconductor chip is arranged using an element substrate as a support substrate, and then metal wiring, an interlayer insulating layer, or the like is formed, or a chip-last (RDL-first) production process in which an article such as a semiconductor chip is arranged after a metal wiring, an interlayer insulating layer, or the like is formed using an element substrate as a support substrate.

[0179]

When the element substrate is used as a support substrate, the element substrate preferably has a layer of

an inorganic substrate from the viewpoint of improving impact resistance. The element substrate preferably has a layer of an organic substrate from the viewpoint of improving flexibility and handleability. The electrical connection between the electrode terminal or the like included in the article and the wiring included in the element substrate is preferably solder bonding, bonding with an anisotropic conductive film, or direct bonding. The direct bonding is preferably bonding by surface activation by plasma treatment such as hybrid bonding. Examples and preferred descriptions concerning the light-transmissive substrate, the inorganic substrate, the organic substrate, the substrate having a semiconductive layer, and the substrate having a semiconductor layer are the same as the examples and preferred descriptions in the first substrate and the donor substrate, respectively.

[0180]

The third pressure-sensitive adhesive layer is also preferably a layer containing a resin having a polydialkylsilicone structure in the structural unit of the resin. Examples and preferred descriptions concerning the polydialkylsilicone structure are the same as the examples and preferred descriptions in the first pressure-sensitive adhesive layer, respectively. As the third pressure-sensitive adhesive layer, a known material such as a known

adhesive layer may be used. The third pressure-sensitive adhesive layer may be a layer formed from a known composition. Note that the third pressure-sensitive adhesive layer may be a layer formed from the same composition as that of the first pressure-sensitive adhesive layer.

[0181]

When the article transferred from the laminate of the present invention is a semiconductor chip and the semiconductor chip is the above-described optical communication element or the like, the maximum transmittance of the third pressure-sensitive adhesive layer at wavelengths of 1300 to 1600 nm is preferably 60% or more, more preferably 70% or more, still more preferably 80% or more, particularly preferably 90% or more.

[0182]

<Laminate 1x, A1x, 1y, And A1y; Photosensitive Composition and Non-photosensitive Composition>

Hereinafter, a composition for forming the light-absorbing layer in the laminate according to the first aspect of the present invention and the light-absorbing layer or the first pressure-sensitive adhesive layer in the laminate according to the second aspect of the present invention will be described. The composition is a photosensitive composition or a non-photosensitive

composition. However, the photosensitive composition or the non-photosensitive composition is not limited to the following embodiments, and obviously, various modifications can be made without departing from the scope of the invention as long as the object of the invention can be achieved. Note that the photosensitive composition is a positive photosensitive composition or a negative photosensitive composition.

[0183]

<Binder Resin (A)>

The composition preferably contains a binder resin (A). The binder resin (A) is a resin having heat resistance in which at least a part remains in a cured product obtained by curing the composition. The binder resin (A) is preferably a resin in which a cross-linked structure is formed and cured by a reaction. The reaction is not particularly limited, and is caused, for example, by heating, irradiation with an energy ray, or the like, and the crosslinked structure may be formed by an (F) crosslinking agent described later. The binder resin (A) is preferably a thermosetting resin. The binder resin (A) is preferably an alkali-soluble resin having an acidic group or an organic solvent-soluble resin having an organic solvent-soluble structure. The binder resin (A) is preferably a resin having solubility, the resin being

capable of imparting positive-type or negative-type photosensitivity to the composition by the later-described photosensitive agent (C) and forming a positive-type or negative-type pattern. (A) Examples and preferred descriptions concerning the binder resin are the same as the examples and preferred descriptions concerning the binder resin (XA) in the light-absorbing layer, respectively.

[0184]

<Radical Polymerizable Compound (B)>

The composition preferably further contains (B) a radical polymerizable compound (hereinafter, referred to as a compound (B)) and/or (F) a crosslinking agent. The compound (B) refers to a compound having a radical polymerizable group. Examples and preferred descriptions concerning the radical polymerizable group are the same as the examples and preferred descriptions concerning the binder resin (XA) in the light-absorbing layer, respectively. The radical polymerizable group is preferably a (meth)acryloyl group from the viewpoint of debris suppression and enhanced positional accuracy. The number of radical polymerizable groups in the compound (B) is preferably 2 or more, more preferably 3 or more, still more preferably 4 or more from the viewpoint of debris suppression and enhanced positional accuracy. On the other

hand, the number of radical polymerizable groups is preferably 12 or less, more preferably 10 or less, still more preferably 8 or less, and particularly preferably 6 or less from the viewpoint of debris suppression and enhanced positional accuracy.

[0185]

<Photosensitive Agent (C)>

The photosensitive composition includes a photosensitive agent (C). The photosensitive agent (C) refers to a compound that gives positive-type or negative-type photosensitivity to a composition by bond cleavage, reaction, or structural change by exposure to generate another compound. The photosensitive agent (C) preferably contains one or more selected from the group consisting of a naphthoquinone diazide compound (C1) (hereinafter, referred to as compound (C1)), a photopolymerization initiator (C2) (hereinafter, referred to as compound (C2)), a photoacid generator (C3), and a photobase generator (C4). Imparting positive photosensitivity to the composition is suitable for forming the recess of the light-absorbing layer or the opening of the light-absorbing layer in the laminate according to the first aspect of the present invention by alkali development. Further, imparting positive photosensitivity to the composition is suitable for forming the recess of the light-absorbing layer or the

opening of the light-absorbing layer and the recess of the first pressure-sensitive adhesive layer or the opening of the first pressure-sensitive adhesive layer in the laminate according to the second aspect of the present invention by alkali development.

[0186]

The compound (C1) refers to a compound whose structure is changed by exposure to generate indene carboxylic acid and/or sulfoindene carboxylic acid. Containing the compound (C1) is suitable for forming a positive-type pattern. During exposure, the exposed part of the film of the composition is selectively solubilized with an alkaline developer by the acidic compound in which the compound (C1) has a structural change, and thus effect of debris suppression and enhanced positional accuracy become remarkable. The compound (C1) preferably includes a compound having a 1,2-naphthoquinonediazide-5-sulfonic acid ester structure (hereinafter, referred to as 5-ester structure) and/or a compound having a 1,2-naphthoquinonediazide-4-sulfonic acid ester structure (hereinafter, referred to as 4-ester structure), and more preferably includes a compound having a 5-ester structure and a compound having a 4-ester structure, from the viewpoint of debris suppression and enhanced positional accuracy. The compound (C1) preferably has a 5-ester

structure of a phenolic hydroxyl group or a 4-ester
structure of a phenolic hydroxyl group.

[0187]

The compound (C2) refers to a compound that undergoes bond cleavage and/or reaction upon exposure to light to generate a radical. Containing the compound (C2) is suitable for forming a negative-type pattern. During exposure, even when an amount of radicals generated from the compound (C2) is small, radical polymerization of the above compound (B) and the like proceeds in a chain manner, so that the effect of debris suppression and enhanced positional accuracy. The compound (C2) is preferably a benzyl ketal-based compound, an α -hydroxyketone-based compound, an α -aminoketone-based compound, a biimidazole-based compound, a phosphine oxide-based compound, an oxime ester-based compound, an acridine-based compound, a titanocene-based compound, a benzophenone-based compound, an acetophenone-based compound, an aromatic ketoester-based compound, or a benzoic acid ester-based compound, and more preferably an oxime ester-based compound from the viewpoint of debris suppression and enhanced positional accuracy. The oxime ester-based compound preferably contains a compound having an oxime ester structure (α -oxime structure) and/or a compound having an oxime ester carbonyl structure (β -oxime structure).

[0188]

The photoacid generator (C3) refers to a compound that undergoes bond cleavage and/or reaction upon exposure to generate an acid. Note that the compound (C3) is a compound different from the compound (C1). Containing the compound (C3) is suitable for forming a negative-type pattern from a viewpoint of promotion of cationic polymerization and the like. On the other hand, in a case where the resin or the like has an acidic group protected by an acid-dissociable group, it is suitable for forming a positive-type pattern, from a viewpoint of releasing the acidic group by exposure, and the effect of improving the sensitivity during exposure becomes remarkable. Examples of the compound (C3) include an ionic compound and a nonionic compound. The ionic compound is preferably a triorganosulfonium salt-based compound. Preferable examples of the nonionic compound include halogen-containing compounds, diazomethane compounds, sulfone compounds, sulfonate ester compounds, carboxylic acid ester compounds, sulfonimide compounds, phosphate ester compounds, and sulfone benzotriazoles compounds.

[0189]

The photobase generator (C4) refers to a compound that undergoes bond cleavage and/or reaction upon exposure to generate a base. Containing the compound (C4) is

suitable for forming a negative-type pattern from a viewpoint of promotion of anionic polymerization and the like. On the other hand, in a case where the resin or the like has an acidic group protected by a base-dissociable group, it is suitable for forming a positive-type pattern, from the viewpoint of releasing the acidic group by exposure, and the effect of improving the sensitivity during exposure becomes remarkable. Examples of the compound (C4) include an ionic compound and a nonionic compound. The ionic compound is preferably a diazabicycloalkene salt-based compound, a triazabicycloalkene salt-based compound, an α -keto quaternary ammonium salt-based compound, a benzyl quaternary ammonium salt-based compound, a guanidine salt-based compound, or a biguanide salt-based compound. The ionic compound preferably has a ketoprofen structure, an oxoxanthene structure, a benzofuran structure, or a naphthalene structure. The nonionic compound is preferably a nitrobenzyl carbamate compound, an anthracenyl carbamate compound, a benzoin-based carbamate compound, an anthraquinone-based carbamate compound, a hydroxycinnamamide-based compound, or a coumarin amide-based compound.

[0190]

<Ultraviolet Absorber (Da) and Colorant (Db) (Db)>

The composition preferably further contains an ultraviolet absorber (Da) and/or a colorant (Db). The ultraviolet absorber (Da) refers to a compound that absorbs light having a wavelength in the ultraviolet region (less than 380 nm). The colorant (Db) refers to a compound that colors by absorbing light having a wavelength of visible light (380 to 780 nm). Coloring means being red, orange, yellow, green, blue, or purple. Examples and preferred descriptions concerning the ultraviolet absorber (Da) and the colorant (Db) are the same as the examples and preferred descriptions in the ultraviolet absorber (XDa) and the colorant (XDb) in the light-absorbing layer, respectively. Similarly to the ultraviolet absorber (XDa) having a specific structure in the light-absorbing layer, the ultraviolet absorber (Da) having a specific structure is a resin different from the above-described binder resin (A), but the ultraviolet absorber (Da) having a specific structure corresponds to both the ultraviolet absorber (Da) and the binder resin (A). That is, when the composition contains the ultraviolet absorber (Da) having a specific structure, the composition contains the ultraviolet absorber (Da) and the binder resin (A).

[0191]

<Dispersant (E)>

From the viewpoint of improving the dispersion

stability of the pigment, the composition preferably further contains the dispersant (E). The dispersant (E) refers to a compound having a structure that interacts with the surface of a pigment and a structure that inhibits approach of pigments to each other. The dispersant (E) preferably has a basic group, an acidic group, or a salt structure thereof, and more preferably has a basic group or a salt structure thereof.

[0192]

<Crosslinking Agent (F)>

The composition further contains the compound (B) and/or the crosslinking agent (F). The crosslinking agent (F) refers to a compound having a cross-linking group capable of reacting with a resin or the like, a cationically polymerizable group, or an anionically polymerizable group. From the viewpoint of debris suppression and enhanced positional accuracy, the crosslinking agent (F) preferably has one or more groups selected from the group consisting of an alkoxyalkyl group, a hydroxyalkyl group, an epoxy group, an oxetanyl group, and a blocked isocyanate group (hereinafter, referred to as specific crosslinking group). The alkoxyalkyl group is preferably an alkoxymethyl group or an alkoxyethyl group, and more preferably a methoxymethyl group or a methoxyethyl group. The hydroxyalkyl group is preferably a methylol

group or an ethylol group. From the viewpoint of debris suppression and enhanced positional accuracy, the number of specific cross-linking groups of the crosslinking agent (F) is preferably 2 or more, more preferably 3 or more, still more preferably 4 or more, and particularly preferably 6 or more. On the other hand, the number of specific crosslinking groups is preferably 12 or less, more preferably 10 or less, still more preferably 8 or less from the viewpoint of debris suppression and enhanced positional accuracy.

[0193]

<Other Additives and Solvents>

The composition preferably further includes a dissolution promoter, a sensitizer, a chain transfer agent, a polymerization inhibitor, a silane coupling agent, an ink repellent agent, or a surfactant. As these additives, known additives may be used. The composition preferably further includes a solvent. In a case where the composition contains a pigment and further contains a dispersant, the solvent is preferably a compound having an acetate bond, a propionate bond, or a butyrate bond from a viewpoint of improving the dispersion stability of the pigment.

[0194]

<Method for producing laminate (laminate 1X)>

Hereinafter, methods for producing a laminate according to the third, fourth, fifth, sixth, seventh, and eighth aspects of the present invention will be described. In the case of being described as the method for producing a laminate of the present invention, the description relates to the method for producing a laminate of the third aspect, the fourth aspect, the fifth aspect, the sixth aspect, the seventh aspect, and the eighth aspect of the present invention. Meanwhile, when a method for producing a laminate according to a specific aspect is described, the method is described as a method for producing a laminate according to the third aspect of the present invention. It is noted that the present invention is not limited to the following embodiments, and various modifications can naturally be made as long as the modifications can achieve the object of the invention and do not depart from the gist of the invention.

[0195]

The method for producing a laminate according to the third aspect of the present invention has the configuration of [1]. With the above configuration, the method for producing a laminate according to the third aspect of the present invention can provide both debris suppression and excellent positional accuracy during transfer of an article such as a semiconductor chip and enable a display device or

a semiconductor device to be obtained with high accuracy. This means that, because a recess is formed in a light-absorbing layer portion, the volume of the light-absorbing layer is reduced as compared with a case where no recess is formed. As a result, it is estimated that the effects of debris suppression and excellent positional accuracy are achieved for the same reasons as in the laminate according to the first aspect of the present invention. In addition, since an article is transferred by irradiation with chemical active rays in a state where a gap is provided between the first substrate and the second substrate, it is considered that the light-absorbing layer evaporated at the time of ablation is efficiently released to the outside of the system. As a result, since redeposition on the second substrate after ablation can be reduced, it is estimated that the effect of debris suppression is achieved. It is considered that the light emission characteristics of the semiconductor chip and the like are improved by achieving the above-described effects of debris suppression and excellent positional accuracy. That is, it is estimated that the light extraction efficiency from a semiconductor chip or the like is improved and that the effect of excellent light emission luminance is achieved.

[0196]

<Method for producing laminate (laminate 1X)>

the method for producing a laminate according to the fourth aspect of the present invention includes:

(10) preparing a laminate 11x including a first substrate and a light-absorbing layer in this order;

(12) tentatively fixing an article to the light-absorbing layer (hereinafter, referred to as step (12));
and

(13) patterning the light-absorbing layer (hereinafter, referred to as step (13)),

in step (12), a plurality of articles are in contact with the light-absorbing layer, and, in step (13), the light-absorbing layer has a recess, and/or in step (13), the light-absorbing layer has an indentation elastic modulus at 50°C of 1.0×10^3 to 2.0×10^9 Pa and a glass transition temperature of -50 to 150°C.

[0197]

With the above configuration, the method for producing a laminate according to the fourth aspect of the present invention can provide both debris suppression and excellent positional accuracy during transfer of an article such as a semiconductor chip and enable a display device or a semiconductor device to be obtained with high accuracy. This means that, because a recess is formed in a light-absorbing layer portion, the volume of the light-absorbing layer is reduced as compared with a case where no recess is

formed. As a result, it is estimated that the effects of debris suppression and excellent positional accuracy are achieved for the same reasons as in the laminate according to the first aspect of the present invention. Since the indentation elastic modulus of the light-absorbing layer is in a specific range and/or the glass transition temperature of the light-absorbing layer is in a specific range, it is considered that the light-absorbing layer can appropriately maintain a force for holding an article and suppress excessive adhesive force between the light-absorbing layer and the article. As a result, it is estimated that the effects of debris suppression and excellent positional accuracy are achieved for the same reasons as in the laminate according to the first aspect of the present invention. It is considered that the light emission characteristics of the semiconductor chip and the like are improved by achieving the above-described effects of debris suppression and excellent positional accuracy. That is, it is estimated that the light extraction efficiency from a semiconductor chip or the like is improved and that the effect of excellent light emission luminance is achieved.

[0198]

<Method for producing laminate (laminate 1Y)>

The method for producing a laminate according to the fifth aspect of the present invention includes:

(10y) preparing laminate a1y including a first substrate, a light-absorbing layer, and a first pressure-sensitive adhesive layer in this order;

(12y) tentatively fixing an article to the first pressure-sensitive adhesive layer (hereinafter, referred to as step (12y));

(13y) patterning the light-absorbing layer and the first pressure-sensitive adhesive layer (hereinafter, referred to as step (13y));

(20) preparing a laminate a2 including a second substrate and a second pressure-sensitive adhesive layer in this order; and

(22y) irradiating the light-absorbing layer with chemical active rays from the first substrate side of the light-absorbing layer while a gap is present between an article provided on the first substrate and a second pressure-sensitive adhesive layer provided on the second substrate to transfer the article from the first pressure-sensitive adhesive layer to the second pressure-sensitive adhesive layer (hereinafter referred to as step (22y)),

in step (12y), a plurality of articles are in contact with the first pressure-sensitive adhesive layer, and, in step (13y), recesses are formed in the light-absorbing layer and the first pressure-sensitive adhesive layer.

[0199]

With the above configuration, the method for producing a laminate according to the fifth aspect of the present invention can provide both debris suppression and excellent positional accuracy during transfer of an article such as a semiconductor chip and enable a display device or a semiconductor device to be obtained with high accuracy. This means that, because a recess is formed in a light-absorbing layer portion and the first pressure-sensitive adhesive layer, the volume of the light-absorbing layer and the volume of the first pressure-sensitive adhesive layer are reduced as compared with a case where no recess is formed. As a result, it is estimated that the effects of debris suppression and excellent positional accuracy are achieved for the same reasons as in the laminate according to the first aspect of the present invention. In addition, since an article is transferred by irradiation with chemical active rays in a state where a gap is provided between the first substrate and the second substrate, it is considered that the light-absorbing layer and /or the first pressure-sensitive adhesive layer evaporated at the time of ablation is efficiently released to the outside of the system. As a result, since redeposition on the second substrate after ablation can be reduced, it is estimated that the effect of debris suppression is achieved. It is considered that the light emission characteristics of the

semiconductor chip and the like are improved by achieving the above-described effects of debris suppression and excellent positional accuracy. That is, it is estimated that the light extraction efficiency from a semiconductor chip or the like is improved and that the effect of excellent light emission luminance is achieved.

[0200]

<Method for producing laminate (laminate 1Y)>

the method for producing a laminate according to the sixth aspect of the present invention includes:

(10y) preparing a laminate aly including a first substrate, a light-absorbing layer and a first pressure-sensitive adhesive layer in this order;

(12y) tentatively fixing an article to the first pressure-sensitive adhesive layer (hereinafter, referred to as step (12y)); and

(13y) patterning the light-absorbing layer and the first pressure-sensitive adhesive layer (hereinafter, referred to as step (13y)),

in step (12), a plurality of articles are in contact with the first pressure-sensitive adhesive layer, and, in step (13y), recesses are formed in the light-absorbing layer and first pressure-sensitive adhesive layer, and/or in step (13y), the first pressure-sensitive adhesive layer has an indentation elastic modulus at 50°C of 1.0×10^3 to

2.0×10^9 Pa and/or a glass transition temperature of -50 to 150°C.

[0201]

With the above configuration, the method for producing a laminate according to the sixth aspect of the present invention can provide both debris suppression and excellent positional accuracy during transfer of an article such as a semiconductor chip and enable a display device or a semiconductor device to be obtained with high accuracy. This means that, because a recess is formed in a light-absorbing layer portion and the first pressure-sensitive adhesive layer, the volume of the light-absorbing layer and the volume of the first pressure-sensitive adhesive layer are reduced as compared with a case where no recess is formed. As a result, it is estimated that the effects of debris suppression and excellent positional accuracy are achieved for the same reasons as in the laminate according to the first aspect of the present invention. It is considered that the light emission characteristics of the semiconductor chip and the like are improved by achieving the above-described effects of debris suppression and excellent positional accuracy. That is, it is estimated that the light extraction efficiency from a semiconductor chip or the like is improved and that the effect of excellent light emission luminance is achieved.

[0202]

The method for producing a laminate according to the seventh aspect of the present invention has the configuration of [10]. That is, the method for producing a laminate according to the seventh aspect of the present invention includes:

(10) preparing a laminate a1x including a first substrate and a light-absorbing layer in this order;

(12z) tentatively fixing an article to the light-absorbing layer and patterning the light-absorbing layer (hereinafter, referred to as step (12z));

(20) preparing a laminate a2 including a second substrate and a second pressure-sensitive adhesive layer in this order; and

(22) irradiating the light-absorbing layer with a chemical active ray from a first substrate side of the light-absorbing layer while a gap is present between an article provided on the first substrate and the second pressure-sensitive adhesive layer provided on the second substrate to transfer the article from the light-absorbing layer to the second pressure-sensitive adhesive layer (hereinafter referred to as step (22)),

in step (12z), a plurality of articles are in contact with the light-absorbing layer, and a recess is formed in the light-absorbing layer.

[0203]

With the above configuration, it is estimated that the method for producing a laminate according to the seventh aspect of the present invention achieves the effects of debris suppression and excellent positional accuracy for the same reason as the method for producing a laminate according to the third aspect of the present invention. It is considered that the light emission characteristics of the semiconductor chip or the like are improved for the same reason. That is, it is estimated that the light extraction efficiency from a semiconductor chip or the like is improved and that the effect of excellent light emission luminance is achieved.

[0204]

The method for producing a laminate according to the eighth aspect of the present invention includes:

(10) preparing a laminate 1x including a first substrate and a light-absorbing layer in this order; and

(12z) tentatively fixing an article to the light-absorbing layer, and then patterning the light-absorbing layer (hereinafter, referred to as step (12z)),

wherein, in step (12z), a plurality of articles are in contact with the light-absorbing layer, and, in step (12z), the light-absorbing layer has a recess, and

in step (12z), the light-absorbing layer has an

indentation elastic modulus at 50°C of 1.0×10^3 to 2.0×10^9 Pa and/or a glass transition temperature of -50 to 150°C.

[0205]

With the above configuration, it is estimated that the method for producing a laminate according to the eighth aspect of the present invention achieves the effects of debris suppression and excellent positional accuracy for the same reason as the method for producing a laminate according to the fourth aspect of the present invention. It is considered that the light emission characteristics of the semiconductor chip or the like are improved for the same reason. That is, it is estimated that the light extraction efficiency from a semiconductor chip or the like is improved and that the effect of excellent light emission luminance is achieved.

[0206]

<Donor substrate; Step of preparing laminate>

The method for producing a laminate of the present invention preferably includes preparing a laminate 0A including a donor substrate and an article in this order. The laminate 0A preferably has a plurality of articles.

[0207]

Examples and preferred descriptions concerning the laminate 0A are as described above. The step of preparing

such a laminate may be a step of producing and preparing a laminate. The step of preparing such a laminate may be a step of preparing a laminate that has already been produced.

[0208]

<Donor substrate; Step of forming article>

The method for producing a laminate of the present invention can include step (01), that is, the step of forming an article on the donor substrate. In the method for producing a laminate of the present invention, the donor substrate has a plurality of articles are preferably present in step (01). Examples and preferred descriptions concerning the donor substrate and the article are as described above. In step (01), having a plurality of articles means a state after step (01). That is, in step (01), a plurality of articles are formed on the donor substrate. Step (01) of forming an article on the donor substrate preferably involves forming a semiconductor chip on the donor substrate. Examples of the method for forming an article in these steps include a method for forming one or more selected from the group consisting of a conductive layer, an insulating layer, and a semiconductive layer, and a method for forming one or more selected from the group consisting of a conductive inorganic layer, an insulating resin layer, an insulating inorganic layer, and a

semiconductor layer is preferable.

[0209]

<Base substrate; step of preparing laminate>

The method for producing a laminate of the present invention preferably includes preparing a laminate 0A including a base substrate and a base pressure-sensitive adhesive layer in this order. The method for producing a laminate of the present invention preferably includes a step of preparing a laminate 0B having a base substrate, a base pressure-sensitive adhesive layer, and an article in this order. The laminate 0B preferably has a plurality of articles. Examples and preferred descriptions concerning the laminate a0 and the laminate 0B are as described above. The step of preparing such a laminate may be a step of producing and preparing a laminate. The step of preparing such a laminate may be a step of preparing a laminate that has already been produced.

[0210]

<Base substrate; step of forming base pressure-sensitive adhesive layer>

The method for producing a laminate of the present invention preferably includes (02) forming a tentatively fixing layer on the base substrate. Examples and preferred descriptions concerning the base pressure-sensitive adhesive layer are as described above. Examples of the

method of forming the base pressure-sensitive adhesive layer in these steps include a method of applying a composition or a method of disposing a film formed from the composition. Examples and preferred descriptions concerning the methods are the same as the examples and preferred descriptions in step (11) to be described later, respectively.

[0211]

<Base substrate; Step of tentatively fixing article>

The method for producing a laminate of the present invention preferably includes (03) tentatively fixing an article to the base pressure-sensitive adhesive layer (hereinafter, referred to as step (03)). The method for producing a laminate of the present invention more preferably includes step (01) and step (03). The method for producing a laminate of the present invention preferably includes a plurality of articles in contact with the base pressure-sensitive adhesive layer in step (03).

[0212]

Examples and preferred descriptions concerning the article are as described above. In step (03), having a plurality of articles means a state after step (03). That is, in step (03), a plurality of articles are tentatively fixed to the base pressure-sensitive adhesive layer. Step (03) preferably includes: (03a) irradiating the article

with chemical active rays from the donor substrate side of the article to transfer the article from the donor substrate to the base pressure-sensitive adhesive layer in a state where the article provided on the donor substrate and the base pressure-sensitive adhesive layer provided on the base substrate are in contact with each other (hereinafter, referred to as step (03a)); or (03b) irradiating the article with chemical active rays from the donor substrate side of the article to transfer the article from the donor substrate to the base pressure-sensitive adhesive layer in a state where a gap is provided between the article provided on the donor substrate and the base pressure-sensitive adhesive layer provided on the base substrate (hereinafter, referred to as step (03b)).

[0213]

In steps (03a) and (03b), it is preferable to transfer a plurality of articles provided on the donor substrate from the donor substrate to the base pressure-sensitive adhesive layer at a time from the viewpoint of process time reduction. In addition, a plurality of articles provided on the donor substrate is preferably transferred from the donor substrate to the base pressure-sensitive adhesive layer in two or more separate times, and more preferably sequentially transferred in two or more separate times. Sequentially transferring the plurality of

articles means transferring the plurality of articles one by one in succession. It is suitable for transferring the article from the donor substrate to the base pressure-sensitive adhesive layer in step (03a) or (03b) that the donor substrate has the photolytic layer or the laminate 0A has the photolytic layer.

[0214]

Step (03) preferably includes bringing the article provided on the donor substrate into contact with the base pressure-sensitive adhesive layer provided on the base substrate to bond them before step (03a) or step (03b). Step (03) more preferably further includes heating after these steps, and still more preferably includes thermocompression bonding. Examples and preferable descriptions regarding the heating step and the thermocompression bonding step are the same as the examples and preferable descriptions in step (12) of tentatively fixing an article to the light-absorbing layer described later.

[0215]

<First substrate; Sep of preparing laminate>

A method for producing a laminate according to the third aspect, the fourth aspect, the seventh aspect, and the eighth aspect of the present invention includes (10) preparing a laminate 1x including a first substrate and a

light-absorbing layer in this order. The method for producing a laminate according to the fifth and sixth aspects of the present invention includes (10y) preparing a laminate aly having a first substrate, a light-absorbing layer, and a first pressure-sensitive adhesive layer in this order. The method for producing a laminate according to the third, fourth, seventh, and eighth aspects of the present invention preferably includes (1X) preparing a laminate 1X which is the laminate of the present invention. The method for producing a laminate according to the fifth and sixth aspects of the present invention preferably includes (1Xy) preparing a laminate 1Y which is the laminate of the present invention. Examples and preferred descriptions concerning the laminate alx, the laminate aly, the laminate 1X, and the laminate 1Y are as described above. The step of preparing such a laminate may be a step of producing and preparing a laminate. The step of preparing such a laminate may be a step of preparing a laminate that has already been produced.

[0216]

<First substrate; Step of forming light-absorbing layer>

The method for producing a laminate according to the third aspect, the fourth aspect, the seventh aspect, and the eighth aspect of the present invention preferably includes (11) forming a light-absorbing layer on the first

substrate. The method for producing a laminate according to the fifth and sixth aspects of the present invention preferably includes (11y-1) forming a light-absorbing layer on the first substrate.

[0217]

Examples and preferred descriptions concerning the first substrate and the light-absorbing layer are as described above. Examples of the method for forming the light-absorbing layer in these steps include a method of applying a composition or a method of disposing a film formed from the composition. Examples of the method for applying the composition include spin coating, curtain flow coating, spray coating, and slit coating. In addition, a method in which the composition is applied and then prebaked is preferable. A prebaking temperature is more preferably 50°C to 150°C. A prebaking time is preferably 30 seconds to 10 minutes. Examples of the method for disposing the film formed from the composition include a method in which the film formed from the composition is bonded by thermocompression bonding. The method of joining by thermocompression bonding is preferably a hot press treatment, a hot lamination treatment, or a hot vacuum lamination treatment.

[0218]

A method in which the composition is applied,

prebaked, and then further post-baked is preferred. In addition, a method in which a film formed from a composition is bonded by thermocompression bonding and then further post-baked is also preferable. The post-baking temperature is preferably higher than 150°C to 300°C. The post-baking time is preferably 5 minutes to 300 minutes. Examples of the treatment atmosphere include an air, oxygen, nitrogen, helium, neon, argon, krypton, or xenon atmosphere, a gas atmosphere containing 1 to 10,000 ppm by mass (0.0001% to 1% by mass) of oxygen, and a vacuum atmosphere. The prebaking method and the post-baking method may be performed in two or more stages. As the prebaking method and the post-baking method, an oven, a hot plate, infrared rays, a flash annealing device, a laser annealing device, or the like can be used.

[0219]

<First substrate; Step of forming first pressure-sensitive adhesive layer>

The method for producing a laminate according to the fifth and sixth aspects of the present invention preferably includes (11y-2) forming a first pressure-sensitive adhesive layer in contact with the light-absorbing layer. Examples and preferred descriptions concerning the first pressure-sensitive adhesive layer are as described above. Examples of the method of forming the first pressure-

sensitive adhesive layer in these steps include a method of applying a composition or a method of disposing a film formed from the composition. Examples and preferred descriptions concerning the methods are the same as the examples and preferred descriptions in step (11) above, respectively.

[0220]

<First substrate; Step of irradiating light-absorbing layer and /or first pressure-sensitive adhesive layer with chemical active ray>

from the viewpoints of reduction in the energy of laser irradiation and enhanced positional accuracy, the method for producing a laminate according to the third and fourth aspects of the present invention preferably includes (11z) irradiating the light-absorbing layer with a chemical active ray from the first substrate side of the light-absorbing layer (hereinafter, referred to as step (11z)) before step (12) described later. The method for producing a laminate according to the seventh and eighth aspects of the present invention preferably further includes step (12z) before step (11z) described later from the viewpoint of reduction in the energy of laser irradiation and enhanced positional accuracy. When the method for producing a laminate according to the third aspect, the fourth aspect, the seventh aspect, and the eighth aspect of

the present invention includes step (11z), from the viewpoint of the effect of the present invention, the condition (b) is preferably satisfied in step (13).

[0221]

from the viewpoints of reduction in the energy of laser irradiation and enhanced positional accuracy, the method for producing a laminate according to the fifth and sixth aspects of the present invention preferably includes a step (12y) of irradiating the light-absorbing layer and the first pressure-sensitive adhesive layer with chemical active rays from the first substrate side of the light-absorbing layer (hereinafter, referred to as step (11zy)) before step (11 y) described later. When the method for producing a laminate according to the fifth and sixth aspects of the present invention includes step (11zy), from the viewpoint of the effect of the present invention, the condition (by) is preferably satisfied in step (13y).

[0222]

When the light-absorbing layer and /or the first pressure-sensitive adhesive layer is a layer formed from a negative photosensitive composition, photocuring partially proceeds by irradiation with chemical active rays, and the degree of crosslinking in these layers is improved. Therefore, when tentatively fixing the article to these layers, it is considered that the article is suppressed

from being buried in the light-absorbing layer or the first pressure-sensitive adhesive layer. As a result, when the article is transferred from the light-absorbing layer or the first pressure-sensitive adhesive layer, since the article can be transferred with less energy, the behavior of the article at the time of transfer is stabilized, the absolute value of the variation in irradiation energy is also reduced, and it is estimated that the effect of excellent positional accuracy becomes remarkable. Examples and preferred descriptions regarding the step of irradiating with chemical active rays in these steps are the same as the examples and preferred descriptions in step (14) and step (14y) described later, respectively.

[0223]

<First substrate; Step of tentatively fixing article>

The method for producing a laminate according to the third and fourth aspects of the present invention includes (12) tentatively fixing an article to the light-absorbing layer (hereinafter, referred to as step (12)). The method for producing a laminate according to the fifth and sixth aspects of the present invention includes (12y) tentatively fixing an article to the first pressure-sensitive adhesive layer (hereinafter, referred to as step (12y)). The method for producing a laminate according to the seventh aspect and the eighth aspect of the present invention includes

(12z) tentatively fixing an article to the light-absorbing layer and patterning the light-absorbing layer (hereinafter, referred to as step (12z)).

[0224]

The method for producing a laminate according to the third and fourth aspects of the present invention includes a plurality of articles in contact with the light-absorbing layer in step (12). The method for producing a laminate according to the fifth and sixth aspects of the present invention includes a plurality of articles in contact with the first pressure-sensitive adhesive layer in step (12y). The method for producing a laminate according to the seventh and eighth aspects of the present invention include a plurality of articles in contact with the light-absorbing layer in step (12z).

[0225]

Examples and preferred descriptions concerning the article are as described above. Having a plurality of articles in contact with the light-absorbing layer in step (12) means a state after step (12). Having a plurality of articles in contact with the first pressure-sensitive adhesive layer in step (12y) means a state after step (12y). Having a plurality of articles in contact with the light-absorbing layer in step (12z) means a state after step (12z). That is, in step (12), a plurality of articles

are tentatively fixed to the light-absorbing layer. In step (12y), a plurality of articles are tentatively fixed to the first pressure-sensitive adhesive layer. In step (12z), a plurality of articles are tentatively fixed to the light-absorbing layer.

[0226]

In the method for producing a laminate according to the seventh and eighth aspects of the present invention, the recess is formed in the light-absorbing layer in step (12z). Forming a recess in the light-absorbing layer in step (12z) means processing the light-absorbing layer into such a state in step (12z). That is, in step (12z), recesses are formed in the light-absorbing layer by patterning the light-absorbing layer. In step (12z), it is also preferable that the light-absorbing layer has an opening by patterning the light-absorbing layer. In step (12z), the light-absorbing layer preferably satisfies any one of the following conditions (p) and (q):

(p) a recess is formed in the light-absorbing layer, and the recess is formed by removing at least a part of the light-absorbing layer to reduce the thickness; and

(q) a recess is formed in the light-absorbing layer, and the recess is an opening.

[0227]

The method for producing a laminate according to the

third and fourth aspects of the present invention preferably includes step (01) and step (12). The method for producing a laminate according to the third and fourth aspects of the present invention includes step (01) and step (03), and also preferably includes step (12). The method for producing a laminate according to the fifth and sixth aspects of the present invention preferably includes step (01) and step (12y). The method for producing a laminate according to the fifth and sixth aspects of the present invention preferably include step (01) and step (03), and also preferably include step (12y). The method for producing a laminate according to the seventh and eighth aspects of the present invention preferably include step (01) and step (12z). The method for producing a laminate according to the seventh and eighth aspects of the present invention preferably include step (01) and step (03), and further include step (12z).

[0228]

< Step of tentatively fixing article (step of irradiating with chemical active ray to transfer article)>

(12)The step preferably includes (12a) irradiating the article with a chemical active ray from a donor substrate side of the article while the article provided on the donor substrate is in contact with the light-absorbing layer provided on the first substrate to transfer the

article from the donor substrate to the light-absorbing layer (hereinafter, referred to as step (12a)); or (12b) irradiating the article with chemical active rays from the donor substrate side of the article to transfer the article from the donor substrate to the light-absorbing layer in a state where a gap is provided between the article provided on the donor substrate and the light-absorbing layer provided on the first substrate (hereinafter, referred to as step (12b)).

[0229]

In step (12a) and step (12b), it is preferable to transfer a plurality of articles provided on the donor substrate from the donor substrate to the light-absorbing layer at a time from the viewpoint of process time reduction. In addition, a plurality of articles provided on the donor substrate is preferably transferred from the donor substrate to the light-absorbing layer in two or more separate times, and more preferably sequentially transferred in two or more separate times. Sequentially transferring the plurality of articles means transferring the plurality of articles one by one in succession. It is suitable for transferring the article from the donor substrate to the light-absorbing layer in step (12a) or (12b) that the donor substrate has the photolytic layer or the laminate 0A has the photolytic layer.

[0230]

Step (12y) preferably includes (12ya) irradiating the article with chemical active rays from the donor substrate side of the article to transfer the article from the donor substrate to the first pressure-sensitive adhesive layer in a state where the article provided on the donor substrate and the first pressure-sensitive adhesive provided on the first substrate are in contact with each other

(hereinafter, referred to as step (12ya)); or (12yb)

irradiating the article with chemical active rays from the donor substrate side of the article to transfer the article from the donor substrate to the first pressure-sensitive adhesive layer in a state where a gap is provided between the article provided on the donor substrate and the first pressure-sensitive adhesive provided on the first substrate (hereinafter, referred to as step (12yb)).

[0231]

From the viewpoint of process time reduction, it is preferable that step (12ya) and step (12yb) transfer a plurality of articles provided on the donor substrate from the donor substrate to the first pressure-sensitive adhesive layer at a time. In addition, a plurality of articles provided on the donor substrate is preferably transferred from the donor substrate to the first pressure-sensitive adhesive layer in two or more separate times, and

more preferably sequentially transferred in two or more separate times. Sequentially transferring the plurality of articles means transferring the plurality of articles one by one in succession. It is suitable for transferring the article from the donor substrate to the first pressure-sensitive adhesive layer in step (12ya) or (12yb) that the donor substrate has the photolytic layer or the laminate 0A has the photolytic layer.

[0232]

Step (12z) preferably includes: (12za) irradiating the article with chemical active rays from the donor substrate side of the article while the article provided on the donor substrate is in contact with the light-absorbing layer provided on the first substrate, transferring the article from the donor substrate to the light-absorbing layer, and patterning the light-absorbing layer (hereinafter, referred to as step (12za)); or (12zb) irradiating the article with chemical active rays from the donor substrate side of the article in a state where a gap is provided between the article provided on the donor substrate and the light-absorbing layer provided on the first substrate, transferring the article from the donor substrate to the light-absorbing layer, and patterning the light-absorbing layer (hereinafter, referred to as step (12zb)).

[0233]

In step (12za) and step (12zb), it is preferable to transfer a plurality of articles provided on the donor substrate from the donor substrate to the light-absorbing layer at a time from the viewpoint of process time reduction. In addition, a plurality of articles provided on the donor substrate is preferably transferred from the donor substrate to the light-absorbing layer in two or more separate times, and more preferably sequentially transferred in two or more separate times. Sequentially transferring the plurality of articles means transferring the plurality of articles one by one in succession. It is suitable for transferring the article from the donor substrate to the light-absorbing layer in step (12za) or step (12zb) that the donor substrate has the photolytic layer or the laminate 0A has the photolytic layer.

[0234]

In the steps (12a), (12b), (12ya), and (12yb), the article is preferably irradiated with chemical active rays from the donor substrate side of the article via the photomask. From the viewpoint of suppressing alteration of the light-absorbing layer and /or the first pressure-sensitive adhesive layer by chemical active rays, the photomask includes a light-transmitting portion and a light-shielding portion, and a region of the light-

transmitting portion is preferably within a region of the donor substrate where an article is provided, and more preferably corresponds to the region where the article is provided. In addition, the region of the light shielding portion is preferably equal to or more than the region of the donor substrate where the article is not provided, and more preferably corresponds to the region where the article is not provided. Examples and preferred descriptions regarding the step of irradiating with chemical active rays in these steps are the same as the examples and preferred descriptions in step (22) and step (22y) described later, respectively.

[0235]

In steps (12a), (12b), (12za), and (12zb), from the viewpoints of process time reduction, reduction in the energy of laser irradiation, debris suppression, and enhanced positional accuracy, it is preferable that the light-absorbing layer is also irradiated with chemical active rays using the article as a mask, and at least a part of the light-absorbing layer irradiated with the chemical active rays is removed. In step (12ya) and step (12yb), it is preferable that the first pressure-sensitive adhesive layer is also irradiated with chemical active rays using the article as a mask, and at least a part of the first pressure-sensitive adhesive irradiated with the

chemical active rays is removed, from the viewpoint of the same effect of the invention. In addition, in step (12ya) and step (12yb), it is more preferable that the light-absorbing layer and the first pressure-sensitive adhesive are also irradiated with chemical active rays using an article as a mask, and at least a part of the light-absorbing layer irradiated with the chemical active rays and at least a part of the first pressure-sensitive adhesive layer in contact with the light-absorbing layer are removed, from the viewpoint of the same effect of the invention.

[0236]

In step (12), the light-absorbing layer preferably satisfies any one of the following conditions (p) and (q):

(p) a recess is formed in the light-absorbing layer, and the recess is formed by removing at least a part of the light-absorbing layer to reduce the thickness; and

(q) a recess is formed in the light-absorbing layer, and the recess is an opening.

In step (12y), the light-absorbing layer and the first pressure-sensitive adhesive layer preferably satisfy any one of the following conditions (py) and (qy).

(py) a recess is formed in the light-absorbing layer and the first pressure-sensitive adhesive layer, the recess is an opening of the first pressure-sensitive adhesive

layer, and the recess is formed by removing at least a part of the light-absorbing layer to reduce the thickness; and

(qy) a recess is formed in the light-absorbing layer and first pressure-sensitive adhesive layer, and the recess is an opening.

[0237]

When the light-absorbing layer satisfies the condition (p) in step (12a), step (12b), step (12za), or step (12zb), it is preferable that at least a part of the light-absorbing layer irradiated with the chemical active rays be removed to reduce the thickness. In step (12a), step (12b), step (12za), or step (12zb), when the light-absorbing layer satisfies the condition (q), it is preferable that at least a part of the light-absorbing layer irradiated with chemical active rays is removed to have an opening.

[0238]

In the case of such a configuration, it is also preferable that the method for producing a laminate according to the seventh aspect and the eighth aspect of the present invention does not include step (13) described later. In step (12za) or step (12zb) of the method for producing a laminate according to each of the seventh aspect and the eighth aspect of the present invention, at least a part of the light-absorbing layer irradiated with

chemical active rays is removed. As a result, since step (13) or step (13y) to be described later becomes unnecessary, the effect of process time reduction becomes remarkable.

[0239]

When the method for producing a laminate according to the third aspect and the fourth aspect of the present invention satisfies condition (a) described later in step (13), it is preferable that the light-absorbing layer be also irradiated with chemical active rays as well using the article as a mask in steps (12a) and (12b) from the viewpoints of process time reduction, reduction in the energy of laser irradiation, debris suppression, and enhanced positional accuracy. In the case of such a configuration, it is also preferable that step (13a) described later does not include step (13a-1) described later.

[0240]

When the method for producing a laminate according to the fifth aspect and the sixth aspect of the present invention satisfy condition (ay) described later in step (13y), it is preferable that the light-absorbing layer be also irradiated with chemical active rays using the article as a mask in steps (12ya) and (12yb) from the viewpoint of the same effects of the invention. From the viewpoint of

the same effects of the invention, it is also preferable that the light-absorbing layer and the first pressure-sensitive adhesive layer be also irradiated with chemical active rays using the article as a mask in steps (12ya) and (12yb). In the case of such a configuration, it is also preferable that step (13ya) to be described later does not include step (13ya-1) to be described later.

[0241]

When the light-absorbing layer and/or the first pressure-sensitive adhesive layer is a layer formed from a positive photosensitive composition, the light-absorbing layer and/or the first pressure-sensitive adhesive layer is also irradiated with chemical active rays in step (12a), step (12b), step (12ya), or step (12yb), whereby bond cleavage, reaction, or structural change of the photosensitive agent proceeds to render the layer alkali-soluble. As a result, since step (13a-1) or step (13ya-1) in step (13a) or step (13ya) described later becomes unnecessary, the effect of process time reduction becomes remarkable.

[0242]

In the method for producing a laminate according to the third aspect, the fourth aspect, the seventh aspect, and the eighth aspect of the present invention, the expression "at least a part of the light-absorbing layer is

removed" means that the thickness of the light-absorbing layer is reduced. It is preferable that at least a part of the light-absorbing layer be removed and that a recess be formed in the light-absorbing layer, and it is more preferable that the light-absorbing layer be present as a layer having a plurality of convex-portion light-absorbing layers and a recess light-absorbing layer, with the thickness of the light-absorbing layer in the recess being smaller than the thickness of the light-absorbing layer in the plurality of convex portions. Note that at least a part of the light-absorbing layer is preferably removed to expose at least a part of the first substrate, and the light-absorbing layer at the corresponding portion is more preferably completely removed. It is particularly preferable that at least a part of the light-absorbing layer be removed and that the light-absorbing layer be present as a layer having a plurality of island-shaped light-absorbing layers.

[0243]

In the method for producing a laminate according to the fifth aspect and sixth aspect of the present invention, the expression "at least a part of the light-absorbing layer and at least a part of the first pressure-sensitive adhesive layer are removed" means that the thickness of the light-absorbing layer and the thickness of the first

pressure-sensitive adhesive layer are reduced. It is preferable that at least a part of the light-absorbing layer and at least a part of the first pressure-sensitive adhesive layer be removed and that a recess be formed in the light-absorbing layer and the first pressure-sensitive adhesive layer. It is preferable that the light-absorbing layer be present as a layer having a plurality of convex-portion light-absorbing layers and a recess light-absorbing layer, the thickness of the light-absorbing layer in the recess be smaller than the thickness of the light-absorbing layer in the plurality of convex portions, and the first pressure-sensitive adhesive layer is present as a layer having a plurality of convex-portion first pressure-sensitive adhesive layers. Note that at least a part of the light-absorbing layer and at least a part of the first pressure-sensitive adhesive layer are preferably removed to expose at least a part of the first substrate, and the first pressure-sensitive adhesive layer at the corresponding portion is more preferably completely removed, and the light-absorbing layer and the first pressure-sensitive adhesive layer at the corresponding portion are still more preferably completely removed. It is particularly preferable that at least a part of the light-absorbing layer and at least a part of the first pressure-sensitive adhesive layer be removed and that the

light-absorbing layer and the first pressure-sensitive adhesive layer be present as a layer having a plurality of island-shaped light-absorbing layers and a plurality of island-shaped first pressure-sensitive adhesive layers, respectively.

[0244]

As described above, it is possible to reduce the volume of the light-absorbing layer and/or the volume of the first pressure-sensitive adhesive layer by patterning, as a recess, a portion at where an article is not in contact with the light-absorbing layer and/or the first pressure-sensitive adhesive layer or by patterning the portion as an opening. The light-absorbing layer and/or first pressure-sensitive adhesive layer having a recess formed by such patterning and the light-absorbing layer and/or first pressure-sensitive adhesive layer having an opening formed by such patterning are more suitable in that the effects of debris suppression and excellent positional accuracy based on the above-described estimated mechanism are remarkable.

[0245]

The thickness of the light-absorbing layer after at least a part thereof is removed is preferably 2.0 μm or less, more preferably 1.0 μm or less, still more preferably 0.50 μm or less, even more preferably 0.30 μm or less, and

particularly preferably 0.10 μm or less. It is also preferable that the light-absorbing layer at the corresponding portion be completely removed and absent. The thickness of the first pressure-sensitive adhesive layer after at least a part thereof is removed is preferably 2.0 μm or less, more preferably 1.0 μm or less, still more preferably 0.50 μm or less, even more preferably 0.30 μm or less, and particularly preferably 0.10 μm or less. It is also preferable that the first pressure-sensitive adhesive layer at the corresponding portion be completely removed and absent.

[0246]

In steps (12) and (12z), the plurality of convex-portion light-absorbing layers or the plurality of island-shaped light-absorbing layers preferably satisfy the relationship of formula (S-xy), where (S_x) is an area of each of the convex-portion or island-shaped light-absorbing layers (hereinafter referred to as the area of the convex-portion or island-shaped light-absorbing layer), and (S_y) is an area of each of the plurality of articles contacting the respective layer.

$$(S_x) \geq (S_y) \quad (S\text{-}xy)$$

In a case where the relationship of the above formula (S-xy) is satisfied, when (S_x)/(S_y) is a ratio of area (S_x) of the convex-portion or island-shaped light-absorbing

layer to area (S_y) of the article, $(S_x)/(S_y)$ is preferably 1.10 or more, more preferably 1.30 or more, still more preferably 1.50 or more, even more preferably 1.65 or more, and particularly preferably 1.90 or more from the viewpoint of debris suppression and enhanced positional accuracy. On the other hand, $(S_x)/(S_y)$ is preferably 4.50 or less, more preferably 4.00 or less, still more preferably 3.50 or less, even more preferably 3.00 or less, and particularly preferably 2.70 or less from the viewpoints of reduction in the energy of laser irradiation.

[0247]

Of the area of the surface 1a of the light-absorbing layer on the first substrate side and the area of the surface 2a opposite to the surface 1a of the light-absorbing layer, the area of the island-shaped light-absorbing layer corresponds to the area of the surface 1a on the first substrate side. In addition, the area of the light-absorbing layer at the convex portion and the area of the light-absorbing layer at the recess are to be determined by determining the recess and the convex portion of the light-absorbing layer by the above-described methods (a1) to (a4).

[0248]

In the step (12y), it is preferable that the plurality of convex-portion first pressure-sensitive

adhesive layers or the plurality of island-shaped first pressure-sensitive adhesive layers satisfy the relationship of the formula (S-pq), when the area of each (hereinafter referred to as the area of the convex-portion or island-shaped first pressure-sensitive adhesive layer) is denoted by (S_p) and the area of a plurality of articles in contact with each is denoted by (S_q) .

$$(S_p) \geq (S_q) \quad (S-pq)$$

In a case where the relationship of the above formula (S-pq) is satisfied, when $(S_p)/(S_q)$ is a ratio of area (S_p) of the convex-portion or island-shaped first pressure-sensitive adhesive layer to area (S_q) of the article, $(S_p)/(S_q)$ is preferably 1.10 or more, more preferably 1.30 or more, still more preferably 1.50 or more, even more preferably 1.65 or more, and particularly preferably 1.90 or more from the viewpoints of debris suppression and enhanced positional accuracy. On the other hand, $(S_p)/(S_q)$ is preferably 4.50 or less, more preferably 4.00 or less, still more preferably 3.50 or less, still more preferably 3.00 or less, and particularly preferably 2.70 or less from the viewpoints of reduction in the energy of laser irradiation.

[0249]

Of the area of the surface of the first pressure-sensitive adhesive layer on the light-absorbing layer side

and the area of the surface opposite to the surface, the area of the island-shaped first pressure-sensitive adhesive layer corresponds to the area of the surface on the light-absorbing layer side. In addition, the area of the first pressure-sensitive adhesive layer at the convex portion and the area of the first pressure-sensitive adhesive layer at the recess are to be determined by determining the recess and the convex portion of the first pressure-sensitive adhesive layer by the above-described methods (b1) to (b4). Examples and preferable descriptions concerning the light-absorbing layer of the convex portion, the island-shaped light-absorbing layer, the first pressure-sensitive adhesive of the convex portion, and the island-shaped first pressure-sensitive adhesive layer in the steps (12), (12y) and (12z) are the same as the examples and preferable descriptions in step (13) described later, respectively.

[0250]

When the method for producing a laminate according to the third aspect and the fourth aspect of the present invention satisfies condition (a) described later in step (13), it is preferable that the light-absorbing layer be also irradiated with chemical active rays as well using the article as a mask in steps (12a) and (12b) from the viewpoints of process time reduction, reduction in the energy of laser irradiation, debris suppression, and

enhanced positional accuracy In the case of such a configuration, step (13a) described later preferably does not include step (13a-1) described later.

[0251]

When the method for producing a laminate according to the fifth aspect and the sixth aspect of the present invention satisfy condition (ay) described later in step (13y), it is preferable that the light-absorbing layer be also irradiated with chemical active rays using the article as a mask in steps (12ya) and (12yb) from the viewpoint of the same effects of the invention. From the viewpoint of the same effects of the invention, it is also preferable that the light-absorbing layer and the first pressure-sensitive adhesive layer be also irradiated with chemical active rays using the article as a mask in steps (12ya) and (12yb). In the case of such a configuration, it is preferable that step (13ya) to be described later does not include step (13ya-1) to be described later.

[0252]

When the light-absorbing layer and/or the first pressure-sensitive adhesive layer is a layer formed from a positive photosensitive composition, the light-absorbing layer and/or the first pressure-sensitive adhesive layer is also irradiated with chemical active rays in step (12a), step (12b), step (12ya), or step (12yb), whereby bond

cleavage, reaction, or structural change of the photosensitive agent proceeds to render the layer alkali-soluble. As a result, since step (13a-1) or step (13ya-1) in step (13a) or step (13ya) described later becomes unnecessary, the effect of process time reduction becomes remarkable.

[0253]

Step(12) preferably includes bringing the article provided on the donor substrate and the light-absorbing layer provided on the first substrate into contact with each other and bonding the article and the light-absorbing layer to each other before step (12a). Step (12y) preferably includes a step of bringing the article provided on the donor substrate and the first pressure-sensitive adhesive layer provided on the first substrate into contact with each other and bonding them to each other before step (12ya). Step (12z) preferably includes a step of bringing the article provided on the donor substrate and the light-absorbing layer provided on the first substrate into contact with each other and bonding them to each other before step (12za). Steps (12), (12y), and (12z) more preferably further include a heating step after these steps, and still more preferably include a thermocompression bonding step. The method of thermocompression bonding is preferably a hot press

treatment, a hot lamination treatment, or a hot vacuum lamination treatment. Examples of the method for thermocompression bonding include a method using a device capable of controlling the pressure at the time of thermocompression bonding, such as a pressing machine, a wafer bonder, or a vacuum laminator.

[0254]

The heating temperature is preferably 50°C or more, more preferably 60°C or more, still more preferably 80°C or more. Meanwhile, the heating temperature is preferably 150°C or less, more preferably 120°C or less, and still more preferably 100°C or less. The heating time is preferably 10 seconds or more, more preferably 30 seconds or more, still more preferably 60 seconds or more, and particularly preferably 180 seconds or more. On the other hand, the heating time is preferably 30 minutes or less, more preferably 20 minutes or less, still more preferably 10 minutes or less, and particularly preferably 5.0 minutes or less.

[0255]

The thermocompression bonding temperature is preferably 20°C or more, more preferably 40°C or more, still more preferably 50°C or more, and particularly preferably 60°C or more. On the other hand, the thermocompression bonding temperature is preferably 150°C

or less, more preferably 120°C or less, still more preferably 100°C or less, particularly preferably 80°C or less. The thermocompression bonding time is preferably 10 seconds or more, more preferably 30 seconds or more, and still more preferably 60 seconds or more. On the other hand, the thermocompression bonding time is preferably 30 minutes or less, more preferably 20 minutes or less, still more preferably 10 minutes or less, and particularly preferably 5.0 minutes or less. The pressure for thermocompression bonding is preferably 0.050 MPa or more, more preferably 0.10 MPa or more. On the other hand, the pressure for thermocompression bonding is preferably 10 MPa or less, more preferably 5 MPa or less. The heating step and the thermocompression bonding step may be performed in two or more stages. The treatment atmosphere is preferably an air, oxygen, nitrogen, helium, neon, argon, krypton, or xenon atmosphere, a gas atmosphere containing 1 to 10,000 ppm by mass (0.0001 to 1 mass%) of oxygen, or a vacuum atmosphere.

[0256]

<Step of tentatively fixing article (step of transferring article by bonding)>

Step (12) preferably includes (12c) bringing the article provided on the donor substrate and the light-absorbing layer provided on the first substrate into

contact with each other and bonding them to each other, and transferring the article from the donor substrate to the light-absorbing layer (hereinafter, referred to as step (12c)). Step (12y) preferably includes (12yc) bringing the article provided on the donor substrate into contact with the first pressure-sensitive adhesive layer provided on the first substrate and bonding the article to each other, and transferring the article from the donor substrate to the first pressure-sensitive adhesive (hereinafter, referred to as step (12yc)). Step (12z) preferably includes (12zc) bringing the article provided on the donor substrate and the light-absorbing layer provided on the first substrate into contact with each other and bonding the articles, transferring the article from the donor substrate to the light-absorbing layer, and patterning the light-absorbing layer (hereinafter, referred to as step (12zc)). In steps (12c) and (12zc), it is more preferable to heat the article and the light-absorbing layer in a state of being brought into contact with each other and bonded to each other, and it is still more preferable to perform thermocompression bonding. In step (12yc), it is more preferable to heat the article and the first pressure-sensitive adhesive layer in a state where the article and the first pressure-sensitive adhesive are brought into contact with each other and bonded to each other, and it is still more preferable to

perform thermocompression bonding. Examples and preferred descriptions concerning the heating step and the thermocompression bonding step are the same as the examples and preferred descriptions in step (12) above, respectively.

[0257]

Step (12) preferably includes (12d) bringing the article provided on the base substrate into contact with the light-absorbing layer provided on the first substrate to bond them, and transferring the article from the base pressure-sensitive adhesive layer to the light-absorbing layer (hereinafter, referred to as step (12d)). Step (12y) preferably includes (12yd) bringing the article provided on the base substrate into contact with the first pressure-sensitive adhesive layer provided on the first substrate to bond them, and transferring the article from the base pressure-sensitive adhesive layer to the first pressure-sensitive adhesive (hereinafter, referred to as step (12yd)). Step (12z) preferably includes (12zd) bringing the article provided on the base substrate into contact with the light-absorbing layer provided on the first substrate to bond them, transferring the article from the base pressure-sensitive adhesive layer to the light-absorbing layer, and patterning the light-absorbing layer (hereinafter, referred to as step (12zd)). In the steps

(12d) and (12zd), it is more preferable to heat the article and the light-absorbing layer in a state of being brought into contact with each other and bonded to each other, and it is still more preferable to perform thermocompression bonding. In step (12yd), it is more preferable to heat the article and the first pressure-sensitive adhesive layer in a state where the article and the first pressure-sensitive adhesive are brought into contact with each other and bonded to each other, and it is still more preferable to perform thermocompression bonding. Examples and preferred descriptions concerning the heating step and the thermocompression bonding step are the same as the examples and preferred descriptions in step (12) above, respectively.

[0258]

<First substrate; Step of patterning light-absorbing layer and/or first pressure-sensitive adhesive layer>

The method for producing a laminate according to the third aspect and fourth aspect of the present invention includes (13) patterning the light-absorbing layer (hereinafter, referred to as step (13)). The method for producing a laminate according to the fifth aspect and sixth aspect of the present invention includes (13y) patterning the light-absorbing layer and the first pressure-sensitive adhesive layer (hereinafter, referred to

as step (13y)). The method for producing a laminate according to the seventh aspect and eighth aspect of the present invention preferably includes (13) patterning the light-absorbing layer (hereinafter, referred to as step (13)).

[0259]

In the method for producing a laminate according to the third aspect and the fourth aspect of the present invention, a recess is formed in the light-absorbing layer in step (13). In the method for producing a laminate according to the fifth aspect and the sixth aspect of the present invention, recesses are formed in the light-absorbing layer and the first pressure-sensitive adhesive layer in step (13y). In the method for producing a laminate according to the seventh aspect and the eighth aspect of the present invention, the light-absorbing layer preferably has a recess in step (13). Forming a recess in the light-absorbing layer in step (13) refers to processing the light-absorbing layer into such a state in step (13). Forming recesses in the light-absorbing layer and the first pressure-sensitive adhesive layer in step (13y) means processing into such a state in step (13y). That is, in step (13), recesses are formed in the light-absorbing layer by patterning the light-absorbing layer. In step (13), it is also preferable that the light-absorbing layer has an

opening by patterning the light-absorbing layer. In step (13y), recesses are formed in the light-absorbing layer and the first pressure-sensitive adhesive by patterning the light-absorbing layer and the first pressure-sensitive adhesive layer. In step (13y), it is also preferable that the light-absorbing layer and the first pressure-sensitive adhesive have openings by patterning the light-absorbing layer and the first pressure-sensitive adhesive layer. In the method for producing a laminate according to the seventh aspect and the eighth aspect of the present invention, a recess is formed in the light-absorbing layer in step (12z), and thus the light-absorbing layer is permitted to be further patterned in step (13).

[0260]

In step (13), the light-absorbing layer preferably satisfies any one of the following conditions (p) and (q):

(p) a recess is formed in the light-absorbing layer, and the recess is formed by removing at least a part of the light-absorbing layer to reduce the thickness; and

(q) a recess is formed in the light-absorbing layer, and the recess is an opening.

In step (13y), the light-absorbing layer and the first pressure-sensitive adhesive layer preferably satisfy any one of the following conditions (py) and (qy).

(py) a recess is formed in the light-absorbing layer

and the first pressure-sensitive adhesive layer, the recess is an opening of the first pressure-sensitive adhesive layer, and the recess is formed by removing at least a part of the light-absorbing layer to reduce the thickness; and

(qy) a recess is formed in the light-absorbing layer and first pressure-sensitive adhesive layer, and the recess is an opening.

[0261]

In the method for producing a laminate according to the seventh and eighth aspects of the present invention, from the viewpoints of reduction in the energy of laser irradiation, debris suppression, and enhanced positional accuracy, it is preferable that, in step (12z), the light-absorbing layer is present, in a state of being in contact with the first substrate, as a layer having a plurality of convex-portion light-absorbing layers and a recess light-absorbing layer, and the thickness of the light-absorbing layer in the recess is smaller than the thickness of the light-absorbing layer in the plurality of convex portions. In the method for producing a laminate according to the seventh aspect and the eighth aspect of the present invention, the plurality of articles preferably each independently contact at least one of the plurality of convex-portion light-absorbing layers. In step (12z), the above aspect refers to a state after step (12z). That is,

in step (12z), it is assumed that the light-absorbing layer is present as a layer having a plurality of convex-portion light-absorbing layers by patterning the light-absorbing layer. In step (12z), the light-absorbing layer is subjected to patterning, and thus the plurality of articles are each independently in contact with at least one of the plurality of convex-portion light-absorbing layers.

[0262]

In the method for producing a laminate according to each of the seventh and eighth aspects of the present invention, from the viewpoints of reduction in the energy of laser irradiation, debris suppression, and enhanced positional accuracy, it is preferable that in step (12z), the light-absorbing layer exists as a plurality of island-shaped light-absorbing layers in a state of being in contact with the first substrate. In the method for producing a laminate according to the seventh aspect and the eighth aspect of the present invention, the plurality of articles preferably each independently contact at least one of the plurality of island-shaped light-absorbing layers. In step (12z), the above aspect refers to a state after step (12z). That is, in step (12z), the light-absorbing layer is subjected to patterning, and thus the light-absorbing layer is present as a layer having a plurality of island-shaped light-absorbing layers. In step

(12z), the light-absorbing layer is patterned so that the plurality of articles are each independently in contact with at least one of the plurality of island-shaped light-absorbing layers.

[0263]

In step (13), at least a part of the light-absorbing layer is preferably removed. In step (13y), at least a part of the first pressure-sensitive adhesive layer is preferably removed. In step (13y), it is more preferable that at least a part of the light-absorbing layer and at least a part of the first pressure-sensitive adhesive layer in contact with the light-absorbing layer are removed.

[0264]

In the method for producing a laminate according to the third aspect, the fourth aspect, the seventh aspect, and the eighth aspect of the present invention, the expression "at least a part of the light-absorbing layer is removed" means that the thickness of the light-absorbing layer is reduced. It is preferable that at least a part of the light-absorbing layer be removed and that a recess be formed in the light-absorbing layer, and it is more preferable that the light-absorbing layer be present as a layer having a plurality of convex-portion light-absorbing layers and a recess light-absorbing layer, with the thickness of the light-absorbing layer in the recess being

smaller than the thickness of the light-absorbing layer in the plurality of convex portions. Note that at least a part of the light-absorbing layer is preferably removed to expose at least a part of the first substrate, and the light-absorbing layer at the corresponding portion is more preferably completely removed. It is particularly preferable that at least a part of the light-absorbing layer be removed and that the light-absorbing layer be present as a layer having a plurality of island-shaped light-absorbing layers.

[0265]

In the method for producing a laminate according to the fifth aspect and sixth aspect of the present invention, the expression "at least a part of the light-absorbing layer and at least a part of the first pressure-sensitive adhesive layer are removed" means that the thickness of the light-absorbing layer and the thickness of the first pressure-sensitive adhesive layer are reduced. It is preferable that at least a part of the light-absorbing layer and at least a part of the first pressure-sensitive adhesive layer be removed and that a recess be formed in the light-absorbing layer and the first pressure-sensitive adhesive layer. It is preferable that the light-absorbing layer be present as a layer having a plurality of convex-portion light-absorbing layers and a recess

light-absorbing layer, the thickness of the light-absorbing layer in the recess be smaller than the thickness of the light-absorbing layer in the plurality of convex portions, and the first pressure-sensitive adhesive layer is present as a layer having a plurality of convex-portion first pressure-sensitive adhesive layers. Note that at least a part of the light-absorbing layer and at least a part of the first pressure-sensitive adhesive layer are preferably removed to expose at least a part of the first substrate, and the first pressure-sensitive adhesive layer at the corresponding portion is more preferably completely removed, and the light-absorbing layer and the first pressure-sensitive adhesive layer at the corresponding portion are still more preferably completely removed. It is particularly preferable that at least a part of the light-absorbing layer and at least a part of the first pressure-sensitive adhesive layer be removed and that the light-absorbing layer and the first pressure-sensitive adhesive layer be present as a layer having a plurality of island-shaped light-absorbing layers and a plurality of island-shaped first pressure-sensitive adhesive layers, respectively.

[0266]

As described above, it is possible to reduce the volume of the light-absorbing layer and/or the volume of

the first pressure-sensitive adhesive layer by patterning, as a recess, a portion at where an article is not in contact with the light-absorbing layer and/or the first pressure-sensitive adhesive layer or by patterning the portion as an opening. The light-absorbing layer and/or first pressure-sensitive adhesive layer having a recess formed by such patterning and the light-absorbing layer and/or first pressure-sensitive adhesive layer having an opening formed by such patterning are more suitable in that the effects of debris suppression and excellent positional accuracy based on the above-described estimated mechanism are remarkable.

[0267]

The thickness of the light-absorbing layer after at least a part thereof is removed is preferably 2.0 μm or less, more preferably 1.0 μm or less, still more preferably 0.50 μm or less, even more preferably 0.30 μm or less, and particularly preferably 0.10 μm or less. It is also preferable that the light-absorbing layer at the corresponding portion be completely removed and absent. The thickness of the first pressure-sensitive adhesive layer after at least a part thereof is removed is preferably 2.0 μm or less, more preferably 1.0 μm or less, still more preferably 0.50 μm or less, even more preferably 0.30 μm or less, and particularly preferably 0.10 μm or

less. It is also preferable that the first pressure-sensitive adhesive layer at the corresponding portion be completely removed and absent.

[0268]

In step (13), it is preferable that the plurality of convex-portion light-absorbing layers or a plurality of island-shaped light-absorbing layers satisfy the relationship of the formula (S-xy) when an area (hereinafter, referred to as an area of the convex-portion or island-shaped light-absorbing layer) of each of the light-absorbing layers is denoted by (S_x) and an area of a plurality of articles in contact with each of the light-absorbing layers is denoted by (S_y).

$$(S_x) \geq (S_y) \quad (S-xy)$$

In a case where the relationship of the above formula (S-xy) is satisfied, when (S_x)/(S_y) is a ratio of area (S_x) of the convex-portion or island-shaped light-absorbing layer to area (S_y) of the article, (S_x)/(S_y) is preferably 1.10 or more, more preferably 1.30 or more, still more preferably 1.50 or more, even more preferably 1.65 or more, and particularly preferably 1.90 or more from the viewpoint of debris suppression and enhanced positional accuracy. On the other hand, (S_x)/(S_y) is preferably 4.50 or less, more preferably 4.00 or less, still more preferably 3.50 or less, even more preferably 3.00 or less, and particularly

preferably 2.70 or less from the viewpoints of reduction in the energy of laser irradiation.

[0269]

Of the area of the surface 1a of the light-absorbing layer on the first substrate side and the area of the surface 2a opposite to the surface 1a of the light-absorbing layer, the area of the island-shaped light-absorbing layer corresponds to the area of the surface 1a on the first substrate side. In addition, the area of the light-absorbing layer at the convex portion and the area of the light-absorbing layer at the recess are to be determined by determining the recess and the convex portion of the light-absorbing layer by the above-described methods (a1) to (a4).

[0270]

It is preferable that the plurality of convex-portion first pressure-sensitive adhesive layers or the plurality of island-shaped first pressure-sensitive adhesive layers in step (13y) satisfy the relationship of the formula (S-pq) when the area (hereinafter, referred to as an area of the convex-portion or island-shaped first pressure-sensitive adhesive) of each of the first pressure-sensitive adhesive layers is denoted by (Sp) and the area of a plurality of articles in contact with each of the first pressure-sensitive adhesive layers is denoted by (Sq).

$$(S_p) \geq (S_q) \quad (S-pq)$$

In a case where the relationship of the above formula (S-pq) is satisfied, when $(S_p)/(S_q)$ is a ratio of area (S_p) of the convex-portion or island-shaped first pressure-sensitive adhesive layer to area (S_q) of the article, $(S_p)/(S_q)$ is preferably 1.10 or more, more preferably 1.30 or more, still more preferably 1.50 or more, even more preferably 1.65 or more, and particularly preferably 1.90 or more from the viewpoints of debris suppression and enhanced positional accuracy. On the other hand, $(S_p)/(S_q)$ is preferably 4.50 or less, more preferably 4.00 or less, still more preferably 3.50 or less, still more preferably 3.00 or less, and particularly preferably 2.70 or less from the viewpoints of reduction in the energy of laser irradiation.

[0271]

Of the area of the surface of the first pressure-sensitive adhesive layer on the light-absorbing layer side and the area of the surface opposite to the surface, the area of the island-shaped first pressure-sensitive adhesive layer corresponds to the area of the surface on the light-absorbing layer side. In addition, the area of the first pressure-sensitive adhesive layer at the convex portion and the area of the first pressure-sensitive adhesive layer at the recess are to be determined by determining the recess

and the convex portion of the first pressure-sensitive adhesive layer by the above-described methods (b1) to (b4).

[0272]

In the method for producing a laminate according to the third aspect, the fourth aspect, the seventh aspect, and the eighth aspect of the present invention, it is preferable that any one of the conditions (a) to (c) is satisfied in step (13).

(a) the light-absorbing layer is a layer formed from a positive photosensitive composition, and step (13) comprises (13a) patterning the light-absorbing layer by photolithography (hereinafter, referred to as step (13a));

(b) the light-absorbing layer is a layer formed from a positive or negative photosensitive composition, and step (13) comprises (13b) patterning the light-absorbing layer by etching (hereinafter, referred to as step (13b)); and

(c) the light-absorbing layer is a layer formed from a non-photosensitive composition, and step (13) includes (13b) patterning the light-absorbing layer by etching (hereinafter, referred to as step (13b)), and the light-absorbing layer has an indentation elastic modulus at 50°C of 1.0×10^3 to 2.0×10^9 Pa and/or a glass transition temperature of -50 to 150°C.

[0273]

In the method for producing a laminate according to

the fifth and sixth aspects of the present invention, in step (13y), any one of the above conditions (ay) to (cy) is preferably satisfied. In step (13), satisfying the condition refers to the state after step (13). In step (13y), satisfying the condition refers to the state after step (13y).

(ay) the light-absorbing layer and /or the first pressure-sensitive adhesive layer is a layer formed from a positive photosensitive composition, and step (13y) includes (13ya) patterning the light-absorbing layer and the first pressure-sensitive adhesive layer by photolithography (hereinafter, referred to as step (13ya)).

(by) The light-absorbing layer and /or the first pressure-sensitive adhesive layer is a layer formed from a positive photosensitive composition or a negative photosensitive composition, and step (13y) includes a step (13yb) of pattern-processing the light-absorbing layer and the first pressure-sensitive adhesive by etching (hereinafter, referred to as step (13yb)).

(cy) the light-absorbing layer and/or the first pressure-sensitive adhesive layer is a layer formed from a non-photosensitive composition, and step (13y) includes step (13yb) patterning the light-absorbing layer and the first pressure-sensitive adhesive layer by etching (hereinafter, referred to as step (13yb)), and first

pressure-sensitive adhesive layer has an indentation elastic modulus at 50°C of 1.0×10^3 to 2.0×10^9 pa and/or a glass transition temperature of -50 to 150°C.

[0274]

<Step of Patterning (Step of Processing by Photolithography)>

In the method for producing a laminate according to the third aspect, the fourth aspect, the seventh aspect, and the eighth aspect of the present invention, the condition (a) is preferably satisfied in step (13) from the viewpoints of reduction in the energy of laser irradiation, debris suppression, and enhanced positional accuracy. In step (13), satisfying the condition refers to the state after step (13). From the viewpoint of the same effect of the invention, in the method for producing a laminate according to the third aspect, the fourth aspect, the seventh aspect, and the eighth aspect of the present invention, when the condition (a) is satisfied in step (13), step (13a) of patterning the light-absorbing layer by photolithography (hereinafter, referred to as step (13a)) preferably includes the steps of: (13a-1) irradiating the light-absorbing layer with chemical active rays from the article side of the light-absorbing layer using the article as a mask (hereinafter, referred to as step (13a-1)); and (13a-2) developing the light-absorbing layer with a

developer to pattern the light-absorbing layer
(hereinafter, referred to as step (13a-2)).

[0275]

The method for producing a laminate according to the fifth and sixth aspects of the present invention preferably satisfy the condition (ay) in step (13y) from the viewpoint of the same effect of the invention. In step (13y), satisfying the condition refers to the state after step (13y). From the viewpoint of the same effect of the invention, in the method for producing a laminate according to the fifth and sixth aspects of the present invention, when the condition of the above (ay) is satisfied in step (13y), it is preferable that (13ya) patterning the light-absorbing layer and the first pressure-sensitive adhesive layer by photolithography (hereinafter, referred to as step (13ya)) includes (13ya-1) irradiating the light-absorbing layer and the first pressure-sensitive adhesive layer with chemical active rays from the article side of the light-absorbing layer using the article as a mask (hereinafter, referred to as step (13ya-1)), and (13ya-2) performing development using a developer to pattern the light-absorbing layer and the first pressure-sensitive adhesive layer (hereinafter, referred to as step (13ya-2)).

[0276]

As described above, it is possible to reduce the

volume of the light-absorbing layer and/or the volume of the first pressure-sensitive adhesive layer by patterning, as a recess, a portion at where an article is not in contact with the light-absorbing layer and/or the first pressure-sensitive adhesive layer or by patterning the portion as an opening. The light-absorbing layer and/or first pressure-sensitive adhesive layer having a recess formed by such patterning and the light-absorbing layer and/or first pressure-sensitive adhesive layer having an opening formed by such patterning are more suitable in that the effects of debris suppression and excellent positional accuracy based on the above-described estimated mechanism are remarkable.

[0277]

Examples of the method of irradiation with chemical active rays in step (13a-1) and step (13ya-1) include a method of patterning exposure with the use of an exposure machine such as a stepper, a scanner, a mirror projection mask aligner (MPA), or a parallel light mask aligner (PLA). Since in steps (13a) and (13ya), chemical active rays are applied using the article as a mask, a photomask may not be used. In addition, from the viewpoint of suppressing damage to the article by chemical active rays, the chemical active rays may be applied through a photomask.

[0278]

The maximum wavelength of the chemical active rays is preferably 180 nm or more, more preferably 200 nm or more, still more preferably 240 nm or more, even more preferably 300 nm or more, and particularly preferably 340 nm or more. On the other hand, the maximum wavelength of the chemical active rays is preferably 450 nm or less, more preferably 420 nm or less, and still more preferably 400 nm or less. The chemical active rays are preferably j-rays (wavelength: 313 nm) of a mercury lamp, i-rays (wavelength: 365 nm) of a mercury lamp, h-rays (wavelength: 405 nm) of a mercury lamp, or g-rays (wavelength: 436 nm) of a mercury lamp, and more preferably a mixed ray of i-rays, h-rays, and g-rays of a mercury lamp. The chemical active ray is preferably an ArF laser (wavelength: 193 nm), a KrF laser (wavelength: 248 nm), a XeCl laser (wavelength: 308 nm), a XeF laser (wavelength: 351 nm), or a YAG laser (wavelength: 266 nm, 355 nm, or 532 nm).

[0279]

The exposure energy of chemical active rays is preferably 10 mJ/cm² or more, more preferably 50 mJ/cm² or more, still more preferably 100 mJ/cm² or more, even more preferably 200 mJ/cm² or more, and particularly preferably 300 mJ/cm² or more in terms of i-ray illuminance value. On the other hand, the exposure energy is preferably 3000 mJ/cm² or less, more preferably 2000 mJ/cm² or less, still

more preferably 1500 mJ/cm² or less, even more preferably 1000 mJ/cm² or less, and particularly preferably 500 mJ/cm² or less in terms of i-ray illuminance value.

[0280]

After irradiation with chemical active rays, it is preferable to perform post-exposure baking from the viewpoint of improving the sensitivity, improving the resolution after development, and expanding the allowable range of development conditions. In particular, when the light-absorbing layer or the first pressure-sensitive adhesive layer is a layer formed from a chemically amplified positive photosensitive composition or a layer formed from a chemically amplified positive photosensitive composition, it is preferable to perform post-exposure baking.

[0281]

Examples of the method of performing development in steps (13a-2) and (13ya-2) include a method of performing development using an automatic developing machine. Examples of the development method include paddle development, spray development, and dip development. When the light-absorbing layer or the first pressure-sensitive adhesive layer is a layer formed from a positive photosensitive composition, a pattern in which an exposed portion is removed with a developer can be formed.

[0282]

The developer is preferably an alkali solution, and is preferably a solution of an organic alkali compound or an aqueous solution of a compound exhibiting alkalinity. Examples of the organic alkali compound or the compound exhibiting alkalinity include 2-aminoethanol, 2-(dimethylamino)ethanol, 2-(diethylamino)ethanol, diethanolamine, trimethylamine, triethylamine, sodium hydroxide, potassium hydroxide, sodium carbonate, potassium carbonate, tetramethylammonium hydroxide, and tetraethylammonium hydroxide, and known compounds may be used. The alkali concentration of the alkali solution is preferably 0.010 mass% or more, more preferably 0.10 mass% or more, still more preferably 1.0 mass% or more, and particularly preferably 2.0 mass% or more. On the other hand, the alkali concentration is preferably 20 mass% or less, more preferably 10 mass% or less, still more preferably 5.0 mass% or less, and particularly preferably 3.0 mass% or less.

[0283]

The developer is also preferably an organic solvent. As the organic solvent, a solvent in the composition described above may be used. As the developer, a mixed solution may be used which contains the organic solvent and a poor solvent with respect to the light-absorbing layer or

the first pressure-sensitive adhesive layer.

[0284]

The temperature of the developer is preferably 10°C or more, more preferably 20°C or more, still more preferably 30°C or more, and particularly preferably 40°C or more. Meanwhile, the temperature of the developer is preferably 100°C or less, more preferably 80°C or less, and still more preferably 60°C or less. The development time is preferably 10 seconds or more, more preferably 30 seconds or more, and still more preferably 60 seconds or more. On the other hand, the development time is preferably 10 minutes or less, more preferably 5.0 minutes or less, and still more preferably 3.0 minutes or less.

[0285]

After development, it is preferable that the obtained pattern is washed with a rinse solution. The rinse solution is preferably water in a case where an alkali solution is used as the developer. As the rinse solution, an aqueous solution of an alcohol, an aqueous solution of an ester, an aqueous solution of a compound exhibiting acidity, or an organic solvent may be used.

[0286]

In step (13a-2), the dissolution rate in the film thickness direction of the exposed portion of the light-absorbing layer is preferably 1.0 $\mu\text{m}/\text{min}$ or more, more

preferably 3.0 $\mu\text{m}/\text{min}$ or more, still more preferably 5.0 $\mu\text{m}/\text{min}$ or more, even more preferably 10.0 $\mu\text{m}/\text{min}$ or more, and particularly preferably 15.0 $\mu\text{m}/\text{min}$ or more. On the other hand, the dissolution rate in the film thickness direction is preferably 100 $\mu\text{m}/\text{min}$ or less, more preferably 50.0 $\mu\text{m}/\text{min}$ or less, and still more preferably 30.0 $\mu\text{m}/\text{min}$ or less.

[0287]

In step (13a-2), the ratio of the dissolution rate in the film thickness direction in the exposed portion to that in the unexposed portion of the light-absorbing layer is preferably 1 or more, more preferably 3 or more, still more preferably 5 or more, even more preferably 7 or more, and particularly preferably 10 or more. On the other hand, the ratio of the dissolution rate is preferably 50 or less, more preferably 30 or less, and still more preferably 20 or less.

[0288]

In step (13ya-2), the dissolution rate in the film thickness direction of the exposed portion of the light-absorbing layer is preferably 1.0 $\mu\text{m}/\text{min}$ or more, more preferably 3.0 $\mu\text{m}/\text{min}$ or more, still more preferably 5.0 $\mu\text{m}/\text{min}$ or more, even more preferably 10.0 $\mu\text{m}/\text{min}$ or more, and particularly preferably 15.0 $\mu\text{m}/\text{min}$ or more. On the other hand, the dissolution rate in the film thickness

direction is preferably 100 $\mu\text{m}/\text{min}$ or less, more preferably 50.0 $\mu\text{m}/\text{min}$ or less, and still more preferably 30.0 $\mu\text{m}/\text{min}$ or less.

[0289]

In step (13ya-2), the ratio of the dissolution rate in the film thickness direction in the exposed portion of the light-absorbing layer to the unexposed portion of the light-absorbing layer is preferably 1 or more, more preferably 3 or more, still more preferably 5 or more, even more preferably 7 or more, and particularly preferably 10 or more. On the other hand, the ratio of the dissolution rate is preferably 50 or less, more preferably 30 or less, and still more preferably 20 or less.

[0290]

In step (13ya-2), examples and preferred descriptions regarding the ratio of the dissolution rate of the first pressure-sensitive adhesive layer in the film thickness direction in the exposed portion and the dissolution rate of the first pressure-sensitive adhesive layer in the film thickness direction in the exposed portion to the unexposed portion are the same as the examples and preferred descriptions regarding the ratio of the dissolution rate of the light-absorbing layer in the film thickness direction in the exposed portion and the dissolution rate of the light-absorbing layer in the film thickness direction in

the exposed portion to the unexposed portion, respectively.

[0291]

<Step of Patterning (Step of Processing by Etching)>

In the method for producing a laminate according to the third aspect, the fourth aspect, the seventh aspect, and the eighth aspect of the present invention, the condition (b) is preferably satisfied in step (13) from the viewpoints of reduction in the energy of laser irradiation, debris suppression, and enhanced positional accuracy. In step (13), satisfying the condition refers to the state after step (13). From the viewpoint of the same effect of the invention, in the method for producing a laminate according to the third aspect, the fourth aspect, the seventh aspect, and the eighth aspect of the present invention, when the condition (b) is satisfied in step (13), it is preferable that (13b) patterning the light-absorbing layer by etching (hereinafter, referred to as step (13b)) includes (13b-1a) performing dry etching from an article side of the light-absorbing layer using the article as a mask to pattern the light-absorbing layer (hereinafter, referred to as step (13b-1a)) or (13b-1b) performing wet etching from the article side of the light-absorbing layer using the article as a mask to pattern the light-absorbing layer (hereinafter, referred to as step (13b-1b)).

[0292]

From the viewpoint of the same effect of the invention, it is preferable that the method for producing a laminate according to the fifth and sixth aspects of the present invention satisfy the condition (by) in step (13y). In step (13y), satisfying the condition refers to the state after step (13y). The method for producing a laminate according to the fifth and the sixth aspects of the present invention preferably includes, from the viewpoint of the same effect of the invention, when the above condition (by) is satisfied in step (13y), (13yb) patterning the light-absorbing layer and the first pressure-sensitive adhesive layer by etching (hereinafter referred to as step (13yb)), which includes (13yb-1a) dry-etching the light-absorbing layer and the first pressure-sensitive adhesive layer from the article side of the light-absorbing layer using the article as a mask (hereinafter referred to as step (13yb-1a)), or (13yb-1b) wet-etching the light-absorbing layer and the first pressure-sensitive adhesive layer from the article side of the light-absorbing layer using the article as a mask (hereinafter referred to as step (13yb-1b)).

[0293]

From the viewpoint of enhanced positional accuracy, the method for producing a laminate according to the third aspect, the fourth aspect, the seventh aspect, and the

eighth aspect of the present invention preferably satisfies the condition (c) in step (13). In step (13), satisfying the condition refers to the state after step (13). From the viewpoint of enhanced positional accuracy, in the method for producing a laminate according to the third, fourth, seventh, and eighth aspects of the present invention, when the condition (c) is satisfied in step (13), step (13b) preferably includes (13b-1a) performing dry etching from an article side of the light-absorbing layer using the article as a mask to pattern the light-absorbing layer; or (13b-1b) performing wet etching from the article side of the light-absorbing layer using the article as a mask to pattern the light-absorbing layer.

[0294]

From the viewpoint of enhanced positional accuracy, the method for producing a laminate according to the fifth and sixth aspects of the present invention preferably satisfy the condition (cy) in step (13y). In step (13y), satisfying the condition refers to the state after step (13y). From the viewpoint of enhanced positional accuracy, in the method for producing a laminate according to the fifth and sixth aspects of the present invention, when the condition of (cy) is satisfied in step (13y), step (13yb) preferably includes (13yb-1a) performing dry etching from an article side of the light-absorbing layer using the

article as a mask to pattern the light-absorbing layer: or (13yb-1b) performing wet etching from the article side of the light-absorbing layer using the article as a mask to pattern the light-absorbing layer.

[0295]

As described above, it is possible to reduce the volume of the light-absorbing layer and/or the volume of the first pressure-sensitive adhesive layer by patterning, as a recess, a portion at where an article is not in contact with the light-absorbing layer and/or the first pressure-sensitive adhesive layer or by patterning the portion as an opening. The light-absorbing layer and/or first pressure-sensitive adhesive layer having a recess formed by such patterning and the light-absorbing layer and/or first pressure-sensitive adhesive layer having an opening formed by such patterning are more suitable in that the effects of debris suppression and excellent positional accuracy based on the above-described estimated mechanism are remarkable. Examples and preferred descriptions concerning the indentation elastic modulus of the light-absorbing layer at 50°C and the glass transition temperature of the light-absorbing layer are as described above. Examples and preferred descriptions concerning the indentation elastic modulus of the first pressure-sensitive adhesive layer at 50°C and the glass transition temperature

of the first pressure-sensitive adhesive layer are as described above.

[0296]

Examples of the dry etching method in the steps (13b-1a) and (13yb-1a) include reactive gas etching in which an etching gas is exposed, plasma etching in which an etching gas ionized or radicalized by an electromagnetic wave is exposed, and reactive ion etching in which an etching gas ionized or radicalized by an electromagnetic wave is accelerated by applying a bias and collided.

[0297]

The etching gas is preferably a gas containing oxygen, argon, fluorine, or chlorine as a main component element. The main component element in the etching gas refers to an element that is included most on a mass basis in the constituent elements of the etching gas. The etching gas is preferably a gas containing one or more selected from the group consisting of oxygen, ozone, argon, fluorine, and chlorine, and more preferably a gas containing oxygen or ozone. The total content ratio of oxygen, ozone, argon, fluorine, and chlorine in the etching gas is preferably 10 mass% or more, more preferably 30 mass% or more, still more preferably 50 mass% or more, even more preferably 70 mass% or more, and particularly preferably 80 mass% or more. On the other hand, the total

content ratio of oxygen, ozone, argon, fluorine, and chlorine in the etching gas is preferably 100 mass% or less. The etching gas is preferably a gas containing oxygen, ozone, argon, fluorine, or chlorine as a main component. The main component in the etching gas refers to a component that is included most on a mass basis in the constituent elements of the etching gas. As the etching gas, a known etching gas may be used.

[0298]

The dry etching temperature is preferably 10°C or more, more preferably 20°C or more, still more preferably 30°C or more, and particularly preferably 40°C or more. Meanwhile, the dry etching temperature is preferably 200°C or less, more preferably 150°C or less, and still more preferably 120°C or less. Furthermore, the dry etching temperature is preferably 100°C or less, more preferably 80°C or less, and still more preferably 60°C or less. The dry etching time is preferably 10 seconds or more, more preferably 30 seconds or more, still more preferably 60 seconds or more, even more preferably 180 seconds or more, and particularly preferably 300 seconds or more. On the other hand, the dry etching time is preferably 60 minutes or less, more preferably 30 minutes or less, still more preferably 20 minutes or less, and particularly preferably 10 minutes or less.

[0299]

The etching rate in the film thickness direction of the light-absorbing layer in steps (13b-1a) and (13yb-1a) is preferably 0.10 $\mu\text{m}/\text{min}$ or more, more preferably 0.50 $\mu\text{m}/\text{min}$ or more, still more preferably 1.0 $\mu\text{m}/\text{min}$ or more, even more preferably 2.0 $\mu\text{m}/\text{min}$ or more, and particularly preferably 3.0 $\mu\text{m}/\text{min}$ or more. On the other hand, the etching rate in the film thickness direction is preferably 10.0 $\mu\text{m}/\text{min}$ or less, more preferably 7.0 $\mu\text{m}/\text{min}$ or less, and still more preferably 5.0 $\mu\text{m}/\text{min}$ or less.

[0300]

In steps (13b-1a) and (13yb-1a), the ratio of the etching rate in the film thickness direction to that in the in-plane direction of the light-absorbing layer is preferably 3 or more, more preferably 5 or more, still more preferably 10 or more, even more preferably 20 or more, and particularly preferably 30 or more. On the other hand, the ratio of the etching rate is preferably 200 or less, more preferably 100 or less, and still more preferably 50 or less.

[0301]

Examples and preferred descriptions regarding the ratio of the etching rate in the film thickness direction of the first pressure-sensitive adhesive and the etching rate in the film thickness direction with respect to the

in-plane direction of the first pressure-sensitive adhesive layer in step (13yb-1a) are the same as the examples and preferred descriptions regarding the ratio of the etching rate in the film thickness direction of the light-absorbing layer and the etching rate in the film thickness direction with respect to the in-plane direction of the light-absorbing layer, respectively.

[0302]

Examples of the method of performing wet etching in steps (13b-1b) and (13yb-1b) include a method of applying an etching solution, a method of spraying an etching solution in a mist form, a method of immersing in an etching solution, and a method of irradiating with ultrasonic waves after immersion in an etching solution. The etching solution is preferably an alkali solution, and is preferably a solution of an organic alkali compound or an aqueous solution of a compound exhibiting alkalinity. Examples and preferred descriptions concerning the alkali solution are the same as the examples and preferred descriptions in the developer, respectively.

[0303]

The etching solution is also preferably an acidic solution. The acidic solution is preferably an aqueous solution of a compound exhibiting acidity. Examples of the acidic solution include hydrofluoric acid, hydrochloric

acid, sulfuric acid, nitric acid, phosphoric acid, phosphorous acid, acetic acid, and oxalic acid, and a known solution may be used. The etching solution is also preferably an organic solvent. As the organic solvent, a solvent in the composition described above may be used. Examples of the organic solvent include cyclopentanone, cyclohexanone, propylene glycol monomethyl ether acetate, diethylene glycol mono-n-butyl ether, N-methyl -2 pyrrolidone, and γ -butyrolactone, and known solvents may be used. As the etching solution, a mixed solution containing an organic solvent and a poor solvent for the light-absorbing layer or the first pressure-sensitive adhesive may be used. Examples and preferred descriptions regarding the conditions of the wet etching method are the same as the examples and preferred descriptions in the conditions of the developing method described above, respectively.

[0304]

The etching rate in the film thickness direction of the light-absorbing layer in step (13b-1b) is preferably 0.10 $\mu\text{m}/\text{min}$ or more, more preferably 0.50 $\mu\text{m}/\text{min}$ or more, still more preferably 1.0 $\mu\text{m}/\text{min}$ or more, still more preferably 2.0 $\mu\text{m}/\text{min}$ or more, particularly preferably 3.0 $\mu\text{m}/\text{min}$ or more. On the other hand, the etching rate in the film thickness direction is preferably 10.0 $\mu\text{m}/\text{min}$ or less, more preferably 7.0 $\mu\text{m}/\text{min}$ or less, and still more

preferably 5.0 $\mu\text{m}/\text{min}$ or less.

[0305]

The etching rate in the film thickness direction of the light-absorbing layer in step (13yb-1b) is preferably 0.10 $\mu\text{m}/\text{min}$ or more, more preferably 0.50 $\mu\text{m}/\text{min}$ or more, still more preferably 1.0 $\mu\text{m}/\text{min}$ or more, still more preferably 2.0 $\mu\text{m}/\text{min}$ or more, particularly preferably 3.0 $\mu\text{m}/\text{min}$ or more. On the other hand, the etching rate in the film thickness direction is preferably 10.0 $\mu\text{m}/\text{min}$ or less, more preferably 7.0 $\mu\text{m}/\text{min}$ or less, and still more preferably 5.0 $\mu\text{m}/\text{min}$ or less.

[0306]

Examples and preferred descriptions regarding the etching rate in the film thickness direction of the first pressure-sensitive adhesive layer in step (13yb-1b) are the same as the examples and preferred descriptions regarding the etching rate in the film thickness direction of the light-absorbing layer, respectively. In step (13b-1a), step (13yb-1a), step (13b-1b), and step (13yb-1b), dry etching or wet etching is performed using an article as a mask, so that a photoresist pattern may not be formed. In addition, from the viewpoint of suppressing damage to the article by the etching gas or the etching solution, a photoresist pattern in contact with the light-absorbing layer or the first pressure-sensitive adhesive layer may be

formed. In the case of forming a photoresist pattern, it is preferable to remove the photoresist pattern after dry etching or wet etching. Examples of the method for removing the photoresist pattern include a removal method using a resist stripping solution and a removal method by ashing.

[0307]

Examples and preferred descriptions regarding that the light-absorbing layer and the first pressure-sensitive adhesive layer are layers formed from a positive photosensitive composition, a negative photosensitive composition, or a non-photosensitive composition are as described above. Examples and preferred descriptions concerning the conditions (a) to (c) and the conditions (ay) to (cy) are the same as the examples and preferred descriptions concerning the conditions (α) to (γ), respectively.

[0308]

In the method for producing a laminate according to the third aspect, the fourth aspect, the seventh aspect, and the eighth aspect of the present invention, from the viewpoints of reduction in the energy of laser irradiation, debris suppression, and enhanced positional accuracy, it is preferable that in step (13), the light-absorbing layer is present, in a state of being in contact with the first

substrate, as a layer having a plurality of convex-portion light-absorbing layers and a recess light-absorbing layer, and the thickness of the light-absorbing layer in the recess is smaller than the thickness of the light-absorbing layer in the plurality of convex portions. In the method for producing a laminate according to the third aspect, the fourth aspect, the seventh aspect, and the eighth aspect of the present invention, it is preferable that the plurality of articles preferably each independently contact at least one of the plurality of convex-portion light-absorbing layers. In step (13), the above aspect refers to a state after step (13). That is, in step (13), the light-absorbing layer is subjected to pattern processing, so that the light-absorbing layer is present as a layer having a plurality of convex-portion light-absorbing layers and a recess light-absorbing layer. In step (13), the light-absorbing layer is subjected to pattern processing, so that the plurality of articles are each independently in contact with at least one of the plurality of convex-portion light-absorbing layers. In the method for producing a laminate according to the seventh and eighth aspects of the present invention, the light-absorbing layer is present, in a state of being in contact with the first substrate, as a layer having a plurality of convex-portion light-absorbing layers and a recess light-absorbing layer in step (12z), and the

thickness of the light-absorbing layer in the recess is smaller than the thickness of the light-absorbing layer in the plurality of convex-portions, and the light-absorbing layer in the recess is also present in the similar aspect in step (13).

[0309]

In the method for producing a laminate according to the third aspect, the fourth aspect, the seventh aspect, and the eighth aspect of the present invention, from the viewpoints of reduction in the energy of laser irradiation, debris suppression, and enhanced positional accuracy, it is preferable that in step (13), the light-absorbing layer is present as a layer having a plurality of island-shaped light-absorbing layers in a state of being in contact with the first substrate. In the method for producing a laminate according to the third aspect, the fourth aspect, the seventh aspect, and the eighth aspect of the present invention, it is preferable that the plurality of articles are each independently in contact with at least one of the plurality of island-shaped light-absorbing layers. In step (13), the above aspect refers to a state after step (13). That is, in step (13), the light-absorbing layer is subjected to pattern processing, so that the light-absorbing layer exists as a plurality of island-shaped light-absorbing layers. In step (13), the light-absorbing

layer is subjected to pattern processing, so that the plurality of articles are each independently in contact with at least one of the plurality of island-shaped light-absorbing layers. In the method for producing a laminate according to the seventh and eighth aspects of the present invention, the light-absorbing layer is present as a layer having a plurality of island-shaped light-absorbing layers in a state of being in contact with the first substrate in step (12z), and the light-absorbing layer is also present in a similar manner in step (13).

[0310]

In the method for producing a laminate according to each of the fifth and sixth aspects of the present invention, from the viewpoints of reduction in the energy of laser irradiation, debris suppression, and enhanced positional accuracy, it is preferable that, in step (13y), the light-absorbing layer is present, in a state of being in contact with the first substrate, as a layer having a plurality of convex-portion light-absorbing layers and a recess light-absorbing layer, and the thickness of the light-absorbing layer in the recess is smaller than the thickness of the light-absorbing layer in the plurality of convex portions. In the method for producing a laminate according to the fifth and sixth aspects of the present invention, from the viewpoint of the same effect of the

invention, in step (13y), the first pressure-sensitive adhesive layer is preferably present as a layer having a plurality of convex-portion first pressure-sensitive adhesive layer in a state of being in contact with at least one of the plurality of convex-portion light-absorbing layers. The first pressure-sensitive adhesive layer is also preferably present as a layer having a plurality of recess first pressure-sensitive adhesive layers in a state of being in contact with at least one of the plurality of recess light-absorbing layers. In the method for producing a laminate according to the fifth and sixth aspects of the present invention, the plurality of articles are preferably each independently in contact with at least one of the plurality of convex-portion first pressure-sensitive adhesive layers. In step (13y), the above aspect refers to a state after step (13y). That is, in step (13y), the light-absorbing layer and the first pressure-sensitive adhesive layer are subjected to patterning, and thus the first pressure-sensitive adhesive layer is present as a layer having a plurality of convex-portion first pressure-sensitive adhesive layers. In step (13y), the light-absorbing layer and the first pressure-sensitive adhesive layer are subjected to patterning, and thus the plurality of articles are each independently in contact with at least one of the plurality of convex-portion first pressure-

sensitive adhesive layers.

[0311]

In the method for producing a laminate according to each of the fifth and sixth aspects of the present invention, from the viewpoints of reduction in the energy of laser irradiation, debris suppression, and enhanced positional accuracy, it is preferable that in step (13y), the light-absorbing layer exists as a plurality of island-shaped light-absorbing layers in a state of being in contact with the first substrate. In the method for producing a laminate according to the fifth and sixth aspects of the present invention, from the viewpoint of the same effect of the invention, in step (13y), the first pressure-sensitive adhesive layer is preferably present as a layer having a plurality of island-shaped first pressure-sensitive adhesive layers in a state of being in contact with at least one of the plurality of island-shaped light-absorbing layers. In the method for producing a laminate according to the fifth and sixth aspects of the present invention, the plurality of articles are preferably each independently in contact with at least one of the plurality of island-shaped first pressure-sensitive adhesive layers. In step (13y), the above aspect refers to a state after step (13y). That is, in step (13y), the light-absorbing layer and the first pressure-sensitive adhesive layer are

subjected to patterning, and thus the first pressure-sensitive adhesive layer is present as a layer having a plurality of island-shaped first pressure-sensitive adhesive layers. In step (13y), the light-absorbing layer and the first pressure-sensitive adhesive layer are subjected to patterning, and thus the plurality of articles are each independently in contact with at least one of the plurality of island-shaped first pressure-sensitive adhesive layers.

[0312]

<Patterning step (configuration and physical properties of light-absorbing layer and /or first pressure-sensitive adhesive layer)>

In the method for producing a laminate of the present invention, from the viewpoints of reduction in the energy of laser irradiation, debris suppression, and enhanced positional accuracy, it is preferable that in step (13), step (13y), step (12), step (12y), or step (12z), when the area of the surface 1a which is the first substrate side of the light-absorbing layer is denoted by (S_{1a}), and the area of the surface 2a facing the surface 1a of the light-absorbing layer is denoted by (S_{2a}), the relationship of the formula (S-1) is satisfied.

$$(S_{1a}) \geq (S_{2a}) \quad (S-1)$$

In step (13), the light-absorbing layer satisfying

the condition refers to the state after step (13).

(13y) That the light-absorbing layer satisfies the relationship of the formula (S-1) in the step means a state after step (13y). In step (12), step (12y), or step (12z), that the light-absorbing layer satisfies the relationship of the formula (S-1) refers to the state after step (12), step (12y), or step (12z). Examples and preferred descriptions concerning the relationship of the above formula (S-1) are as described above.

[0313]

In step (13), step (13y), step (12), step (12y), or step (12z), the light-absorbing layer or the first pressure-sensitive adhesive layer satisfies the relationship of the above formula (S-1), whereby the area of contact between the light-absorbing layer and the article or between the first pressure-sensitive adhesive layer and the article can be reduced. Therefore, it is considered that an excessive adhesive force between the light-absorbing layer and the article or between the first pressure-sensitive adhesive layer and the article can be suppressed. As a result, when the article is transferred from the light-absorbing layer or the first pressure-sensitive adhesive layer, the transfer can be performed with less energy. It is therefore estimated that residuals of the light-absorbing layer or the first pressure-

sensitive adhesive layer on the surface of the article and scattering of the light-absorbing layer or the first pressure-sensitive adhesive layer during ablation are suppressed and that the effect of debris suppression becomes remarkable. Furthermore, since transfer can be performed with less energy, the behavior of the article during transfer becomes stable, and the absolute value of variation in irradiation energy also becomes small, and it is estimated that the effect of excellent positional accuracy becomes remarkable.

[0314]

In the method for producing a laminate of the present invention, from the viewpoint of enhanced positional accuracy, it is also preferable that the relationship of the formula (S-2) is satisfied when the area of the surface 1a of the light-absorbing layer on the first substrate side is denoted by (S_{1a}) and the area of the surface 2a facing the surface 1a of the light-absorbing layer is denoted by (S_{2a}) in step (13), step (13y), step (12), step (12y), or step (12z).

$$(S_{1a}) < (S_{2a}) \quad (S-2)$$

In step (13), that the light-absorbing layer satisfies the relationship of the formula (S-2) refers to the state after step (13). In step (13y), that the light-absorbing layer satisfies the relationship of the formula

(S-2) refers to the state after step (13y). In step (12), step (12y), or step (12z), that the light-absorbing layer satisfies the relationship of the formula (S-2) refers to the state after step (12), step (12y), or step (12z).

Examples and preferred descriptions concerning the relationship of the above formula (S-2) are as described above.

[0315]

In step (13), step (13y), step (12), step (12y), or step (12z), the light-absorbing layer or the first pressure-sensitive adhesive layer satisfies the relationship of the above formula (S-2), so that the area of contact between the light-absorbing layer and the first substrate or the area of contact between the first pressure-sensitive adhesive layer and the light-absorbing layer can be reduced. Therefore, it is considered that it is possible to suppress a reactive force that the light-absorbing layer receives from the first substrate at the time of ablation or a reactive force that the first pressure-sensitive adhesive layer receives from the light-absorbing layer. As a result, it is estimated that the excessive energy transmitted from the light-absorbing layer or the first pressure-sensitive adhesive layer to the article by the reactive force can be suppressed, and the behavior of the article at the time of transfer is

stabilized, so that the effect of excellent positional accuracy becomes remarkable.

[0316]

in the method for producing a laminate according to the fourth aspect of the present invention, the light-absorbing layer has an indentation elastic modulus at 50°C of 1.0×10^3 to 2.0×10^9 Pa and/or a glass transition temperature of -50 to 150°C in step (13). in the method for producing a laminate according to the third aspect of the present invention, the light-absorbing layer has an indentation elastic modulus at 50°C of 1.0×10^3 to 2.0×10^9 Pa and/or a glass transition temperature of -50 to 150°C in step (13).

[0317]

in the method for producing a laminate according to the eighth aspect of the present invention, the light-absorbing layer has an indentation elastic modulus at 50°C of 1.0×10^3 to 2.0×10^9 Pa and/or a glass transition temperature of -50 to 150°C in step (12z). in the method for producing a laminate according to the seventh aspect of the present invention, the light-absorbing layer has an indentation elastic modulus at 50°C of 1.0×10^3 to 2.0×10^9 Pa and/or a glass transition temperature of -50 to 150°C in step (12z).

[0318]

In the method for producing a laminate according to the sixth aspect of the present invention, the first pressure-sensitive adhesive layer has an indentation elastic modulus at 50°C of 1.0×10^3 to 2.0×10^9 Pa and/or a glass transition temperature of -50 to 150°C in step (13y). In the method for producing a laminate according to the fifth aspect of the present invention, the first pressure-sensitive adhesive layer preferably has an indentation elastic modulus at 50°C of 1.0×10^3 to 2.0×10^9 Pa and/or a glass transition temperature of -50 to 150°C in step (13y).

[0319]

The fact that the indentation elastic modulus and/or the glass transition temperature are/is within the above range in step (13) means a state after step (13). The fact that the indentation elastic modulus and/or the glass transition temperature are/is within the above range in step (13y) means a state after step (13y). The fact that the indentation elastic modulus and/or the glass transition temperature are/is within the above range in step (12z) means a state after step (12z). Examples and preferred descriptions concerning the indentation elastic modulus of the light-absorbing layer at 50°C and the glass transition temperature of the light-absorbing layer are as described above. Examples and preferred descriptions concerning the

indentation elastic modulus of the first pressure-sensitive adhesive layer at 50°C and the glass transition temperature of the first pressure-sensitive adhesive layer are as described above. Examples and preferred descriptions concerning other configurations and physical property values of the light-absorbing layer are as described above. In addition, other examples and preferred descriptions regarding the configuration and physical property values of the first pressure-sensitive adhesive layer are also as described above.

[0320]

<First substrate; Step of crosslinking light-absorbing layer and /or first pressure-sensitive adhesive layer>

From the viewpoints of reduction in the energy of laser irradiation, debris suppression, and enhanced positional accuracy, the method for producing a laminate according to the third and fourth aspects of the present invention preferably further includes (14) crosslinking a pattern of the light-absorbing layer (hereinafter, referred to as step (14)) before step (13) or after step (13). From the viewpoints of reduction in the energy of laser irradiation, debris suppression, and enhanced positional accuracy, the method for producing a laminate according to the seventh and eighth aspects of the present invention preferably further includes (14) crosslinking a pattern of

the light-absorbing layer (hereinafter, referred to as step (14)) after step (12z). In the method for producing a laminate according to the third aspect, the fourth aspect, the seventh aspect, and the eighth aspect of the present invention, from the viewpoint of the same effect of the invention, step (14) preferably includes (14a) heating the pattern of the light-absorbing layer (hereinafter, referred to as step (14a)); or (14b-1) irradiating the light-absorbing layer with a chemical active ray from the first substrate side of the light-absorbing layer (hereinafter, referred to as step (14b-1)).

[0321]

The method for producing a laminate according to the third and fourth aspects of the present invention preferably further includes step (14) after step (12) and before step (13). It is also preferable that the method for producing a laminate according to the third and fourth aspects of the present invention further includes step (14) after step (13) and before step (20), or after step (13) and before step (21). In addition, the method for producing a laminate according to the seventh aspect and the eighth aspect of the present invention preferably further includes step (14) after step (12z) and before step (20), or after step (12z) and before step (21).

[0322]

When the method for producing a laminate according to the third aspect, the fourth aspect, the seventh aspect, and the eighth aspect of the present invention has step (14), from the viewpoint of the effect of the present invention, in step (13), it is preferable to satisfy any one of the conditions (a) to (c), it is more preferable to satisfy the condition (a) and/or the condition (b), and it is still more preferable to satisfy the condition (a).

[0323]

From the viewpoints of reduction in the energy of laser irradiation, debris suppression, and enhanced positional accuracy, the method for producing a laminate according to the fifth and sixth aspects of the present invention preferably further includes (14y) crosslinking the pattern of the light-absorbing layer and /or the pattern of the first pressure-sensitive adhesive layer (hereinafter, referred to as step (14y)) before step (13y) or after step (13y). In the method for producing a laminate according to the sixth aspect and the sixth aspect of the present invention, from the viewpoint of the same effect of the invention, step (14y) preferably includes (14ya) heating the pattern of the light-absorbing layer and /or the pattern of the first pressure-sensitive adhesive layer (hereinafter, referred to as step (14ya)), or (14yb-1) irradiating the light-absorbing layer and the first

pressure-sensitive adhesive layer with chemical active rays from the first substrate side of the light-absorbing layer (hereinafter, referred to as step (14yb-1)).

[0324]

The methods for producing a laminate according to the fifth and sixth aspects of the present invention preferably further include step (12y) after step (13y) and before step (14y). It is also preferable that the method for producing a laminate according to the fifth and sixth aspects of the present invention further include step (13y) after step (20) and before step (13y), or after step (21 y) and before step (14).

[0325]

When the method for producing a laminate according to the fifth and sixth aspects of the present invention has step (14y), from the viewpoint of the effect of the present invention, in step (13y), it is preferable to satisfy any one of the conditions (ay) to (cy), it is more preferable to satisfy the condition (ay) and/or the condition (by), and it is still more preferable to satisfy the condition (ay).

[0326]

When the light-absorbing layer and /or the first pressure-sensitive adhesive layer is a layer formed from a negative photosensitive composition, photocuring proceeds

by irradiation with chemical active rays, and the degree of crosslinking in these layers is improved. In addition, by heating, curing proceeds due to generation of radicals, acids, or bases, and the degree of crosslinking in these layers is improved. When the light-absorbing layer and /or the first pressure-sensitive adhesive layer is a layer formed from a positive photosensitive composition, bond cleavage, reaction, or structural change of the photosensitive agent proceeds by irradiation with chemical active rays, and carboxy groups, phenolic hydroxyl groups, and the like increase. As a result, the polarity in these layers greatly changes, so that hydrogen bond formation and intermolecular interaction in the layers increase. In addition, by heating, curing proceeds due to generation of radicals, acids, or bases, and the degree of crosslinking in these layers is improved. Therefore, it is considered that internal stress is generated in these layers to suppress excessive adhesive force between the light-absorbing layer and the article or between the first pressure-sensitive adhesive layer and the article. As a result, when the article is transferred from the light-absorbing layer or the first pressure-sensitive adhesive layer, the transfer can be performed with less energy. It is therefore estimated that residuals of the light-absorbing layer or the first pressure-sensitive adhesive

layer on the surface of the article and scattering of the light-absorbing layer or the first pressure-sensitive adhesive layer during ablation are suppressed and that the effect of debris suppression becomes remarkable.

Furthermore, since transfer can be performed with less energy, the behavior of the article during transfer becomes stable, and the absolute value of variation in irradiation energy also becomes small, and it is estimated that the effect of excellent positional accuracy becomes remarkable.

[0327]

Examples of the method of heating in steps (14a) and (14ya) include a method of heating using an oven, a hot plate, infrared rays, a flash annealing device, a laser annealing device, or the like.

[0328]

The heating temperature is preferably 50°C or higher, more preferably 80°C or higher, still more preferably 100°C or higher, still more preferably 120°C or higher, and particularly preferably 150°C or higher. On the other hand, the heating temperature is preferably 500°C or less, more preferably 400°C or less, still more preferably 300°C or less, still more preferably 250°C or less, and particularly preferably 200°C or less. The heating time is preferably 10 seconds or more, more preferably 30 seconds or more, still more preferably 60 seconds or more, still

more preferably 180 seconds or more, and particularly preferably 300 seconds or more. On the other hand, the heating time is preferably 60 minutes or less, more preferably 30 minutes or less, still more preferably 20 minutes or less, and particularly preferably 10 minutes or less. The heating step may be performed in two or more stages. The treatment atmosphere is preferably an air, oxygen, nitrogen, helium, neon, argon, krypton, or xenon atmosphere, a gas atmosphere containing 1 to 10,000 ppm by mass (0.0001 to 1 mass%) of oxygen, or a vacuum atmosphere.

[0329]

Examples of the method of irradiation with chemical active rays in step (14b-1) and step (14yb-1) include a method of exposure with the use of an exposure machine such as a stepper, a scanner, a mirror projection mask aligner (MPA), or a parallel light mask aligner (PLA).

[0330]

The maximum wavelength of the chemical active rays is preferably 180 nm or more, more preferably 200 nm or more, still more preferably 240 nm or more, even more preferably 300 nm or more, and particularly preferably 340 nm or more. On the other hand, the maximum wavelength of the chemical active rays is preferably 450 nm or less, more preferably 420 nm or less, and still more preferably 400 nm or less. The chemical active rays are preferably j-rays (wavelength:

313 nm) of a mercury lamp, i-rays (wavelength: 365 nm) of a mercury lamp, h-rays (wavelength: 405 nm) of a mercury lamp, or g-rays (wavelength: 436 nm) of a mercury lamp, and more preferably a mixed ray of i-rays, h-rays, and g-rays of a mercury lamp. The chemical active ray is preferably an ArF laser (wavelength: 193 nm), a KrF laser (wavelength: 248 nm), a XeCl laser (wavelength: 308 nm), a XeF laser (wavelength: 351 nm), or a YAG laser (wavelength: 266 nm, 355 nm, or 532 nm).

[0331]

The exposure energy of chemical active rays is preferably 10 mJ/cm² or more, more preferably 50 mJ/cm² or more, still more preferably 100 mJ/cm² or more, even more preferably 200 mJ/cm² or more, and particularly preferably 300 mJ/cm² or more in terms of i-ray illuminance value. On the other hand, the exposure energy is preferably 3000 mJ/cm² or less, more preferably 2000 mJ/cm² or less, still more preferably 1500 mJ/cm² or less, even more preferably 1000 mJ/cm² or less, and particularly preferably 500 mJ/cm² or less in terms of i-ray illuminance value.

[0332]

In the method for producing a laminate according to the third aspect, the fourth aspect, the seventh aspect, and the eighth aspect of the present invention, from the viewpoints of reduction in the energy of laser irradiation,

debris suppression, and enhanced positional accuracy, and enhanced positional accuracy, when the method includes step (13a), the wavelength of the chemical active rays in step (14b-1) is preferably a wavelength different from the wavelength of the chemical active rays in step (13a). In the methods for producing a laminate according to the fifth and sixth aspects of the present invention, from the viewpoint of the same effect of the invention, when step (13ya) is included, the wavelength of the chemical active ray in step (14yb-1) is preferably a wavelength different from the wavelength of the chemical active ray in step (13ya). In the methods for producing a laminate according to the seventh and eighth aspects of the present invention, the wavelength of the chemical active rays in step (14b-1) is preferably a wavelength different from the wavelength of the chemical active rays in step (12z) from the viewpoints of reduction in the energy of laser irradiation, debris suppression, and enhanced positional accuracy. With the above configuration, it is possible to apply the light-absorbing layer and /or the first pressure-sensitive adhesive layer which are not crosslinked by chemical active rays in step (13a), step (13ya), or step (12z). In addition, it is preferable from the viewpoint of selectively crosslinking the light-absorbing layer and/or the first pressure-sensitive adhesive layer with the

chemical active rays in step (14b-1) or step (14yb-1).

[0333]

From the viewpoints of reduction in the energy of laser irradiation, debris suppression, and enhanced positional accuracy, the method for producing a laminate according to the third, fourth, seventh, and eighth aspects of the present invention preferably further includes, when step (14) includes step (14b-1), (14b-2) heating the pattern of the light-absorbing layer (hereinafter, referred to as step (14b-2)) after step (14b-1). From the viewpoint of reduction in the energy of laser irradiation, debris suppression, and enhanced positional accuracy, the method for producing a laminate according to the fifth and sixth aspects of the present invention preferably further includes, when step (14y) includes step (14yb-1), (14yb-2) heating the pattern of the light-absorbing layer (hereinafter, referred to as step (14yb-2)) after step (14yb-1). The illustration and preferred description of the step of heating in steps (14b-2) and (14yb-2) are the same as the illustration and preferred description in steps (14a) and (14ya), respectively.

[0334]

<Second substrate; Step of preparing laminate>

The method for producing a laminate according to the third, fifth, and seventh aspects of the present invention

includes (20) preparing a laminate a2 including a second substrate and a second pressure-sensitive adhesive layer in this order (hereinafter, referred to as step (20)). The method for producing a laminate according to the fourth, sixth, and eighth aspects of the present invention preferably further includes (20) preparing a laminate a2 including a second substrate and a second pressure-sensitive adhesive layer in this order (hereinafter, referred to as step (20)). Examples and preferred descriptions concerning the laminate a2 are as described above. The step of preparing such a laminate may be a step of producing and preparing a laminate. The step of preparing such a laminate may be a step of preparing a laminate that has already been produced.

[0335]

<Second substrate; Step of forming second pressure-sensitive adhesive layer>

The method for producing a laminate according to the third, fifth, and seventh aspects of the present invention preferably includes (21) forming a second pressure-sensitive adhesive layer on the second substrate. The method for producing a laminate according to the fourth, sixth, and eighth aspects of the present invention preferably further includes (21) forming a second pressure-sensitive adhesive layer on the second substrate. Examples

and preferred descriptions concerning the second substrate and the second pressure-sensitive adhesive layer are as described above. Examples of the method of forming the second pressure-sensitive adhesive layer in these steps include a method of applying a composition or a method of disposing a film formed from the composition. Examples and preferred descriptions concerning the methods are the same as the examples and preferred descriptions in step (11) above, respectively.

[0336]

<Second substrate; Step of Transferring Article>

The method for producing a laminate according to the third and seventh aspects of the present invention includes (22) irradiating the light-absorbing layer with a chemical active ray from a first substrate side of the light-absorbing layer while a gap is present between an article provided on the first substrate and the second pressure-sensitive adhesive layer provided on the second substrate to transfer the article from the light-absorbing layer to the second pressure-sensitive adhesive layer (hereinafter, referred to as a step (22)). The method for producing a laminate according to the fourth and eighth aspects of the present invention preferably further includes step (22) from the viewpoint of improving the yield and reliability. In the method for producing a laminate according to the

third aspect, the fourth aspect, the seventh aspect, and the eighth aspect of the present invention, it is preferable to have a plurality of articles in contact with the second pressure-sensitive adhesive layer in step (22).
[0337]

A method for producing a laminate according to a fifth aspect of the present invention includes (22y) irradiating the light-absorbing layer with chemical active rays from the first substrate side of the light-absorbing layer while a gap is present between an article provided on the first substrate and a second pressure-sensitive adhesive layer provided on the second substrate to transfer the article from the first pressure-sensitive adhesive layer to the second pressure-sensitive adhesive layer (hereinafter, referred to as step (22y)). The method for producing a laminate according to the sixth aspect of the present invention preferably further includes step (22y). In the method for producing a laminate according to the fifth and sixth aspects of the present invention, it is preferable to have a plurality of articles in contact with the second pressure-sensitive adhesive layer in step (22).
[0338]

Examples and preferred descriptions concerning the article are as described above. In step (22), having a plurality of articles means a state after step (22).

Having a plurality of articles in step (22y) refers to a state after step (22y). That is, in step (22), the plurality of articles are transferred from the light-absorbing layer to the second pressure-sensitive adhesive layer. In step (22y), a plurality of articles are transferred from the first pressure-sensitive adhesive layer to the second pressure-sensitive adhesive layer.

[0339]

From the viewpoint of improving the yield and reliability, step (22) preferably involves transferring a plurality of articles provided on the first substrate from the light-absorbing layer to the second pressure-sensitive adhesive layer in two or more separate times, and more preferably sequentially transferring the plurality of articles from the light-absorbing layer to the second pressure-sensitive adhesive layer in two or more separate times. From the viewpoint of improving the yield and reliability, step (22y) preferably involves transferring a plurality of articles provided on the first substrate from the first pressure-sensitive adhesive layer to the second pressure-sensitive adhesive layer in two or more separate times, and more preferably sequentially transferring the plurality of articles from the first pressure-sensitive adhesive layer to the second pressure-sensitive adhesive layer in two or more separate times. Sequentially

transferring the plurality of articles means transferring the plurality of articles one by one in succession.

[0340]

In steps (22) and (22y), the gap provided between the article and the second pressure-sensitive adhesive layer is preferably 10 μm or more, more preferably 20 μm or more, still more preferably 30 μm or more, particularly preferably 50 μm or more from the viewpoint of debris suppression. On the other hand, the gap provided between the article and the second pressure-sensitive adhesive layer is preferably 500 μm or less, more preferably 300 μm or less, still more preferably 200 μm or less, particularly preferably 100 μm or less from the viewpoints of reduction in the energy of laser irradiation and enhanced positional accuracy.

[0341]

Steps (22) and (22y) preferably also involves irradiating the light-absorbing layer with chemical active rays from the first substrate side of the light-absorbing layer through a photomask. From the viewpoints of reduction in the energy of laser irradiation, debris suppression, and enhanced positional accuracy, the photomask includes a light-transmitting portion and a light-shielding portion, and a region of the light-transmitting portion is preferably within a region of the

first substrate where the article is provided, and more preferably corresponds to the region where the article is provided. In addition, the region of the light shielding portion is preferably equal to or more than the region of the first substrate where no article is provided, and more preferably corresponds to the region where no article is provided.

[0342]

The chemical active ray is preferably a laser from the viewpoint of process time reduction, debris suppression, and enhanced positional accuracy. The chemical active rays are also preferably incoherent light from the viewpoint of process time reduction. Examples of the lasers include solid-state lasers such as YAG lasers, YVO₄ lasers, fiber lasers, and semiconductor lasers, and gas lasers such as carbon dioxide lasers, excimer lasers, and argon lasers. The beam shape of the laser is not limited, and the spot size of the laser is also not limited. When the spot size of the laser is smaller than that of the article, the spot of the laser may be scanned to irradiate the entire surface of the article.

[0343]

The maximum wavelength of the chemical active rays is preferably 180 nm or more, more preferably 200 nm or more, still more preferably 240 nm or more, even more preferably

300 nm or more, and particularly preferably 340 nm or more. On the other hand, the maximum wavelength of the chemical active rays is preferably 550 nm or less, more preferably 450 nm or less, still more preferably 420 nm or less, and particularly preferably 400 nm or less. The chemical active rays are also preferably j-rays (wavelength: 313 nm) of a mercury lamp, i-rays (wavelength: 365 nm) of a mercury lamp, h-rays (wavelength: 405 nm) of a mercury lamp, or g-rays (wavelength: 436 nm) of a mercury lamp, and more preferably a mixed ray of i-rays, h-rays, and g-rays of a mercury lamp. When the chemical active ray is a laser, the laser is particularly preferably an ArF laser (wavelength: 193 nm), a KrF laser (wavelength: 248 nm), a XeCl laser (wavelength: 308 nm), a XeF laser (wavelength: 351 nm), or a YAG laser (wavelength: 266 nm, 355 nm, or 532 nm).

[0344]

From the viewpoint of process time reduction, the energy density of the laser is preferably 100 mJ/cm² or more, more preferably 300 mJ/cm² or more, and still more preferably 300 mJ/cm² or more. On the other hand, the energy density is preferably 3000 mJ/cm² or less, more preferably 2000 mJ/cm² or less, still more preferably 1000 mJ/cm² or less from the viewpoints of yield improvement, reliability improvement, debris suppression, and enhanced positional accuracy.

[0345]

<Element substrate; Step of preparing laminate>

The method for producing a laminate of the present invention preferably further includes (30) preparing a laminate a3 including an element substrate and a third pressure-sensitive adhesive layer in this order (hereinafter, referred to as step (30)). Examples and preferred descriptions concerning the laminate a3 are as described above. The step of preparing such a laminate may be a step of producing and preparing a laminate. The step of preparing such a laminate may be a step of preparing a laminate that has already been produced.

[0346]

<Element substrate; Step of forming third pressure-sensitive adhesive layer>

The production method of the present invention preferably further includes (31) forming a third pressure-sensitive adhesive layer on the element substrate (hereinafter, referred to as step (31)). Examples and preferred descriptions concerning the element substrate and the third pressure-sensitive adhesive layer are as described above. Examples of the method of forming the third pressure-sensitive adhesive layer in these steps include a method of applying a composition or a method of disposing a film formed from the composition. Examples and

preferred descriptions concerning the methods are the same as the examples and preferred descriptions in step (11) above, respectively.

[0347]

<Element substrate; Step of transferring article to third pressure-sensitive adhesive layer>

The method for producing a laminate of the present invention preferably further includes (32) bringing an article provided on the second substrate into contact with a third pressure-sensitive adhesive layer provided on the element substrate into contact with each other and bonding the articles to each other, and transferring the article from the second pressure-sensitive adhesive layer to the third pressure-sensitive adhesive layer (hereinafter, referred to as step (32)). In step (32), it is more preferable to heat the article and the third pressure-sensitive adhesive layer in a state where the article and the third pressure-sensitive adhesive layer are brought into contact with each other and bonded to each other, and it is still more preferable to perform thermocompression bonding. The method for producing a laminate of the present invention preferably includes a plurality of articles in contact with the third pressure-sensitive adhesive layer in step (32).

[0348]

<Element substrate; Step of transferring article to element substrate>

The method for producing a laminate of the present invention preferably further includes (32J) bringing an article provided on the second substrate into contact with and bonding an element substrate and/or wiring provided on the element substrate to each other, and transferring the article from the second pressure-sensitive adhesive layer to the element substrate (hereinafter, referred to as step (32J)). When the method for producing a laminate of the present invention includes step (32J), it is preferable not to include the steps (30) and (31). In step (32J), it is more preferable to heat the article in a state where the article and the element substrate and/or the wiring provided on the element substrate are brought into contact with each other and bonded to each other, and it is still more preferable to perform thermocompression bonding.

[0349]

The method for producing a laminate of the present invention preferably further includes (31J) subjecting the element substrate and/or the wiring provided on the element substrate to plasma treatment (hereinafter, referred to as step (31J)). The method for producing a laminate of the present invention preferably includes step (31J) after step (32J). The method for producing a laminate of the present

invention preferably includes a plurality of articles in contact with the element substrate and/or the wiring provided on the element substrate in step (32J). Examples and preferred descriptions concerning the article are as described above. In step (32), having a plurality of articles means a state after step (32). Having a plurality of articles in step (32J) refers to a state after step (32J). That is, in step (32), a plurality of articles are transferred from the second pressure-sensitive adhesive layer to the third pressure-sensitive adhesive layer. In step (32J), the plurality of articles are transferred from the second pressure-sensitive adhesive layer to the element substrate. Examples and preferred descriptions regarding the step of heating and the step of thermocompression bonding in these steps are the same as the examples and preferred descriptions in the above step (12), respectively.

[0350]

In the method for producing a laminate of the present invention, it is preferable that the electrode terminal included in the article and the wiring included in the element substrate are electrically connected by solder bonding or bonding with an anisotropic conductive film in step (32) or after step (32). In the method for producing a laminate of the present invention, it is preferable that

the electrode terminal included in the article and the wiring included in the element substrate are electrically connected by solder bonding, bonding using an anisotropic conductive film, or direct bonding in step (32J) or after step (32J).

[0351]

The method for producing a laminate of the present invention is preferably used for producing an electronic component, an electronic device, a moving body, a building, or a window. Examples of the electronic component include a semiconductor device, an antenna, a display device, an optical device, a printed wiring board, a semiconductor package, an active component including a semiconductor device, and a passive component. Examples and preferred descriptions regarding electronic components, semiconductor devices, antennas, display devices, optical devices, printed wiring boards, semiconductor packages, active components including semiconductor devices, and passive components are as described above.

[0352]

<Schematic Cross-sectional View of Production Process of Micro LED Display>

A process of producing a micro LED display including an LED which is a semiconductor chip using the method for producing a laminate according to the third and fourth

aspects of the present invention will be described with reference to a schematic cross-sectional view in Fig. 1 as an example. In the drawings, (1) represents (Step 1), and the same applies hereinafter. (Step 1) First, a prebaked film of a light-absorbing layer 2, a layer formed from a positive photosensitive composition, is formed on a first substrate (quartz glass substrate) 1. (Step 2) Next, a semiconductor chip (LED) 4 including a gallium nitride semiconductor, the semiconductor chip 4 being provided with an electrode terminal 4a and placed on a donor substrate (sapphire substrate) 3, is prepared, and the light-absorbing layer 2 and the semiconductor chip 4 are bonded together. (Step 3) Next, only the semiconductor chip 4 is irradiated with the laser 5 from the donor substrate 3 side, and the semiconductor chip 4 is transferred from the donor substrate 3 to the light-absorbing layer 2. (Step 4) Thereafter, the donor substrate 3 is peeled off and removed from the semiconductor chip 4. (Step 5) Next, the light-absorbing layer 2 is irradiated with chemical active rays 6 from the semiconductor chip 4 side using the semiconductor chip 4 as a mask to form the exposed light-absorbing layer 7 having alkali solubility and the unexposed light-absorbing layer 8. (Step 6) Next, after development with an alkaline developer to remove the exposed light-absorbing layer 7 to obtain a pattern of the light-absorbing layer 2,

the unexposed light-absorbing layer 8 is heated and crosslinked to form the crosslinked light-absorbing layer 9. (Step 7) Next, a second pressure-sensitive adhesive layer 11 is formed on the second substrate (alkali-free glass substrate) 10. Thereafter, the semiconductor chip 4 is irradiated with the laser 5 from the first substrate 1 side while a gap is present between the semiconductor chip 4 and the second pressure-sensitive adhesive layer. In this case, the laser 5 is applied in two or more separate times to sequentially transfer the semiconductor chip 4 from the first substrate 1 to the second pressure-sensitive adhesive layer 11. (Step 8) The plurality of semiconductor chips 4 are transferred to desired positions of the second pressure-sensitive adhesive layer 11 with excellent positional accuracy while suppressing debris in laser transfer. The light-absorbing layer 12 after laser irradiation is formed on the first substrate 1, or the light-absorbing layer 12 after laser irradiation does not remain due to ablation during laser irradiation. Thereafter, the semiconductor chip 4 is disposed on a support substrate or the like, and a micro LED display is obtained by a known Chip-first (RDL-last) production process in which metal wiring, an interlayer insulating layer, and the like are formed.

[0353]

The production process of Steps 1 to 8 corresponds to the method for producing a laminate according to the third aspect of the present invention. In addition, the production process of Steps 1 to 5 or the production process of Steps 1 to 6 corresponds to the method for producing a laminate according to the fourth aspect of the present invention. The laminate obtained in Step 5 or 6 corresponds to the laminate according to the first aspect of the present invention.

[0354]

In addition, a process of producing a micro LED display including an LED which is a semiconductor chip using the method for producing a laminate according to the fifth and sixth aspects of the present invention will be described with reference to a schematic cross-sectional view in Fig. 2 as an example. (Step 1) First, a prebaked film of the light-absorbing layer 2, which is a layer formed from a positive photosensitive composition, is formed on the first substrate (quartz glass substrate) 1, and a prebaked film of the first pressure-sensitive adhesive layer 2a, which is a layer formed from a positive photosensitive composition, is further formed. (Step 2) Next, a semiconductor chip (LED) 4 having a gallium nitride semiconductor including an electrode terminal 4a and placed on a donor substrate (sapphire substrate) 3 is prepared,

and the first pressure-sensitive adhesive layer 2a and the semiconductor chip 4 are bonded together. (Step 3) Next, only the semiconductor chip 4 is irradiated with the laser 5 from the donor substrate 3 side, and the semiconductor chip 4 is transferred from the donor substrate 3 to the first pressure-sensitive adhesive layer 2a. (Step 4) Thereafter, the donor substrate 3 is peeled off and removed from the semiconductor chip 4. (Step 5) Next, the light-absorbing layer 2 and the first pressure-sensitive adhesive layer 2a are irradiated with chemical active rays 6 from the semiconductor chip 4 side using the semiconductor chip 4 as a mask to form the light-absorbing layer and the first pressure-sensitive adhesive layer 7a after exposure having alkali solubility, and the unexposed light-absorbing layer 8 and the unexposed first pressure-sensitive adhesive layer 8a. (Step 6) Next, after development with an alkaline developer to remove the exposed light-absorbing layer and first pressure-sensitive adhesive layer 7a to obtain a pattern of the light-absorbing layer 2 and a pattern of the first pressure-sensitive adhesive layer 2a, the unexposed light-absorbing layer 8 and the unexposed first pressure-sensitive adhesive layer 8a are heated and crosslinked to form the crosslinked light-absorbing layer 9 and the crosslinked first pressure-sensitive adhesive layer 9a. (Step 7) Next, a second pressure-sensitive adhesive layer

11 is formed on the second substrate (alkali-free glass substrate) 10. Thereafter, the semiconductor chip 4 is irradiated with the laser 5 from the first substrate 1 side while a gap is present between the semiconductor chip 4 and the second pressure-sensitive adhesive layer. In this case, the laser 5 is applied in two or more separate times to sequentially transfer the semiconductor chip 4 from the first substrate 1 to the second pressure-sensitive adhesive layer 11. (Step 8) The plurality of semiconductor chips 4 are transferred to desired positions of the second pressure-sensitive adhesive layer 11 with excellent positional accuracy while suppressing debris in laser transfer. The light-absorbing layer and the first pressure-sensitive adhesive 12a after laser irradiation are formed on the first substrate 1, or the light-absorbing layer and the first pressure-sensitive adhesive layer 12a after laser irradiation do not remain due to ablation during laser irradiation. Thereafter, the semiconductor chip 4 is disposed on a support substrate or the like, and a micro LED display is obtained by a known Chip-first (RDL-last) production process in which metal wiring, an interlayer insulating layer, and the like are formed.

[0355]

The production process of Steps 1 to 8 corresponds to the method for producing a laminate according to the fifth

aspect of the present invention. In addition, the production process of Steps 1 to 5 or the production process of Steps 1 to 6 corresponds to the method for producing a laminate according to the sixth aspect of the present invention. The laminate obtained in Step 5 or 6 corresponds to the laminate according to the second aspect of the present invention.

[0356]

A process of producing a micro LED display including an LED which is a semiconductor chip using the method for producing a laminate according to the seventh aspect and the eighth aspect of the present invention will be described with reference to a schematic cross-sectional view in Fig. 3 as an example. (Step 1) First, a prebaked film of a light-absorbing layer 2, a layer formed from a positive photosensitive composition, is formed on a first substrate (quartz glass substrate) 1. (Step 2) Next, a semiconductor chip (LED) 4 including a gallium nitride semiconductor, the semiconductor chip 4 being provided with an electrode terminal 4a and placed on a donor substrate (sapphire substrate) 3, is prepared, and the light-absorbing layer 2 and the semiconductor chip 4 are bonded together. (Step 3) Next, the semiconductor chip 4 is irradiated with the laser 5 from the donor substrate 3 side, and the light-absorbing layer 2 is irradiated with

the laser 5 using the semiconductor chip 4 as a mask. The semiconductor chip 4 irradiated with the laser 5 is transferred from the donor substrate 3 to the light-absorbing layer 2, and the light-absorbing layer 2 at the portion irradiated with the laser 5 is removed to form an unexposed light-absorbing layer 8. That is, in this step, the semiconductor chip 4 is transferred to the light-absorbing layer 2, and a pattern of the light-absorbing layer 2 is obtained. (Step 4) Thereafter, the donor substrate 3 is peeled off and removed from the semiconductor chip 4. (Step 5) Next, the unexposed light-absorbing layer 8 is heated and crosslinked to form the light-absorbing layer 9 after crosslinking. (Step 6) Next, a second pressure-sensitive adhesive layer 11 is formed on the second substrate (alkali-free glass substrate) 10. Thereafter, the semiconductor chip 4 is irradiated with the laser 5 from the first substrate 1 side while a gap is present between the semiconductor chip 4 and the second pressure-sensitive adhesive layer. In this case, the laser 5 is applied in two or more separate times to sequentially transfer the semiconductor chip 4 from the first substrate 1 to the second pressure-sensitive adhesive layer 11. (Step 7) The plurality of semiconductor chips 4 are transferred to desired positions of the second pressure-sensitive adhesive layer 11 with excellent positional

accuracy while suppressing debris in laser transfer. The light-absorbing layer 12 after laser irradiation is formed on the first substrate 1, or the light-absorbing layer 12 after laser irradiation does not remain due to ablation during laser irradiation. Thereafter, the semiconductor chip 4 is disposed on a support substrate or the like, and a micro LED display is obtained by a known Chip-first (RDL-last) production process in which metal wiring, an interlayer insulating layer, and the like are formed.

[0357]

The production process of Steps 1 to 7 corresponds to the method for producing a laminate according to the seventh aspect of the present invention. In addition, the production process of Steps 1 to 4 or the production process of Steps 1 to 5 corresponds to the method for producing a laminate according to the eighth aspect of the present invention. The laminate obtained in Step 4 or 5 corresponds to the laminate according to the first aspect of the present invention.

EXAMPLES

[0358]

The present invention will be described more concretely hereinafter with reference to Examples, Reference Examples, and Comparative Examples. However, the

present invention is not limited to scopes thereof. The names corresponding to the abbreviations of the compounds used in the following description or table are collectively shown in Table 1-2. The structures corresponding to the abbreviated compounds ADMS1, ADMS2, and OADA are shown below.

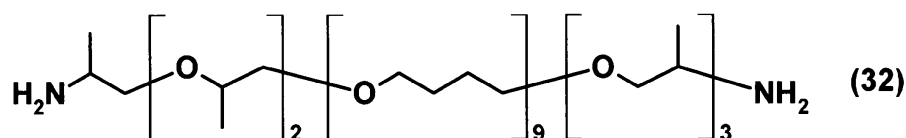
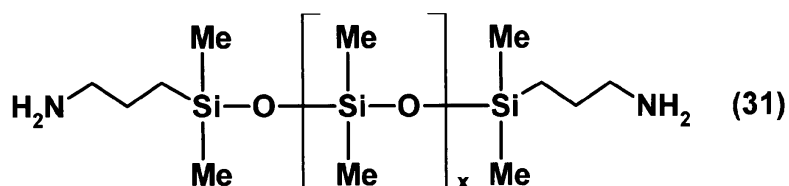
[0359]

[Table 1-2]

Abbreviation	Corresponding name	Abbreviation	Corresponding name
6FAP	2,2-bis(3-amino-4-hydroxyphenyl)hexafluoropropane	HEA	2-hydroxyethyl acrylate
ACA	acrylic acid	HPMA	4-hydroxyphenyl methacrylate
ADMS1	dual-end amino group-modified dimethyl silicone represented by general formula (31); x = 7 to 11 is a main component; number average molecular weight: 860; amino group equivalent: 430 g/mol	HST	4-hydroxystyrene
		LAA	lauryl acrylate
ADMS2	dual-end amino group-modified dimethyl silicone represented by general formula (31); x = 15 to 23 is a main component; number average molecular weight: 1,600; amino group equivalent: 800 g/mol	MAA	methacrylic acid
		MCS	m-cresol
BGPF	9,9-bis(4-glycidoxyphenyl)fluorene	MOEA	2-methoxyethyl acrylate
BMA	butyl methacrylate	MOI	2-(methacryloyloxy)ethyl isocyanate
BnMA	benzyl methacrylate	NA	5-norbornene-2,3-dicarboxylic anhydride
BPDA	3,3',4,4'-biphenyltetracarboxylic dianhydride	NC-3000-H	epoxy resin having a structural unit containing a biphenyl skeleton, a benzene skeleton, and one epoxy group (manufactured by Nippon Kayaku Co., Ltd.)
BTDA	3,3',4,4'-benzophenonetetracarboxylic dianhydride		
BTMA	2-[2-hydroxy-5-[2-(methacryloyloxy)ethyl]phenyl]-2H-benzotriazole	OADA	diamine having an oxyalkylene structure represented by general formula (32)
		ODBC	oxydibenzoyl dichloride
BUA	butyl acrylate	ODPA	oxydiphthalic dianhydride
CHN	cyclohexanone	PDA	1,4-phenylenediamine
DAE	bis(4-aminophenyl)ether	PGME	propylene glycol monomethyl ether
DDC	1,10-decanedicarboxylic acid dichloride	PHA	phthalic anhydride
DFA	N,N-dimethylformamide dimethyl acetal	PMDA	pyromellitic dianhydride
EHA	2-ethylhexyl acrylate	SIDA	1,3-bis(3-aminopropyl)tetramethyldisiloxane
EL	ethyl lactate	STR	styrene
GBL	γ -butyrolactone	THPHA	1,2,3,6-tetrahydrophthalic anhydride
GMA	glycidyl methacrylate	TMAH	tetramethylammonium hydroxide
HAD	formaldehyde		

[0360]

[Chem 1]



[0361]

<Synthesis Example of Each Resin>

As the binder resin (A), the composition of each resin obtained in Synthesis Examples 1 to 19 is collectively shown in Table 1-3 to Table 1-5. Each resin was synthesized by a known method by appropriately changing a monomer compound to be a monomer and a copolymerization ratio based on a method described in a known document. The copolymerization ratio of the monomers is as shown in Table 1-3 to Table 1-5.

[0362]

In Synthesis Example 3, DFA, which was an esterifying agent, was reacted with the amide acid structural unit in the resin to convert the amide acid structural unit into an amide acid ester structural unit having a methyl group.

In Synthesis Example 10, GMA having an epoxy group was reacted with a carboxy group derived from MAA in the resin, and ring-opening addition was performed on all the epoxy groups of GMA.

In Synthesis Examples 16 and 17, an MOI having an isocyanate group was reacted with a hydroxy group derived from HEA in the resin, and all the isocyanate groups of the MOI were added.

[0363]

The phenol group-containing acrylic resins (PAC-1) and (PAC-3) obtained in Synthesis Examples 8 and 10 correspond to the ultraviolet absorber (Da) having the specific structure described above. That is, the phenol group-containing acrylic resins (PAC-1) and (PAC-3) correspond to both the ultraviolet absorber (Da) and the binder resin (A). Similarly, the phenol group-containing acrylic resins (PAC-1) and (PAC-3) in the light-absorbing layer correspond to the ultraviolet absorber (XDa) having the specific structure described above, and correspond to both the ultraviolet absorber (XDa) and the binder resin (XA).

[0364]

[Table 1-3]

	Polymer	Monomer [molar ratio]							Weight-average molecular weight	Acid equivalent Phenol equivalent Carboxylic acid equivalent [g/mol]
		Carboxylic acid derivative		Amine derivative			End-capping agent	Esterifying agent		
Synthesis Example 1	Polyimide (PI-1)	BTDA (44)	BPDA (44)	ADMS1 (80)	ADMS2 (5)	6FAP (15)	PHA (20)	-	30,000	Acid equivalent: 3,640 Phenol equivalent: 3,640
Synthesis Example 2	Polyimide (PI-2)	-	BPDA (88)	ADMS1 (80)	ADMS2 (5)	6FAP (15)	PHA (20)	-	30,000	Acid equivalent: 3,600 Phenol equivalent: 3,600
Synthesis Example 3	Polyimide precursor (PIP-1)	BTDA (44)	BPDA (44)	ADMS1 (80)	ADMS2 (5)	6FAP (15)	PHA (20)	DFA (200)	20,000	Acid equivalent: 1,200 Phenol equivalent: 3,760 Carboxylic acid equivalent: 1,760
Synthesis Example 4	Polybenzoxazole precursor (PBP-1)	ODBC (45)	DDC (45)	DAE (10)	OADA (10)	6FAP (80)	NA (20)	-	30,000	Acid equivalent: 360 Phenol equivalent: 400 Carboxylic acid equivalent: 3,250
Synthesis Example 5	Polyimide precursor (PIP-2)	PMDA (20)	BPDA (80)	PDA (100)	-	-	-	-	30,000	Acid equivalent: 190 Carboxylic acid equivalent: 190

[0365]

[Table 1-4]

	Polymer	Monomer [molar ratio]				Weight-average molecular weight	Acid equivalent (= phenol equivalent) [g/mol]	Double bond equivalent [g/mol]
		Phenol compound		Aldehyde compound bisalkoxymethyl compound				
Synthesis Example 6	Phenol resin (PR-1)	MCS (100)		HAD (100)		3,000	120	-
	Polymer	Monomer [molar ratio]				Weight-average molecular weight	Acid equivalent (= phenol equivalent) [g/mol]	Double bond equivalent [g/mol]
		Hydroxystyrene copolymerization component		Styrene copolymerization component				
Synthesis Example 7	Polyhydroxystyrene (PHS-1)	HST (80)		STR (20)		9,500	150	-
	Polymer	Monomer [molar ratio]				Weight-average molecular weight	Acid equivalent Phenol equivalent Carboxylic acid equivalent [g/mol]	Double bond equivalent [g/mol]
		Aliphatic copolymerization component	Acidic copolymerization component	Aromatic copolymerization component Phenol group-containing copolymerization component	Radical polymerizable group-containing compound			
Synthesis Example 8	Phenol group-containing acrylic resin (PAC-1)	BMA (60)	-	BTMA (40)	-	15,000	Acid equivalent: 530 Phenol equivalent: 530	-
Synthesis Example 9	Phenol group-containing acrylic resin (PAC-2)	BMA (40)	MAA (20)	BnMA (20) HPMA (20)	-	15,000	Acid equivalent: 360 Phenol equivalent: 720 Carboxylic acid equivalent: 720	-
Synthesis Example 10	Phenol group-containing acrylic resin (PAC-3)	BMA (40)	MAA (40)	BTMA (20)	GMA (20)	15,000	Acid equivalent: 610 Phenol equivalent: 1,840 Carboxylic acid equivalent: 920	610

[0366]

[Table 1-5]

	Polymer	Monomer [molar ratio]				Weight-average molecular weight	Acid equivalent (= carboxylic acid equivalent) [g/mol]	Double bond equivalent [g/mol]
		Aliphatic copolymerization component	Acidic copolymerization component	Aromatic copolymerization component	Radical polymerizable group-containing compound			
Synthesis Example 11	Acrylic resin (AC-1)	EHA (85)	ACA (15)	-	-	60,000	1,110	-
Synthesis Example 12	Acrylic resin (AC-2)	EHA (50) LAA (40)	ACA (10)	-	-	50,000	1,950	-
Synthesis Example 13	Acrylic resin (AC-3)	EHA (50) BUA (20)	ACA (10)	STR (20)	-	30,000	1,450	-
Synthesis Example 14	Acrylic resin (AC-4)	LAA (50) BUA (20)	ACA (10)	STR (20)	-	30,000	1,730	-
Synthesis Example 15	Acrylic resin (AC-5)	EHA (30) BUA (20)	ACA (10)	STR (40)	-	15,000	1,290	-
Synthesis Example 16	Acrylic resin (AC-6)	MOEA (70) HEA (15)	ACA (15)	-	MOI (15)	15,000	950	950
Synthesis Example 17	Acrylic resin (AC-7)	EHA (70) HEA (15)	ACA (15)	-	MOI (15)	15,000	1,200	1,200
	Polymer	Monomer [molar ratio]				Weight-average molecular weight	Acid equivalent (= carboxylic acid equivalent) [g/mol]	Double bond equivalent [g/mol]
		Polyfunctional epoxy compound	Polyfunctional carboxylic dianhydride	Carboxylic anhydride	Radical polymerizable group-containing carboxylic acid compound			
Synthesis Example 18	Polycyclic side chain-containing resin (CR-1)	BGPF (100)	ODPA (90)	PHA (20)	MAA (200)	4,700	470	470
	Polymer	Monomer [molar ratio]			Radical polymerizable group-containing carboxylic acid compound	Weight-average molecular weight	Acid equivalent (= carboxylic acid equivalent) [g/mol]	Double bond equivalent [g/mol]
		Polyfunctional epoxy compound		Carboxylic anhydride				
Synthesis Example 19	Acid-modified epoxy resin (AE-1)	NC-3000-H (Epoxy equivalent: 290 g/mol) (Epoxy group standard: 0.2 mol) (Epoxy group standard molar ratio: 100)		THPHA (0.18 mol) (molar ratio: 90)	MAA (0.20 mol) (molar ratio: 100)	4,500	570	510

[0367]

The structural units and structures of the resins obtained in Synthesis Examples and the resins used in Examples, Reference Examples, and Comparative Examples are collectively shown in Table 2-1.

[0368]

[Table 2-1]

Binder resin (A)	Imide cyclization ratio Benzoxazole cyclization ratio	Structural unit and structure of binder resin (A)	355 nm Absorbance
Polyimide (PI-1)	Imide cyclization ratio = 100%	Polyimide structure (structural unit having imide structure and silicone structure)	1.3
Polyimide (PI-2)	Imide cyclization ratio = 100%		1.2
Polyimide precursor (PIP-1)	Imide cyclization ratio = 10%	Polyimide precursor structure (structural unit having amide structure, imide structure, and silicone structure); Content ratio of amide acid ester structural unit is 65 mol%, content ratio of amide acid structural unit is 25 mol%, and content ratio of imide ring-closed structural unit is 10 mol%	1.1
Polybenzoxazole precursor (PBP-1)	Benzoxazole cyclization ratio = 0%	Polybenzoxazole precursor structure (structural unit having amide structure and oxyalkylene structure); nadimide group at end of resin	1.4
Polyimide precursor (EIP-1)	Imide cyclization ratio = 0%	Polyimide precursor structure (structural unit having amide structure); content ratio of amide acid structural unit is 100 mol%	2.0
Binder resin (A)	Structural unit and structure of binder resin (A)		355 nm Absorbance
Phenol resin (PR-1)	Phenol resin structure		1.2
Polyhydroxystyrene (PHS-1)	Polyhydroxystyrene structure		1.3
Phenol group-containing acrylic resin (AC-1)	Acrylic resin structure; structural unit having benzotriazole structure		1.4
Phenol group-containing acrylic resin (AC-2)	Acrylic resin structure; structural unit having phenolic hydroxyl group		1.1
Phenol group-containing acrylic resin (AC-3)	Acrylic resin structure; structural unit having benzotriazole structure; Radical polymerizable group: methacryloyl group (glycidyl methacrylate residue)		1.9
Acrylic resin (AC-1)	Acrylic resin structure		0.4
Acrylic resin (AC-2)	Acrylic resin structure		0.4
Acrylic resin (AC-3)	Acrylic resin structure		1.0
Acrylic resin (AC-4)	Acrylic resin structure		1.0
Acrylic resin (AC-5)	Acrylic resin structure		1.2
Acrylic resin (AC-6)	Acrylic resin structure; radical polymerizable group: methacryloyl group (2-(methacryloyloxy)ethyl isocyanate residue)		0.5
Acrylic resin (AC-7)	Acrylic resin structure; radical polymerizable group: methacryloyl group (2-(methacryloyloxy)ethyl isocyanate residue)		0.5
Polycyclic side chain- containing resin (CR-1)	Cardo-based resin structure including fluorene structure; radical polymerizable group: methacryloyl group (methacrylic acid residue)		1.3
Acid-modified epoxy resin (AE-1)	Epoxy methacrylate resin structure including biphenyl structure; radical polymerizable group: methacryloyl group (methacrylic acid residue)		1.2

[0369]

<Preparation Examples of Pigment Dispersions>

As a pigment dispersion liquid, the compositions of the dispersion liquids obtained in Preparation Examples Dsp-1 and Dsp-2 are collectively shown in Table 2-2. In Preparation Examples Dsp-1 to Dsp-2, pigment dispersions were prepared by the following methods. A list and description of the colorant (D) and the dispersant (E) used in Examples, Reference Examples, and Comparative Examples are collectively shown in Table 2-2. Note that (A.R.52-

B.B.7) is a dye obtained by mixing and stirring at A.R.52/B.B.7 = 1/1 (molar ratio), filtering the precipitated salt, washing it with water three times, and then drying it.

[0370]

Preparation Examples Dsp-1 and Dsp-2

Preparation of pigment dispersions (Dsp-1) to (Dsp-3)

On the basis of the method described in paragraphs[0138] to[0140] of WO 2022/196261 A and Preparation Example 1, a colorant described in Table 2-2 and D.BYK-21116 which is a block copolymer acrylic resin-based dispersant as a dispersant were used, and a wet media dispersion treatment was performed by a circulation method so that the average primary particle size of the pigment was the value described in Table 2-2. Thereafter, filtration was performed with a filter of 0.80 μ m ϕ to obtain pigment dispersions (Dsp-1) to (Dsp-2) having a solid concentration of 15 mass% and colorant/dispersant = 100/35 (mass ratio). The average primary particle size of the pigment in the obtained pigment dispersion is shown in Table 2-2. The average primary particle size of the pigment in the cured film, the crystallite size of the pigment in the pigment dispersion liquid, and the crystallite size of the pigment in the cured film are also shown in Table 2-2.

[0371]

[Table 2-2]

	Pigment dispersion	Composition [parts by mass]		Solvent	Average primary particle size in pigment dispersion [nm]	Average primary particle size of pigment in cured film [nm]
		Colorant (D)	Dispersant (E)			
Preparation Example Dsp-1	Pigment dispersion (Dsp-1)	TPK-1227 (100)	D.BYK-21116 (35)	PGME /EL/GBL = 40/30/30	100	80
Preparation Example Dsp-2	Pigment dispersion (Dsp-2)	P.B.60 (100)			100	80
Colorant (Db) Dispersant (E) Ultraviolet absorber (Da)		Description of colorant (Db), description of dispersant (E), description of ultraviolet absorber (Da)				355 nm Absorbance
TPK-1227		Carbon black of which the surface is treated so as to introduce a sulfonic acid group thereto (manufactured by CABOT Corporation)				2.5
P.B.60		C.I. Pigment Blue 60 (indanthrone blue pigment)				2.5
D.BYK-21116		Block copolymer acrylic resin-based dispersant including block A having a quaternary ammonium salt structure and a tertiary amino group and block B having neither quaternary ammonium salt structure nor tertiary amino group (manufactured by BYK Japan KK; amine value: 70 mgKOH/g (solid concentration: 100 mass%))				-
A.R.52		C.I. Acid Red 52 (xanthene-based red dye)				-
B.B.7		C.I. Basic Blue 7 (triarylmethane-based blue dye)				-
A.R.52-B.B.7		A.R.52/B.B.7 = dye obtained by mixing and stirring at 1/1 (molar ratio), filtering precipitated salt, washing with water three times, and then drying				2.1
da-1		Ultraviolet absorber having triazine structure, three benzene structures, and three phenolic hydroxyl groups				1.7

[0372]

<Evaluation Methods in Examples, Reference Examples, and Comparative Examples>

Evaluation methods in Examples, Reference Examples, and Comparative Examples are described below. Note that a TEMPAX glass substrate (manufactured by AGC Techno Glass Co., Ltd.) and an LED substrate described later were used without being pretreated. Quartz glass substrate (manufactured by Corning Incorporated) and alkali-free

glass substrate (Eagle XG; A hot plate (HP-1SA manufactured by Corning Incorporated); manufactured by AS ONE Corporation) at 130°C for 2 minutes to perform a dehydration baking treatment.

[0373]

(1) Weight-average Molecular Weight of Resin

For the polyimides (PI-1) to (PI-2), the polyimide precursors (PIP-1) to (PIP-2), and the polybenzoxazole precursor (PBP-1), N-methyl -2 pyrrolidone solutions of 0.10 mass% of each resin were prepared. GPC analyzer (Waters 2690; (manufactured by Waters Corporation), and N-methyl -2 pyrrolidone in which lithium chloride and phosphoric acid were each dissolved at 0.050 mol/L was used as a fluidized bed, and the weight average molecular weight in terms of polystyrene was measured and determined.

Regarding other resins, with the use of a GPC analyzer (HLC-8220; manufactured by Tosoh Corporation), and with the use of tetrahydrofuran or N-methyl-2-pyrrolidone as a fluidized bed, the weight-average molecular weight in terms of polystyrene was measured and then obtained by a method at around normal temperature, based on "JIS K7252-3 (2008)".

[0374]

(2) Imide cyclization ratio and benzoxazole cyclization ratio of resin

Each of the above resins was dissolved in GBL so as to have a concentration of 35 mass% to prepare a resin solution. Each of the resin solutions was placed on a silicon wafer with a spin coater (1H-DX, manufactured by Mikasa Co., Ltd.) and then baked at 120°C for 180 seconds to prepare a resin film having a film thickness of 4.0 to 5.0 μm . The produced silicon wafer with a resin film was divided into two parts, and one part was placed in a clean oven (CLH-21CD-S; manufactured by Koyo Thermo Systems Co., Ltd.) and heated at 140°C for 30 minutes in a nitrogen atmosphere having an oxygen concentration of 20 ppm by mass or less, and then the temperature was further raised and the one part was heated at 320°C for 60 minutes to completely cyclize to the imide ring (resin film after heating). The other was used as it was without heat treatment (resin film before heating). The transmitted infrared absorption spectrum of the resin film before and after heating was measured using an infrared spectrophotometer (FT-720; manufactured by Horiba, Ltd.). The presence of an absorption peak (around 1780 cm^{-1} and around 1377 cm^{-1}) of the imide structure due to the polyimide was confirmed, and a peak intensity (X) around 1377 cm^{-1} before heating and a peak intensity (Y) around 1377 cm^{-1} after heating were determined. The imide cyclization ratio in the resin film before heating was

calculated from the following formula.

$$\text{Imide cyclization ratio [\%]} = (X/Y) \times 100.$$

[0375]

A resin film having a film thickness of 4.0 to 5.0 μm was produced by the same method as described above. The produced silicon wafer with a resin film was divided into two parts, and one part was heated at 320°C for 30 minutes using a buzzer hot plate (HPD-3000BZN; manufactured by As One Corporation) to completely cyclize to the benzoxazole ring (resin film after heating). The other was used as it was without heat treatment (resin film before heating).

The transmitted infrared absorption spectrum of the resin film before and after heating was measured using an infrared spectrophotometer (FT-720; manufactured by Horiba, Ltd.). The presence of an absorption peak of a benzoxazole structure derived from polybenzoxazole (a peak derived from C = C (C = N) stretching vibration around 1570 cm^{-1}) was confirmed, and the peak intensity (P) around 1570 cm^{-1} before heating and the peak intensity (Q) around 1570 cm^{-1} after heating were determined. The benzoxazole cyclization ratio in the resin film before heating was calculated from the following formula.

$$\text{Benzoxazole cyclization ratio [\%]} = (P/Q) \times 100.$$

[0376]

(3) Absorbance of light-absorbing layer

A prebaked film of the composition was produced on a TEMPAX glass substrate (manufactured by AGC TECHNO GLASS CO., LTD.) by the method described in Example 1 below. The absorbance of the prebaked film at wavelengths of 200 to 800 nm was measured using an ultraviolet-visible spectrophotometer (U-2910 manufactured by Hitachi, Ltd.). The film thickness of the prebaked film was measured using an optical interference-type film thickness measurement device (Lambda Ace VM-1030, manufactured by Dainippon Screen Mfg. Co., Ltd.). Further, as will be described later, in a case where the film thickness cannot be measured by the optical interference-type film thickness measurement device, a surface roughness/contour shape measuring instrument (SURFCOM1400D; The film thickness of the prebaked film was measured using (manufactured by TOKYO SEIMITSU CO., LTD.)). The absorbance per 1.0 μm of thickness of the light-absorbing layer was calculated from the following equation.

$$\text{Absorbance per 1.0 } \mu\text{m of thickness} = \text{absorbance} \times (1/\text{film thickness of light-absorbing layer}).$$

[0377]

(4) Absorbance of binder resin, ultraviolet absorber, and colorant

A composition a containing an arbitrary binder resin, any one of an arbitrary ultraviolet absorber and an

arbitrary colorant, and an arbitrary solvent is prepared so that the content ratio of the ultraviolet absorber or the colorant in the total solid content of the composition a is 15 mass%. Further, a composition b containing the binder resin and the solvent and not containing an ultraviolet absorber and a colorant is prepared. Prebaked films of the composition a and the composition b were each produced on a TEMPAX glass substrate (manufactured by AGC TECHNO GLASS CO., LTD.) by the method described in Example 1 below. The absorbance of each prebaked film at wavelengths of 200 to 800 nm was measured using an ultraviolet-visible spectrophotometer (U-2910 manufactured by Hitachi, Ltd.). The film thickness of each prebaked film was measured using an optical interference-type film thickness measurement device (Lambda Ace VM-1030, manufactured by Dainippon Screen Mfg. Co., Ltd.). As described later, when the film thickness could not be measured with the optical interference-type film thickness measurement device, the film thickness of each prebaked film was measured using a surface texture and contour measuring instrument (SURFCOM 1400D manufactured by TOKYO SEIMITSU CO., LTD.). The absorbance per 1.0 μm of thickness of the prebaked film was calculated from the following equation. The calculated absorbance of the prebaked film of the composition b was taken as the absorbance of the binder resin. The

difference between the calculated absorbance of the prebaked film of composition a and the calculated absorbance of the prebaked film of composition b was taken as the absorbance of the ultraviolet absorber or the absorbance of the colorant.

Absorbance per 1.0 μm of thickness = absorbance $\times$ (1/film thickness of light-absorbing layer).

[0378]

(5) Area ratio ((S_{2a})/(S_{1a})) and cross-sectional shape of pattern

After a prebaked film of the light-absorbing layer was produced on a quartz glass substrate by the method described in Example 1 below, a semiconductor chip was transferred from the laminate 0A, and a film obtained by patterning the light-absorbing layer by exposure and development was produced. After the prebaked film was produced as described above, as shown in Tables 3-1 to 3-8 described later, a film was produced by patterning the light-absorbing layer by etching instead of exposure and development in some Examples. In addition, after a film obtained by patterning the light-absorbing layer was produced, as shown in Tables 3-1 to 3-8 described later, a film after treatment with any of (x1), (x2), and (x3) described later was produced. Thereafter, the semiconductor chip was peeled off and removed from the

light-absorbing layer. Using a field emission scanning electron microscope (S-4800; manufactured by Hitachi High-Technologies Corporation), the pattern of the produced light-absorbing layer was observed, and the area (S_{1a}) of the first-a surface, which is the first substrate side of the light-absorbing layer, and the area (S_{2a}) of the second-a surface facing the first-a surface of the light-absorbing layer were measured. In addition, the cross-section of the pattern of the produced light-absorbing layer was observed, and the taper angle of the cross-section was measured.

[0379]

(6) Indentation elastic modulus and indentation elastic modulus ratio before and after specific treatment

An alkali-free glass substrate (Eagle XG; After the prebaked film of the composition was produced in Corning Incorporated), the semiconductor chip was not transferred from the laminate 0A, and the light-absorbing layer was patterned by exposure and development to produce a film. A patterned film (sample a before treatment) having a region where the indentation elastic modulus can be measured was produced by exposing a part of the prebaked film to light by exposure through a photomask during exposure or the like. After the prebaked film was produced as described above, as shown in Tables 3-1 to 3-8 described later, a

film was produced by patterning a light-absorbing layer having a region where the indentation elastic modulus can be measured by etching instead of exposure and development in some Examples. A film in which the light-absorbing layer was patterned was similarly produced by the method described in Example 1 below, and a film (sample b after treatment) after the treatment of (x1) described later was produced. After the preparation of the sample a before treatment as described above, as shown in Tables 3-1 to 3-8 described later, a film (sample b after treatment) after treatment of either (x2) or (x3) described later was produced instead of the treatment of (x1) described later. [0380]

The indentation elastic modulus was measured using a nanoindenter (TriboIndenter TI950; manufactured by Hysitron, Inc.). The pre-treatment sample a and the post-treatment sample b produced above were cut into pieces having a width of 10 mm and a length of 10 mm, and were fixed to a sample fixing stage using an adhesive (Aron Alpha fast-acting multi-use; manufactured by Toagosei Co., Ltd.). Next, using a Berkovich indenter (triangular pyramid diamond indenter), the indentation elastic modulus was measured under the following conditions by an indentation load/unloading test in which the light-absorbing layer was pushed into the first substrate side

from the surface of the light-absorbing layer and then unloaded. As an index of the indentation elastic modulus, an average value of values at a depth of 20 to 40 nm from the surface of the light-absorbing layer was calculated from the obtained load-indentation depth diagram.

<<Indentation Elastic Modulus Measurement Conditions>>

Measurement environment: $50^{\circ}\text{C} \pm 2^{\circ}\text{C}$, atmospheric pressure, air atmosphere

Measurement frequency: 100 Hz

Measurement method: continuous stiffness measurement method

[0381]

(7) Glass transition temperature and difference in glass transition temperature before and after specific treatment

In the same manner as the measurement sample of the indentation elastic modulus described above, a patterned film (sample c before treatment) of the light-absorbing layer having a region in which the glass transition temperature can be measured was produced by the method described in Example 1 below. After the prebaked film was produced as described above, as shown in Tables 3-1 to 3-8 described later, a film was produced by patterning a light-absorbing layer having a region where the glass transition temperature can be measured by etching instead of exposure and development in some Examples. A film in which the

light-absorbing layer was patterned was similarly produced by the method described in Example 1 below, and a film (sample d after treatment) after the treatment of (x1) described later was produced. After preparation of the sample c before treatment as described above, as shown in Tables 3-1 to 3-8 described later, a film (sample d after treatment) after treatment of either (x2) or (x3) described later was produced instead of the treatment of (x1) described later.

[0382]

The glass transition temperature was measured with a differential scanning calorimeter (DSC-50; manufactured by Shimadzu Corporation). The pre-treatment sample c and the post-treatment sample d produced above were scraped off, and a differential scanning calorimetry curve was created by changing the temperature conditions in the order of (7-1) to (7-4) below. The temperature at the intersection of the straight line obtained by extending the baseline on the low temperature side in the obtained differential scanning calorimetry curve to the high temperature side and the tangent at the point where the gradient of the curve of the stepwise change portion of the glass transition is maximized was measured as the glass transition temperature.

<<Glass Transition Temperature Measurement Conditions>>

Measurement environment: nitrogen atmosphere

Measurement conditions:

(7-1) Raising the temperature from 25°C to 300°C at a temperature raising rate of 10°C/min

(7-2) Cooling from 300°C to 25°C

(7-3) Raising the temperature from 25°C to 500°C at a temperature raising rate of 10°C/min

(7-4) Cooling from 500°C to 25°C

[0383]

(8) Energy density during transfer

According to the method described in Example 1 below, the semiconductor chip was transferred by laser transfer from the light-absorbing layer provided on the first substrate to the second light-absorbing layer provided on the second substrate. Here, laser transfer was performed by arbitrarily changing the energy density of the laser with which the semiconductor chip was irradiated, and three semiconductor chips were transferred at each energy density. The semiconductor chip in the laminate 2 after the transfer was observed, and the number of semiconductor chips transferred without being reversed or overturned was determined. As an index of the energy density at the time of transfer, the minimum value of the energy density at which the number of semiconductor chips transferred without reversing or overturning is three was obtained. It was determined as follows, and A+, A, B+, B, C+, and C in which

the energy density was 600 mJ/cm² or less were regarded as acceptable.

A+: The energy density is 150 mJ/cm² or less.

A: The energy density is more than 150 mJ/cm² and 200 mJ/cm² or less.

B+: The energy density is more than 200 mJ/cm² and 300 mJ/cm² or less.

B: The energy density is more than 300 mJ/cm² and 400 mJ/cm² or less.

C+: The energy density is more than 400 mJ/cm² and 500 mJ/cm² or less.

C: The energy density is more than 500 mJ/cm² and 600 mJ/cm² or less.

D: The energy density is more than 600 mJ/cm² and 1000 mJ/cm² or less.

E: The energy density is more than 1000 mJ/cm².

[0384]

(9) Debris during transfer

According to the method described in Example 1 below, the semiconductor chip was transferred by laser transfer from the light-absorbing layer provided on the first substrate to the second light-absorbing layer provided on the second substrate. The semiconductor chip in the laminate 2 after the transfer was observed using an FPD/LSI inspection microscope (OPTIPHOT-300; manufactured by Nikon

Corporation). Note that a semiconductor chip was disposed at the center of the observation region, and observation was performed by adjusting the magnification so that the area of the semiconductor chip occupying the observation region was 1/4. As an index of debris at the time of transfer, the presence or absence of residues was observed to calculate the presence area of residues. It was determined as follows, and A+, A, B+, B, C+, and C in which the residue existing area was 20% or less were regarded as acceptable.

A+: No residue

A: The residue existing area is 3% or less.

B+: The residue existing area is 6% or less.

B: The residue existing area is more than 6% and 10% or less.

C+: The residue existing area is more than 10% and 15% or less.

C: The residue existing area is more than 15% and 20% or less.

D: The residue existing area is more than 20% and 50% or less.

E: The residue existing area is more than 50% and 100% or less.

[0385]

(10) Positional accuracy

According to the method described in Example 1 below, the semiconductor chip was transferred by laser transfer from the light-absorbing layer provided on the first substrate to the second light-absorbing layer provided on the second substrate. An image of the semiconductor chip in the laminate 1X before transfer and an image of the semiconductor chip in the laminate 2 after transfer were photographed using a CCD camera installed coaxially with a laser light source. The positional displacement amount of the center of the semiconductor chip before and after the transfer was measured from the difference between the center coordinates of the semiconductor chip in the respective images. As an index of the positional accuracy, an average value of the obtained positional displacement amounts was calculated. It was determined as follows, and A+, A, B+, B, C+, and C in which the positional displacement amount was 0 μm or more and less than 4.0 μm were regarded as acceptable.

A+: The positional displacement amount is 0 μm or more and less than 1.0 μm .

A: The positional displacement amount is 1.0 μm or more and less than 2.0 μm .

B+: The positional displacement amount is 2.0 μm or more and less than 2.5 μm .

B: The positional displacement amount is 2.5 μm or

more and less than 3.0 μm .

C+: The positional displacement amount is 3.0 μm or more and less than 3.5 μm .

C: The positional displacement amount is 3.5 μm or more and less than 4.0 μm .

D: The positional displacement amount is 4.0 μm or more and less than 5.0 μm .

E: The positional displacement amount is 5.0 μm or more.

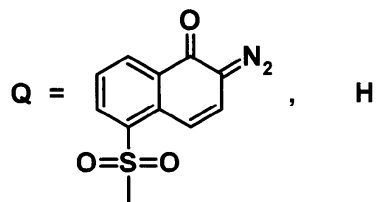
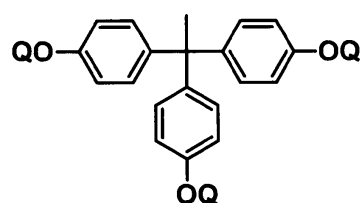
[0386]

<Compounds used in Examples, Reference Examples, and Comparative Examples>

The structures of the compounds used in Examples, Reference Examples, and Comparative Examples are shown below.

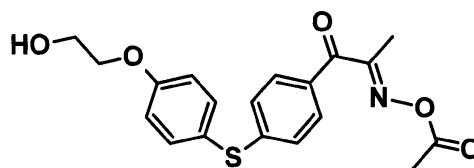
[0387]

[Chem 2]

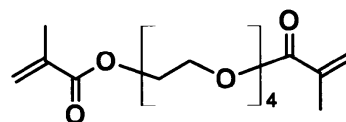


1.7 : 1.3

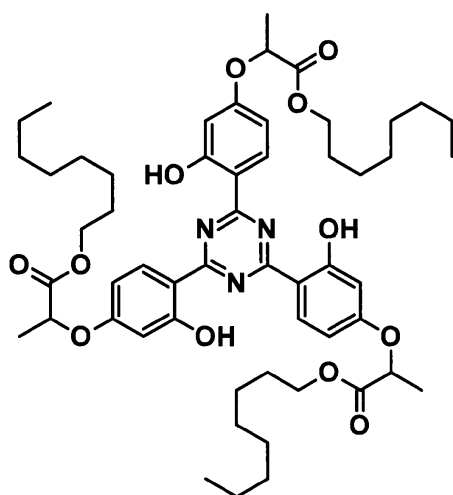
(NQD-1)



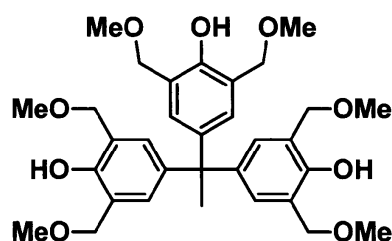
(c-1)



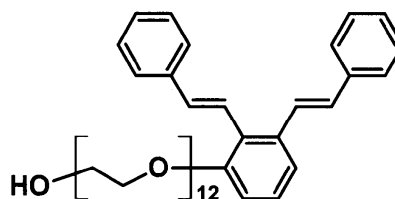
(b-1)



(da-1)



(f-1)



(p-1)

[0388]

<Preparation of Photosensitive Composition>

Composition 1 to Composition 36 were prepared with the compositions shown in Table 3-1 to Table 3-8. In Table 3-1 to Table 3-8, the numerical values in parentheses represent parts by mass of the solid content of each component. When the composition contained a pigment, first, a preparation liquid containing no pigment dispersion liquid was prepared, and then the pigment

dispersion liquid and the preparation liquid were mixed to prepare a composition. Using PGMEA/EL/GBL = 40/30/30 (mass ratio) as a solvent, the composition was prepared so that the solid concentration was 30 mass%. The solution of the obtained composition was filtered through a 0.45 μm filter and used. Note that compositions 7 to 9, 35, and 36 were prepared in the same manner using CHN as a solvent.

[0389]

<Example 1>

<<Preparation of Laminate 0A>>

A 4 inch diameter LED substrate (with an alignment mark) was prepared as the laminate 0A, and cut into a width of 20 mm $\times$ a length of 20 mm with a dicer. The LEDs mounted on the LED board are as follows. The size of the semiconductor chip, the size of the electrode terminal, and the distance between the adjacent semiconductor chips are measured using a field emission scanning electron microscope (S-4800; (manufactured by Hitachi High-Technologies Corporation)).

Donor substrate: Sapphire substrate having a diameter of 4 inches (thickness: 0.80 mm)

Type of semiconductor chip: gallium nitride semiconductor

Size of semiconductor chip: 20.2 μm in width $\times$ 30.3 μm in length $\times$ 9.4 μm in height (height including the

electrode terminal)

Number of electrode terminals: two electrode terminals on one surface (flip-chip type structure)

Size of electrode terminal: $17.5\ \mu\text{m} \times 11.0\ \mu\text{m} \times 3.4\ \mu\text{m}$

Type of electrode terminal: Au electrode

Distance between adjacent semiconductor chips: $10.0\ \mu\text{m}$ in width direction and $10.0\ \mu\text{m}$ in length direction

[0390]

<<Preparation of Laminate 1x>>

A diluted solution of Composition 1 was applied, using a spin coater, to a quartz glass substrate having a thickness of 0.70 mm and a diameter of 4 inches (manufactured by Corning; having a transmittance of 97.7% at a wavelength of 355 nm at a thickness of 0.70 mm; first substrate), and then the coating was prebaked at 120°C for 120 seconds using a hot plate to prepare a prebaked film as a light-absorbing layer having a film thickness of about 2.0 μm , thereby preparing a laminate 1x. The film thickness of the light-absorbing layer was measured using an optical interference-type film thickness measurement device (Lambda Ace VM-1030, manufactured by Dainippon Screen Mfg. Co., Ltd.) with the refractive index set to 1.543. To improve the accuracy of the measured value, an appropriate value of the refractive index to be set is

selected depending on the type of the resin contained in the light-absorbing layer. When the film thickness cannot be measured by the above-described optical interference-type film thickness measurement device, for example, when the light-absorbing layer contains a colorant, the film thickness of the light-absorbing layer is measured by a surface roughness/contour shape measuring instrument (SURFCOM1400D; manufactured by TOKYO SEIMITSU CO., LTD.) under measurement conditions including a measurement magnification of 10,000 times, a measurement length of 1.0 mm, and a measurement speed of 0.30 mm/s.

[0391]

<<Preparation of Laminate 1X>>

The laminate 1X was placed on the stage of a flip-chip bonder (FC-3000WS; manufactured by Toray Engineering Co., Ltd.) such that the light-absorbing layer was exposed on the surface. Next, the laminate 0A was bonded so that the surface having the two electrode terminals provided in the semiconductor chip was in contact with the light-absorbing layer of the laminate 1X, and thermocompression bonding was performed for 120 seconds under the conditions of 50°C and 0.50 MPa while the light-absorbing layer and the semiconductor chip were bonded. Thereafter, the semiconductor chip was irradiated with a laser having a wavelength of 355 nm and an energy density of 600 mJ/cm²

from the donor substrate side of the semiconductor chip using a laser irradiation apparatus (manufactured by Toray Engineering Co., Ltd.), and the semiconductor chip was transferred from the donor substrate to the light-absorbing layer. After all the semiconductor chips were irradiated with a laser and transferred, the donor substrate was separated. Note that only the semiconductor chip was irradiated with the laser by irradiating the semiconductor chip with the laser from the donor substrate side of the semiconductor chip through the photomask.

[0392]

Thereafter, with the use of a double-sided alignment - single-sided exposure system (Mask Aligner PEM-6M, manufactured by Union Optical Co., Ltd.), exposure was performed from the semiconductor chip side of the light-absorbing layer using the semiconductor chip as a mask with i-ray (wavelength: 365 nm), h-ray (wavelength: 405 nm), and g-ray (wavelength: 436 nm) of an ultra-high pressure mercury lamp. After the exposure, the film was subjected to development with a 2.38 mass% TMAH aqueous solution with the use of a small-size development device for photolithography (AD-1200; manufactured by Takizawa Sangyo K.K.), and rinsed with water for 30 seconds to prepare a developed film. The development time was 60 seconds, 90 seconds, or 120 seconds. When patterning could not be

achieved after development with a 2.38 mass% TMAH aqueous solution, an exposed film was produced in the same manner as described above, developed with cyclopentanone after exposure, and rinsed with water for 30 seconds to prepare a developed film. Similarly, the development time was 60 seconds, 90 seconds, or 120 seconds. The light-absorbing layer was patterned by the above method to prepare a laminate 1X.

[0393]

<<Preparation of Laminate a2>>

Polydimethylsilicone (Polydimethylsiloxane; Hereinafter, "PDMS") was diluted with toluene, and a diluent was prepared so that PDMS/toluene = 1/3 (mass ratio). Next, a diluted solution was applied, using a spin coater, to an alkali-free glass substrate having a thickness of 0.5 mm and a diameter of 4 inches (Eagle XG; manufactured by Corning; provided with an alignment mark; second substrate), and then the coating was prebaked at 120°C for 180 seconds using a hot plate to prepare a prebaked film as a second pressure-sensitive adhesive layer having a film thickness of about 5.0 μm , thereby preparing a laminate a2. The film thickness of the second pressure-sensitive adhesive layer was measured using an optical interference-type film thickness measurement device (Lambda Ace VM-1030, manufactured by Dainippon Screen Mfg. Co.,

Ltd.) with the refractive index set to 1.543.

[0394]

<<Preparation of Laminate 2>>

The laser light source, the laminate 1X, and the laminate 2 were disposed in this order. At this time, the surface of the semiconductor chip provided in the laminate 1X, which had no electrode terminal, and the surface of the second pressure-sensitive adhesive layer provided in the laminate 2 were opposed to each other, and the laminate was held while maintaining a gap of 50 μm between the semiconductor chip and the second pressure-sensitive adhesive layer. The spot size of the laser is 30 μm in width $\times$ 40 μm in length. The laser light source and the position of the laminate 1X were adjusted such that the center of one semiconductor chip was disposed at the center of the spot of the laser, and the semiconductor chip adjacent to the semiconductor chip irradiated with the laser was not irradiated with the laser. After the position adjustment, the semiconductor chip was irradiated with a laser having a wavelength of 355 nm from the light-absorbing layer side of the semiconductor chip, and the semiconductor chip was transferred from the light-absorbing layer to the second light-absorbing layer. The laminate 2 was prepared by irradiating all the semiconductor chips with a laser and transferring the semiconductor chips.

[0395]

In the laminate 1X, the patterned light-absorbing layer was analyzed by a method such as nuclear magnetic resonance spectroscopy, infrared spectroscopy, gas chromatography mass spectrometry, liquid chromatography mass spectrometry, or time-of-flight secondary ion mass spectrometry to analyze the structural unit of the resin contained in the light-absorbing layer and the structure of the compound contained in the light-absorbing layer. The light-absorbing layer formed from the composition 1 contains the following resin and compound, and contains a resin having a structure derived from the resin contained in the composition 1 and a compound having a structure derived from the compound contained in the composition 1.

Resin (XA1x): Resin having a phenolic hydroxyl group and having an imide structure and a silicone structure in the structural unit

Ultraviolet absorber (XDa): A compound having a phenolic hydroxyl group, a triazine structure, and three benzene structures.

[0396]

<<Production of micro LED display>>

A light-absorbing layer formed from the composition 1 was produced on a quartz glass substrate as the first substrate by the method described in the preparation of the

laminate 1X. Next, the LED as a semiconductor chip was transferred to the light-absorbing layer and the light-absorbing layer was patterned by the method described in the preparation of the laminate 0A and the preparation of the laminate 1X. Next, a second pressure-sensitive adhesive layer containing PDMS was produced on an alkali-free glass substrate as the second substrate by the method described in the preparation of the laminate a2.

Thereafter, an LED as a semiconductor chip was transferred to the second pressure-sensitive adhesive layer by the method described in the preparation of the laminate 2. An alkali-free glass substrate was prepared as another support substrate, a third pressure-sensitive adhesive layer (temporary fixing layer) containing polyimide was prepared on the support substrate, and an LED as a semiconductor chip was transferred to the third pressure-sensitive adhesive layer. The thickness of the LED was 2.0 μm , the length of one side was 10 μm , and the length of the other side was 20 μm .

[0397]

Next, a positive photosensitive composition containing polysiloxane and silica particles was applied to the support substrate and the LED using a spin coater, and then prebaked at 120°C for 120 seconds using a hot plate to prepare a prebaked film. Next, the prebaked film was

subjected to patterning exposure, development, and rinsing through a photomask having a predetermined pattern to form a matrix-shaped pattern having a plurality of openings that expose the LEDs and their surroundings. The shape of the opening was rectangular, and the length of one side was 15 μm and the length of the other side was 25 μm . In the matrix-shaped pattern, the pattern dimension between openings each having a side length of 15 μm was 5.0 μm , and the pattern dimension between openings each having a side length of 25 μm was also 5.0 μm . Thereafter, heating and thermal curing were performed to form a barrier layer having a film thickness of about 4.0 μm . As thermal curing conditions, the temperature was raised to 200°C at a temperature raising rate of 3.5°C/min in a nitrogen atmosphere having an oxygen concentration of 20 ppm by mass or less, heat treatment was performed at 200°C for 60 minutes, and then the temperature was cooled to 50°C.

[0398]

Next, a positive photosensitive composition containing polysiloxane was applied to the support substrate and the LED using a spin coater, and then prebaked at 120°C for 120 seconds using a hot plate to prepare a prebaked film. Next, the prebaked film was subjected to patterning exposure, development, and rinsing through a photomask having a predetermined pattern to form

a plurality of opening patterns penetrating in the thickness direction up to the LEDs. The shape of the opening pattern was circular, and the diameter of the bottom in the minimum pattern was 2.0 μm . Thereafter, heating and thermal curing were performed to form a planarization layer having a film thickness of about 4.0 μm . As thermal curing conditions, the temperature was raised to 200°C at a temperature raising rate of 3.5°C/min in a nitrogen atmosphere having an oxygen concentration of 20 ppm by mass or less, heat treatment was performed at 200°C for 60 minutes, and then the temperature was cooled to 50°C.

[0399]

Next, a titanium barrier metal was deposited on the planarization layer and the barrier layer by sputtering, and a copper seed layer was further deposited on the barrier metal by sputtering. Next, a photoresist layer was formed, and copper metal wiring electrically connected to the LED was formed on the opening pattern portion of the planarization layer and a part of the surface of the planarization layer by a plating method. Thereafter, the photoresist layer, the seed layer, and the barrier metal at the portion where the metal wiring was not formed were removed. The thickness of the metal wiring formed on a part of the surface of the planarization layer was 5.0 μm .

[0400]

Next, a positive photosensitive composition containing a polyimide and a polybenzoxazole precursor was applied to the planarization layer and the barrier layer using a spin coater, and then prebaked at 120°C for 120 seconds using a hot plate to prepare a prebaked film. Next, after the prebaked film was subjected to patterning exposure, development, and rinsing through a photomask having a predetermined pattern, the film was heated and thermally cured to form an interlayer insulating layer having a film thickness of about 10 μm . As thermal curing conditions, heat treatment was performed at 110°C for 30 minutes in a nitrogen atmosphere having an oxygen concentration of 100 ppm by mass or less, and then heat treatment was further performed at 230°C for 60 minutes. Next, a titanium barrier metal film was formed on the interlayer insulating layer by sputtering, and a copper seed layer was further formed on the barrier metal film by sputtering. Subsequently, a photoresist layer was formed, and copper metal wiring electrically connected to the LED was formed on the opening pattern portion of the interlayer insulating layer and a part of the surface of the interlayer insulating layer by a plating method. Thereafter, the photoresist layer, the seed layer, and the barrier metal at the portion where the metal wiring was not

formed were removed. The thickness of the metal wiring formed on a part of the surface of the interlayer insulating layer was 5.0 μm . Thereafter, the formation of the interlayer insulating layer and the formation of the metal wiring were repeated twice to form three interlayer insulating layers. The total film thickness of the three interlayer insulating layers was 30 μm .

[0401]

Next, a barrier metal film was formed on the metal wiring of the opening pattern portion of the interlayer insulating layer by sputtering to form solder bumps. Thereafter, the solder was reflowed by heating at 260°C for 1 minute, and electrically connected to a light emitting element driving substrate having a driver IC as a driving element via a solder bump. Next, the support substrate was peeled off, and the counter substrate was bonded with an adhesive layer or the like to produce a micro LED display including LEDs as a plurality of semiconductor chips.

[0402]

<<Evaluation of Light Emission Luminance>>

The micro LED display produced by the above method was allowed to emit light, and an external quantum efficiency measuring apparatus (C9920, manufactured by Hamamatsu Photonics K.K.) was used to measure the light extraction efficiency as an index of the light emission

luminance. As the light extraction efficiency, a relative value with respect to the value was calculated assuming that the light extraction efficiency of the micro LED display according to Example 1 was 1.00. It was determined as follows, and A+, A, B+, B, C+, and C in which the relative value of the light extraction efficiency was 1.00 were regarded as acceptable.

A+: The relative value of the light extraction efficiency is 1.30 or more.

A: The relative value of the light extraction efficiency is 1.20 or more and less than 1.30.

B+: The relative value of the light extraction efficiency is 1.10 or more and less than 1.20.

B: The relative value of the light extraction efficiency is 1.00 or more and less than 1.10.

C+: The relative value of the light extraction efficiency is 0.95 or more and less than 1.00.

C: The relative value of the light extraction efficiency is 0.90 or more and less than 0.95.

D: The relative value of the light extraction efficiency is 0.70 or more and less than 0.90.

E: The relative value of the light extraction efficiency is less than 0.70.

[0403]

<Examples 2 to 48, Examples 52 to 57, and Comparative

Examples 1 to 3>

The same operation and evaluation as in Example 1 were performed using each composition shown in Tables 3-1 to 3-8. These evaluation results are collectively shown in Tables 3-1 to 3-8. When a composition having positive photosensitivity was used in each of Examples, the development time was 60 seconds, 90 seconds, or 120 seconds. From these results, the optimum development time (60 seconds, 90 seconds, or 120 seconds) and the optimum exposure energy at the development time were determined. After exposure with the optimum exposure energy, the pattern after development at the optimum development time was thermally cured at 200°C for 60 minutes. As thermal curing conditions, the temperature was raised to 200°C at a temperature raising rate of 3.5°C/min in a nitrogen atmosphere having an oxygen concentration of 20 ppm by mass or less, heat treatment was performed at 200°C for 60 minutes, and then the temperature was cooled to 50°C. Meanwhile, when a composition having negative photosensitivity was used, a photomask in which a light-transmitting portion and a light-shielding portion were inverted was used as the photomask, and the development time was 1.3 times as long as measured BP. After exposure with the optimum exposure energy, the pattern after development was thermally cured at 220°C for 60 minutes.

As thermal curing conditions, the temperature was raised to 220°C at a temperature raising rate of 3.5°C/min in a nitrogen atmosphere having an oxygen concentration of 20 ppm by mass or less, heat treatment was performed at 220°C for 60 minutes, and then the temperature was cooled to 50°C. In Examples 1 to 48, the light-absorbing layer is present as a layer having a plurality of island-shaped light-absorbing layers, and a plurality of semiconductor chips each independently contact at least one of the plurality of island-shaped light-absorbing layers.

[0404]

As shown in Table 3-6, in Example 6 and Examples 44 to 46, various properties were evaluated by changing the thickness of the light-absorbing layer. In Example 47, in the method described in the preparation of the laminate 0A, the size of the semiconductor chip was changed to width 10.1 μm × length 15.2 μm × height 4.7 μm (height including electrode terminal), the size of the electrode terminal was changed to 8.8 μm ×5.5 μm ×1.7 μm , and the area ratio of the light-absorbing layer ($(S_{2a})/(S_{1a})$) was changed to evaluate various properties. In Example 48, in the method described in the preparation of the laminate 0A, the size of the semiconductor chip was changed to width 7.5 μm × length 11.3 μm × height 3.5 μm (height including electrode terminal), the size of the electrode terminal was changed to 6.6

$\mu\text{m} \times 4.1 \mu\text{m} \times 2.5 \mu\text{m}$, and the area ratio of the light-absorbing layer ($(S_{2a})/(S_{1a})$) was changed to evaluate various properties.

[0405]

In Examples 52 to 57, the light-absorbing layer was processed such that $0.20 \mu\text{m}$ of a portion corresponding to pattern processing remained by changing the exposure condition and/or the development condition in the method described in the preparation of the laminate 1X. In Examples 52 to 57, the light-absorbing layer is present as a layer having a plurality of convex-portion light-absorbing layers and a recess light-absorbing layer, a thickness of the light-absorbing layer in the recess is smaller than a thickness of the light-absorbing layer in the plurality of convex portions, and a plurality of semiconductor chips each independently contact at least one of the plurality of convex-portion light-absorbing layers. That is, the thickness of the light-absorbing layer in the recess is $0.20 \mu\text{m}$. As shown in Table 3-7, in Examples 52 to 55, various properties were evaluated by varying the thickness of the light-absorbing layer. In Example 56, in the method described in the preparation of the laminate 0A, the size of the semiconductor chip was changed to width $10.1 \mu\text{m} \times$ length $15.2 \mu\text{m} \times$ height $4.7 \mu\text{m}$ (height including electrode terminal), the size of the electrode terminal was

changed to $8.8\text{ }\mu\text{m}\times 5.5\text{ }\mu\text{m}\times 1.7\text{ }\mu\text{m}$, and the area ratio of the light-absorbing layer ($(S_{2a})/(S_{1a})$) was changed to evaluate various properties. In Example 57, in the method described in the preparation of the laminate 0A, the size of the semiconductor chip was changed to width $7.5\text{ }\mu\text{m}\times$ length $11.3\text{ }\mu\text{m}\times$ height $3.5\text{ }\mu\text{m}$ (height including electrode terminal), the size of the electrode terminal was changed to $6.6\text{ }\mu\text{m}\times 4.1\text{ }\mu\text{m}\times 2.5\text{ }\mu\text{m}$, and the area ratio of the light-absorbing layer ($(S_{2a})/(S_{1a})$) was changed to evaluate various properties.

[0406]

As shown in Tables 3-1 to 3-8, the light-absorbing layer and /or the first pressure-sensitive adhesive layer were patterned by performing exposure and development or dry etching as step (13) or step (13y). As shown in Tables 3-1 to 3-8, step (14) or step (14y) involved performing any one of the following (x1), (x2), and (x3) treatments. Note that Examples 41 to 43 correspond to the method for producing a laminate according to the fifth and sixth aspects of the present invention.

(x1) The light-absorbing layer is heated at 150°C for 30 minutes.

(x2) The light-absorbing layer is irradiated with j-rays (wavelength: 313 nm) of an ultra-high pressure mercury lamp at 300 mJ/cm^2 .

(x3) The light-absorbing layer is irradiated with j-rays (wavelength: 313 nm) of an ultra-high pressure mercury lamp at 300 mJ/cm², and then the light-absorbing layer is heated at 100°C for 30 minutes.

[0407]

<Example 49>

In the method described in the preparation of the laminate 1x among the methods described in Example 1, a prebaked film of a light-absorbing layer was prepared on a quartz glass substrate using the composition 5 to prepare the laminate 1x. Furthermore, in the method described in the preparation of the laminate 1x, the conditions for irradiating the semiconductor chip with a laser from the donor substrate side of the semiconductor chip were changed to a wavelength of 355 nm and an energy density of 1200 mJ/cm². Further, both the semiconductor chip and the light-absorbing layer were irradiated with the laser by irradiating the semiconductor chip with the laser from the donor substrate side of the semiconductor chip without using the photomask. By such a method, the semiconductor chip was transferred from the donor substrate to the light-absorbing layer, and the light-absorbing layer at the portion irradiated with the laser was removed, and the light-absorbing layer was patterned into a plurality of island-shaped light-absorbing layers. Note that subsequent

exposure and development were not performed, and the light-absorbing layer was heated at 150°C for 30 minutes using a hot plate to be crosslinked, thereby preparing a laminate 1X. The same operation and evaluation as in Example 1 were performed except for these methods. These evaluation results are collectively shown in Table 3-6. In Example 49, the light-absorbing layer is present as a layer having a plurality of island-shaped light-absorbing layers, and a plurality of semiconductor chips each independently contact at least one of the plurality of island-shaped light-absorbing layers.

[0408]

<Example 50 and Example 51>

The same operation and evaluation as in Example 49 were performed using each composition shown in Table 3-6. These evaluation results are collectively shown in Table 3-6. As shown in Table 3-6, step (14) involved performing any one of the above (x1), (x2), and (x3) treatments. Note that Examples 49 to 51 correspond to the method for producing a laminate according to the seventh and eighth aspects of the present invention. In Examples 50 and 51, the light-absorbing layer is present as a layer having a plurality of island-shaped light-absorbing layers, and a plurality of semiconductor chips each independently contact at least one of the plurality of island-shaped light-

absorbing layers.

[0409]

<Example 58>

In the same manner as in Example 49 described above, in the method described in the preparation of the laminate 1X described above, the semiconductor chip was transferred from the donor substrate to the light-absorbing layer by changing the condition for irradiating the semiconductor chip with the laser from the donor substrate side of the semiconductor chip, and a part of the light-absorbing layer at the portion irradiated with the laser was removed. By such a method, the light-absorbing layer was processed into a plurality of convex-portion light-absorbing layers and a plurality of recess light-absorbing layers such that 0.20 μm of the corresponding portion remained. The same operation and evaluation as in Example 49 were performed except for these methods. These evaluation results are collectively shown in Table 3-7. In Example 58, the light-absorbing layer is present as a layer having a plurality of convex-portion light-absorbing layers and a recess light-absorbing layer, a thickness of the light-absorbing layer in the recess is smaller than a thickness of the light-absorbing layer in a plurality of semiconductor chips each independently contact at least one of the plurality of convex-portion light-absorbing layers. That is, the

thickness of the light-absorbing layer in the recess is 0.20 μm .

[0410]

<Example 59 and Example 60>

The same operation and evaluation as in Example 58 were performed using each composition shown in Table 3-7. These evaluation results are collectively shown in Table 3-7. As shown in Table 3-7, step (14) involved performing any one of the above (x1), (x2), and (x3) treatments. Note that Examples 58 to 60 correspond to the method for producing a laminate according to the seventh and eighth aspects of the present invention. In Examples 59 and 60, the light-absorbing layer is present as a layer having a plurality of convex-portion light-absorbing layers and a recess light-absorbing layer, a thickness of the light-absorbing layer in the recess is smaller than a thickness of the light-absorbing layer in the plurality of convex portions, and a plurality of semiconductor chips each independently contact at least one of the plurality of convex-portion light-absorbing layers. That is, the thickness of the light-absorbing layer in the recess is 0.20 μm .

[0411]

In each of the above Examples, Reference Examples, and Comparative Examples, dry etching was performed using a

high-throughput ashing/etching apparatus (MAS-8220AT; manufactured by Canon Inc.) under the following conditions. The etching time was an etching time that was calculated from the etching rate and was capable of patterning the light-absorbing layer and /or the first pressure-sensitive adhesive layer.

<<Dry Etching Conditions>>

Etching gas: $\text{CF}_4/\text{O}_2 = 25/75$ (volume ratio)

RF power: 300W

Etching temperature: 50°C

Treatment pressure: 20Pa

Gas flow rate: 50 sccm.

[0412]

[Table 3-1-1]

	Composition	Composition [parts by mass]			Patterning and crosslinking of light-absorbing layer		Physical property value of light-absorbing layer			
		Binder resin (A)	Photosensitive agent (C) Ultraviolet absorber (Da) Dissolution accelerator	Compound (B) Crosslinking agent (F)	Step (13)	Step (14)	Photosensitivity	Thickness [μm]	355 nm Absorbance	Area ratio (S _{1a}) / (S _{2a})
Example 1	1	PI-1 (100)	NQD-1 (15) da-1 (15) p-1 (5)	f-1 (3)	Exposure and development	Absent	Positive	2.0	1.8	1.36
Example 2						(x1) Treatment		2.0	1.8	1.36
Example 3	2	PI-2 (100)		2.0				1.6	1.36	
Example 4				3				2.0	1.6	1.12
Example 5	4	PIP-1 (100)		f-1 (3)				2.0	1.6	1.36
Example 6	5	PBP-1 (100)						2.0	1.6	1.36
Example 7	6	PBP-1 (100)	c-1 (10) da-1 (15)	b-1 (10) f-1 (3)	Etching	Absent	Negative	2.0	1.4	1.20
Example 8						(x2) Treatment		2.0	1.4	1.20
Example 9						(x3) Treatment		2.0	1.4	1.20
Example 10	7	PI-1 (100)	da-1 (15)	f-1 (3)	Etching	Absent	Non-photosensitive	2.0	1.4	1.20
Example 11						(x1) Treatment		2.0	1.4	1.20
Example 12	8	PI-2 (100)		2.0				1.2	1.20	
Example 13				9				f-1 (9)	2.0	1.2

*1: Values of indentation elastic modulus before treatment, as Examples 1, 7, and 10 do not undergo step (14).

*2: In Examples 1, 7, and 10, since the step (14) is not performed, the value of the glass transition temperature before treatment

[Table 3-1-2]

	Composition	Physical property value of light-absorbing layer					Laser transfer characteristics			Light emission characteristics
		Cross-sectional shape of pattern [°]	Indentation elastic modulus after treatment [Pa]	Indentation elastic modulus ratio	Glass transition temperature after treatment [°C]	Difference in glass transition temperature [°C]	Energy density	Debris	Positional accuracy	Light emission luminance
Example 1	1	45	2.2×10^6 *1	—	31 *2	—	B	C+	C+	B
Example 2		45	7.0×10^8	3.2×10^2	133	52	B+	B+	B+	B+
Example 3	2	45	8.0×10^8	3.2×10^2	134	52	B	B+	B+	B+
Example 4	3	70	1.3×10^9	5.2×10^2	148	60	B	B	B	B
Example 5	4	45	2.5×10^8	3.2×10^2	101	52	A	B+	B+	B+
Example 6	5	45	6.5×10^7	3.2×10^2	73	52	A	A	B+	A
Example 7	6	60	4.6×10^5 *1	—	12 *2	—	C	C+	C	B
Example 8		60	5.5×10^8	1.2×10^3	123	70	B	B+	B	B+
Example 9		60	7.4×10^8	1.6×10^3	133	72	B+	B+	B	B+
Example 10	7	60	2.2×10^6 *1	—	31 *2	—	C	C+	C	B
Example 11		60	2.6×10^8	1.2×10^2	101	32	B	B+	B	B+
Example 12	8	60	5.6×10^8	1.1×10^2	123	32	C+	B+	B	B+
Example 13	9	75	1.6×10^9	3.2×10^2	146	52	C+	B	C+	B

*1: Values of indentation elastic modulus before treatment, as Examples 1, 7, and 10 do not undergo step (14).

*2: In Examples 1, 7, and 10, since the step (14) is not performed, the value of the glass transition temperature before treatment

[0413]

[Table 3-2-1]

	Composition	Composition [parts by mass]			Patterning and crosslinking of light-absorbing layer		Physical property value of light-absorbing layer			
		Binder resin (A)	Photosensitive agent (C) Ultraviolet absorber (Da) Dissolution accelerator	Compound (B) Crosslinking agent (F)	Step (13)	Step (14)	Photosensitivity	Thickness [μm]	355 nm Absorbance	Area ratio (S _{1a}) / (S _{2a})
Example 14	10	PR-1 (100)	NQD-1 (15) da-1 (15) p-1 (5)	f-1 (3)	Exposure and development	(x1) Treatment	Positive	2.0	1.6	1.36
Example 15	11	PHS-1 (100)						2.0	1.6	1.36
Example 16	12	PAC-2 (100)						2.0	1.6	1.36
Example 17	13	PAC-3 (100) *3	c-1 (10) da-1 (15)	b-1 (10) f-1 (3)	Etching	(x2) Treatment	Negative	2.0	1.4	1.20
Example 18						(x3) Treatment		2.0	1.4	1.20
Example 19	14	PAC-1 (100) *3	—	f-1 (3)	Etching	(x1) Treatment	Non-photosensitive	2.0	1.9	1.20

*3: PAC-1 and PAC-3 correspond to the binder resin (A) and the ultraviolet absorber (Da)

[Table 3-2-2]

	Composition	Physical property value of light-absorbing layer					Laser transfer characteristics			Light emission characteristics
		Cross-sectional shape of pattern [°]	Indentation elastic modulus after treatment [Pa]	Indentation elastic modulus ratio	Glass transition temperature after treatment [°C]	Difference in glass transition temperature [°C]	Energy density	Debris	Positional accuracy	Light emission luminance
Example 14	10	45	3.5×10^6	3.2×10^2	32	52	A	A	A	A
Example 15	11	45	3.5×10^6	3.2×10^2	32	52	A	A	A	A
Example 16	12	45	1.3×10^6	3.2×10^2	20	52	A	A+	A	A
Example 17	13	60	2.0×10^6	1.2×10^3	31	70	B+	A	B+	A
Example 18		60	2.8×10^6	1.6×10^3	31	72	A	A	B+	A
Example 19	14	60	5.9×10^5	1.4×10^2	13	32	A+	A	A	A

*3: PAC-1 and PAC-3 correspond to the binder resin (A) and the ultraviolet absorber (Da)

[0414]

[Table 3-3-1]

	Composition	Composition [parts by mass]			Patterning and crosslinking of light-absorbing layer		Physical property value of light-absorbing layer			
		Binder resin (A)	Photosensitive agent (C) Ultraviolet absorber (Da) Dissolution accelerator	Compound (B) Crosslinking agent (F)	Step (13)	Step (14)	Photosensitivity	Thickness [μm]	355 nm Absorbance	Area ratio (S _{1a}) / (S _{2a})
Example 20	15	AC-3 (100)	NQD-1 (15) da-1 (15) p-1 (5)	f-1 (3)	Exposure and development	(x1) Treatment	Positive	2.0	1.6	1.43
Example 21	16	AC-4 (100)						2.0	1.6	1.43
Example 22	17	AC-5 (100)						2.0	1.8	1.36
Example 23	18	AC-6 (100)	c-1 (10) da-1 (15)	f-1 (3)	Etching	(x2) Treatment	Negative	2.0	1.3	1.36
Example 24	19	AC-7 (100)		f-1 (3)				2.0	1.3	1.36
Example 25	20			b-1 (10) f-1 (3)				(x3) Treatment	2.0	1.2
Example 26				b-1 (30) f-1 (3)		2.0			1.2	1.20
Example 27	21			b-1 (30) f-1 (3)		(x2) Treatment		2.0	1.1	1.09
Example 28	22	b-1 (10) f-1 (3)		2.0				1.4	1.20	
Example 29	23	AE-1 (100)		2.0				1.4	1.20	
Example 30	24	AC-1 (100)	da-1 (15)	f-1 (3)	Etching	(x1) Treatment	Non-photosensitive	2.0	1.0	1.20
Example 31	25	AC-2 (100)						2.0	1.0	1.20
Example 32	26							f-1 (1)	2.0	1.0
Example 33	27	AC-3 (100)		f-1 (3)				2.0	1.2	1.20
Example 34	28	AC-4 (100)						2.0	1.2	1.20
Example 35	29	AC-5 (100)						2.0	1.4	1.20

[Table 3-3-2]

	Composition	Physical property value of light-absorbing layer					Laser transfer characteristics			Light emission characteristics
		Cross-sectional shape of pattern [°]	Indentation elastic modulus after treatment [Pa]	Indentation elastic modulus ratio	Glass transition temperature after treatment [°C]	Difference in glass transition temperature [°C]	Energy density	Debris	Positional accuracy	Light emission luminance
Example 20	15	40	1.3×10^6	3.2×10^2	20	52	A	A+	A	A
Example 21	16	40	5.3×10^5	3.2×10^2	13	52	A	A+	A+	A
Example 22	17	45	1.3×10^7	3.2×10^3	50	52	A+	A+	A	A
Example 23	18	45	1.5×10^6	2.3×10^2	20	50	B+	A	A	A
Example 24	19	45	4.0×10^5	2.3×10^2	12	50	B+	A+	A	A
Example 25	20	60	2.0×10^6	1.2×10^3	31	70	B+	A	B+	A
Example 26		60	2.8×10^6	1.6×10^3	31	72	A	A	B+	A
Example 27	21	75	5.7×10^6	3.3×10^3	43	80	B+	B+	B+	B+
Example 28	22	60	3.0×10^7	1.2×10^3	61	70	B+	B+	B+	A
Example 29	23	60	1.5×10^7	1.2×10^3	60	70	B+	B+	B+	A
Example 30	24	60	2.5×10^5	1.3×10^2	1	34	B+	A+	A	A
Example 31	25	60	1.8×10^5	1.3×10^2	0	34	B+	A+	A+	A
Example 32	26	45	9.7×10^4	7.0×10^1	-10	24	B+	B+	B+	A
Example 33	27	60	5.9×10^5	1.4×10^2	13	34	B+	A	A	A
Example 34	28	60	2.3×10^5	1.4×10^2	11	34	B+	A+	A	A
Example 35	29	60	5.5×10^6	1.4×10^2	43	34	A	A	A	A

[0415]

[Table 3-4-1]

	Composition	Composition [parts by mass]				Patterning and crosslinking of light-absorbing layer		Physical property value of light-absorbing layer		
		Binder resin (A)	Photosensitive agent (C) Colorant (Db) Dissolution accelerator	Compound (B) Crosslinking agent (F) Dispersant	Pigment dispersion	Step (13)	Step (14)	Photosensitivity	Thickness [μm]	355 nm Absorbance
Example 36	30	PBP-1 (100)	NQD-1 (15) A.R.52-B.B.7 (10) P-1 (5)	f-1 (3)	-	Exposure and development	(x1) Treatment	Positive	2.0	1.6
Example 37	31		NQD-1 (15) TPK-1227 (10) P-1 (5)	f 1 (3) D.BYK-21116 (3.5)	Dsp-1				2.0	1.9
Example 38	32		NQD-1 (15) P.B.60 (10) P-1 (5)		Dsp-2				2.0	1.9
Example 39	33	PBP-1 (100)	C-1 (10) P.B.60 (10)	b-1 (10) f-1 (3) D.BYK-21116 (3.5)	Dsp-2	Etching	(x2) Treatment	Negative	2.0	1.6
Example 40	34	PI-1 (100)	P.B.60 (10)	f-1 (3) D.BYK-21116 (3.5)	Dsp-2	Etching	(x1) Treatment	Non-photosensitive	2.0	1.6

[Table 3-4-2]

	Composition	Physical property value of light-absorbing layer						Laser transfer characteristics			Light emission characteristics
		Area ratio (S_{1a}) / (S_{2a})	Cross-sectional shape of pattern [°]	Indentation elastic modulus after treatment [Pa]	Indentation elastic modulus ratio	Glass transition temperature after treatment [°C]	Difference in glass transition temperature [°C]	Energy density	Debris	Positional accuracy	Light emission luminance
Example 36	30	1.36	45	6.5×10^7	3.2×10^2	73	52	A	A	B+	A
Example 37	31	1.36	45	8.5×10^7	3.2×10^2	84	52	A+	A	B+	A
Example 38	32	1.36	45	8.5×10^7	3.2×10^2	84	52	A+	A	B+	A
Example 39	33	1.20	60	7.5×10^5	1.2×10^3	133	70	B	B+	B	B+
Example 40	34	1.20	60	4.6×10^5	1.2×10^2	122	32	B	B+	B	B+

[0416]

[Table 3-5-1]

	Composition for forming light-absorbing layer	Patterning and crosslinking of light-absorbing layer and first pressure-sensitive adhesive layer		Physical property value of light-absorbing layer				
		Step (13y)	Step (14y)	Photosensitivity	Thickness [μm]	355 nm Absorbance	Area ratio (S _{1a}) / (S _{2a})	Cross-sectional shape of pattern [°]
Example 41	Composition 5	Exposure and development	(x1) Treatment	Positive	1.0	1.6	1.16	45
Example 42	Composition 6	Etching	(x2) Treatment	Negative	1.0	1.4	1.16	60
Example 43	Composition 7	Etching	(x1) Treatment	Non-photosensitive	1.0	1.4	1.16	60
	Composition for forming first pressure-sensitive adhesive layer	-		Physical property value of first pressure-sensitive adhesive layer				
		-	-	Photosensitivity	Thickness [μm]	355 nm Absorbance	Area ratio (S _{1a}) / (S _{2a})	Cross-sectional shape of pattern [°]
Example 41	Composition 17	-	-	Positive	1.0	1.8	1.17	45
Example 42	Composition 20	-	-	Negative	1.0	1.2	1.17	60
Example 43	Composition 24	-	-	Non-photosensitive	1.0	1.0	1.17	60

[Table 3-5-2]

	Composition for forming light-absorbing layer	Physical property value of light-absorbing layer				Laser transfer characteristics			Light emission characteristics
		Indentation elastic modulus after treatment [Pa]	Indentation elastic modulus ratio	Glass transition temperature after treatment [°C]	Difference in glass transition temperature [°C]	Energy density	Debris	Positional accuracy	Light emission luminance
Example 41	Composition 5	6.5×10^7	3.2×10^2	73	52	A+	A	A	A
Example 42	Composition 6	5.5×10^8	1.2×10^3	123	70	B+	B+	B+	B+
Example 43	Composition 7	2.6×10^8	1.2×10^2	101	32	B+	B+	B+	B+
	Composition for forming first pressure-sensitive adhesive layer	Physical property value of first pressure-sensitive adhesive layer				-			
		Indentation elastic modulus after treatment [Pa]	Indentation elastic modulus ratio	Glass transition temperature after treatment [°C]	Difference in glass transition temperature [°C]	-	-	-	-
Example 41	Composition 17	1.3×10^7	3.2×10^2	50	52	-	-	-	-
Example 42	Composition 20	2.0×10^6	1.2×10^3	31	70	-	-	-	-
Example 43	Composition 24	2.5×10^5	1.3×10^2	1	34	-	-	-	-

[0417]

[Table 3-6-1]

	Composition	Composition [parts by mass]			Patterning and crosslinking of light-absorbing layer		Physical property value of light-absorbing layer		
		Binder resin (A)	Photosensitive agent (C) Ultraviolet absorber (Da) Dissolution accelerator	Compound (B) Crosslinking agent (F)	Step (12a)	Step (14)	Photosensitivity	Thickness [μm]	355 nm Absorbance
Example 44	5	PBP-1 (100)	NQD-1 (15) da-1 (15) p-1 (5)	f-1 (3)	Exposure and development	(x1) Treatment	Positive	0.50	1.6
Example 45								1.0	1.6
Example 6								2.0	1.6
Example 46								3.0	1.6
Example 47								2.0	1.6
Example 48								2.0	1.6
Example 49	5	PBP-1 (100)	NQD-1 (15) da-1 (15) p-1 (5)	f-1 (3)	Patterning of light-absorbing layer with laser during transfer of semiconductor chip	(x1) Treatment	Positive	2.0	1.6
Example 50	6	PBP-1 (100)	c-1 (10) da-1 (15)	b-1 (10) f-1 (3)		(x2) Treatment	Negative	2.0	1.4
Example 51	7	PI-1 (100)	da-1 (15)	f-1 (3)		(x1) Treatment	Non-photosensitive	2.0	1.4

[Table 3-6-2]

	Composition	Physical property value of light-absorbing layer						Laser transfer characteristics			Light emission characteristics
		Area ratio (S _{1a}) / (S _{2a})	Cross-sectional shape of pattern [°]	Indentation elastic modulus after treatment [Pa]	Indentation elastic modulus ratio	Glass transition temperature after treatment [°C]	Difference in glass transition temperature [°C]	Energy density	Debris	Positional accuracy	Light emission luminance
Example 44	5	1.08	45	6.5 × 10 ⁷	3.2 × 10 ²	73	52	A	A+	B+	A+
Example 45		1.17	45	6.5 × 10 ⁷	3.2 × 10 ²	73	52	A	A+	B+	A
Example 6		1.36	45	6.5 × 10 ⁷	3.2 × 10 ²	73	52	A	A	B+	A
Example 46		1.55	45	6.5 × 10 ⁷	3.2 × 10 ²	73	52	A	B+	B+	A
Example 47		1.76	45	6.5 × 10 ⁷	3.2 × 10 ²	73	52	A	A+	A	A
Example 48		2.08	45	6.5 × 10 ⁷	3.2 × 10 ²	73	52	A+	A+	A+	A
Example 49	5	1.12	70	6.5 × 10 ⁷	3.2 × 10 ²	73	52	A	A	B+	A
Example 50	6	1.12	70	5.5 × 10 ⁸	1.2 × 10 ³	123	70	B	B+	B	B+
Example 51	7	1.12	70	2.6 × 10 ⁸	1.2 × 10 ²	101	32	B	B+	B	B+

[0418]

[Table 3-7-1]

	Composition	Composition [parts by mass]			Patterning and crosslinking of light-absorbing layer		Physical property value of light-absorbing layer		
		Binder resin (A)	Photosensitive agent (C) Ultraviolet absorber (Da) Dissolution accelerator	Compound (B) Crosslinking agent (F)	Step (12a)	Step (14)	Photosensitivity	Thickness [μm]	355 nm Absorbance
Example 52	5	PBP-1 (100)	NQD-1 (15) da-1 (15) p-1 (5)	f-1 (3)	Exposure and development *4	(x1) Treatment	Positive	0.50	1.6
Example 53								1.0	1.6
Example 54								2.0	1.6
Example 55								3.0	1.6
Example 56								2.0	1.6
Example 57								2.0	1.6
Example 58	5	PBP-1 (100)	NQD-1 (15) da-1 (15) p-1 (5)	f-1 (3)	Patterning of light-absorbing layer with laser during transfer of semiconductor chip *4	(x1) Treatment	Positive	2.0	1.6
Example 59	6	PBP-1 (100)	c-1 (10) da-1 (15)	b-1 (10) f-1 (3)		(x2) Treatment	Negative	2.0	1.4
Example 60	7	PI-1 (100)	da-1 (15)	f-1 (3)		(x1) Treatment	Non-photosensitive	2.0	1.4

*4: In Examples 52 to 60, the light-absorbing layer has a recess, and the thickness of the light-absorbing layer in the recess is 0.20 μm.

[Table 3-7-2]

	Composition	Physical property value of light-absorbing layer						Laser transfer characteristics			Light emission characteristics
		Area ratio (S _x) / (S _y)	Cross-sectional shape of pattern [°]	Indentation elastic modulus after treatment [Pa]	Indentation elastic modulus ratio	Glass transition temperature after treatment [°C]	Difference in glass transition temperature [°C]	Energy density	Debris	Positional accuracy	Light emission luminance
Example 52	5	1.05	45	6.5 × 10 ⁷	3.2 × 10 ²	73	52	B+	A	B+	A+
Example 53		1.14	45	6.5 × 10 ⁷	3.2 × 10 ²	73	52	B+	A	B+	A
Example 54		1.32	45	6.5 × 10 ⁷	3.2 × 10 ²	73	52	B+	B+	B+	A
Example 55		1.51	45	6.5 × 10 ⁷	3.2 × 10 ²	73	52	B+	B	B+	A
Example 56		1.68	45	6.5 × 10 ⁷	3.2 × 10 ²	73	52	B+	A	A	A
Example 57		1.95	45	6.5 × 10 ⁷	3.2 × 10 ²	73	52	A	A	A+	A
Example 58	5	1.11	70	6.5 × 10 ⁷	3.2 × 10 ²	73	52	B+	B+	B+	A
Example 59	6	1.11	70	5.5 × 10 ⁸	1.2 × 10 ³	123	70	C+	B	B	B+
Example 60	7	1.11	70	2.6 × 10 ⁸	1.2 × 10 ²	101	32	C+	B	B	B+

*4: In Examples 52 to 60, the light-absorbing layer has a recess, and the thickness of the light-absorbing layer in the recess is 0.20 μm.

[0419]

[Table 3-8-1]

	Composition	Composition [parts by mass]			Patterning and crosslinking of light-absorbing layer		Physical property value of light-absorbing layer			
		Binder resin (A)	Photosensitive agent (C) Ultraviolet absorber (Da) Dissolution accelerator	Crosslinking agent (F)	Step (13)	Step (14)	Photosensitivity	Thickness [μm]	355 nm Absorbance	Area ratio (S _{1a}) / (S _{2a})
Comparative Example 1	7	PI-1 (100)	da-1 (15)	f-1 (3)	Absent	(x1) Treatment	Non-photosensitive	2.0	1.4	-
Comparative Example 2	35	PI-2 (100)		f-1 (15)	Absent			2.0	1.1	-
Comparative Example 3	36	PIP-2 (100)	-	-	Absent			2.0	2.0	-

[Table 3-8-2]

	Composition	Physical property value of light-absorbing layer					Laser transfer characteristics			Light emission characteristics
		Cross-sectional shape of pattern [°]	Indentation elastic modulus after treatment [Pa]	Indentation elastic modulus ratio	Glass transition temperature after treatment [°C]	Difference in glass transition temperature [°C]	Energy density	Debris	Positional accuracy	Light emission luminance
Comparative Example 1	7	-	2.6 × 10 ⁸	1.2 × 10 ²	101	32	C	D	D	C
Comparative Example 2	35	-	3.2 × 10 ⁹	1.2 × 10 ³	205	70	D	D	D	D
Comparative Example 3	36	-	3.7 × 10 ⁹	6.8 × 10 ¹	205	22	D	D	D	D

[0420]

In Comparative Examples 1 to 3, since the light-absorbing layer is not patterned, various properties are poor. Further, in Comparative Example 2 and Comparative Example 3, the indentation elastic modulus of the light-absorbing layer and the glass transition temperature of the light-absorbing layer do not satisfy the matters specifying the invention of the present application. Therefore, Comparative Examples 2 and 3 are further inferior in various properties.

DESCRIPTION OF REFERENCE SIGNS

[0421]

- 1: First substrate (quartz glass substrate)
- 2: light-absorbing layer
- 2a: First pressure-sensitive adhesive layer
- 3: Donor substrate (sapphire substrate)
- 4: Semiconductor chip (LED)
- 4a: Electrode terminal
- 5: Laser
- 6: Chemical active ray
- 7: light-absorbing layer after exposure
- 7a: light-absorbing layer and first pressure-sensitive adhesive layer after exposure
- 8: Unexposed light-absorbing layer

8a: Unexposed first pressure-sensitive adhesive layer

9: light-absorbing layer after crosslinking

9a: First pressure-sensitive adhesive layer after crosslinking

10: Second substrate (alkali-free glass substrate)

11: Second pressure-sensitive adhesive layer

12: light-absorbing layer after laser irradiation

12a: light-absorbing layer and first pressure-sensitive adhesive layer after laser irradiation

CLAIMS

[Claim 1] A method for producing a laminate, comprising:

- (10) preparing a laminate a1x including a first substrate and a light-absorbing layer in this order;
- (12) tentatively fixing an article to the light-absorbing layer (hereinafter, referred to as step (12));
- (13) patterning the light-absorbing layer (hereinafter, referred to as step (13));
- (20) preparing a laminate a2 including a second substrate and a second pressure-sensitive adhesive layer in this order; and

(22) irradiating the light-absorbing layer with a chemical active ray from a first substrate side of the light-absorbing layer while a gap is present between an article provided on the first substrate and the second pressure-sensitive adhesive layer provided on the second substrate to transfer the article from the light-absorbing layer to the second pressure-sensitive adhesive layer (hereinafter referred to as step (22)),

wherein, in step (12), a plurality of articles are in contact with the light-absorbing layer, and, in step (13), a recess is formed in the light-absorbing layer.

[Claim 2] the method for producing a laminate according

to claim 1, wherein the light-absorbing layer has an indentation elastic modulus at 50°C of 1.0×10^3 to 2.0×10^9 Pa in step (13) and/or a glass transition temperature of -50 to 150°C in step (13).

[Claim 3] The method for producing a laminate according to claim 1 or 2, further comprising: (01) forming an article on a donor substrate,

wherein step (12) comprises (12a) irradiating the article with a chemical active ray from a donor substrate side of the article while the article provided on the donor substrate is in contact with the light-absorbing layer provided on the first substrate to transfer the article from the donor substrate to the light-absorbing layer (hereinafter, referred to as step (12a)), and

in step (12a), the light-absorbing layer is irradiated with a chemical active ray using the article as a mask, and at least a part of the light-absorbing layer irradiated with the chemical active ray is removed.

[Claim 4] The method for producing a laminate according to claim 1 or 2, wherein

in step (13), the light-absorbing layer is present, in a state of being in contact with the first substrate, as a plurality of convex-portion light-absorbing layers and a

recess light-absorbing layer, a thickness of the light-absorbing layer in the recess is smaller than a thickness of the light-absorbing layer in the plurality of convex portions; and

the plurality of articles each independently contact at least one of the plurality of convex-portion light-absorbing layers.

[Claim 5] The method for producing a laminate according to claim 1 or 2, wherein, in step (13), the light-absorbing layer is present in a state of being in contact with the first substrate as a plurality of island-shaped light-absorbing layers, and the plurality of articles each independently contact at least one of the plurality of island-shaped light-absorbing layers.

[Claim 6] The method for producing a laminate according to claim 1 or 2, wherein, in step (13), any one of the following conditions (a) to (c) is satisfied:

(a) the light-absorbing layer is a layer formed from a positive photosensitive composition, and step (13) comprises (13a) patterning the light-absorbing layer by photolithography (hereinafter, referred to as step (13a));

(b) the light-absorbing layer is a layer formed from a positive or negative photosensitive composition, and step

(13) comprises (13b) patterning the light-absorbing layer by etching (hereinafter, referred to as step (13b)); and

(c) the light-absorbing layer is a layer formed from a non-photosensitive composition, and step (13) comprises step (13b) patterning the light-absorbing layer by etching, wherein light-absorbing layer has an indentation elastic modulus at 50°C of 1.0×10^3 to 2.0×10^9 Pa and/or a glass transition temperature of -50 to 150°C.

[Claim 7] The method for producing a laminate according to claim 6,

wherein condition (a) is satisfied in step (13), and step (13a) comprises (13a-1) irradiating the light-absorbing layer with a chemical active ray from an article side of the light-absorbing layer using the article as a mask; and (13a-2) developing the light-absorbing layer with a developer to pattern the light-absorbing layer.

[Claim 8] The method for producing a laminate according to claim 6,

wherein condition (c) is satisfied in step (13), and step (13b) comprises (13b-1a) performing dry etching from an article side of the light-absorbing layer using the article as a mask to pattern the light-absorbing layer; or (13b-1b) performing wet etching from the article side of

the light-absorbing layer using the article as a mask to pattern the light-absorbing layer.

[Claim 9] The method for producing a laminate according to claim 1 or 2, further comprising, before or after step (13), (14) crosslinking a pattern of the light-absorbing layer (hereinafter, referred to as step (14)),

wherein step (14) comprises (14a) crosslinking the pattern of the light-absorbing layer by heating; or (14b-1) irradiating the light-absorbing layer with a chemical active ray from the first substrate side of the light-absorbing layer.

[Claim 10] A method for producing a laminate, comprising:

(10) preparing a laminate a1x including a first substrate and a light-absorbing layer in this order;

(12z) tentatively fixing an article to the light-absorbing layer and ablating the light-absorbing layer (hereinafter, referred to as step (12z));

(20) preparing a laminate a2 including a second substrate and a second pressure-sensitive adhesive layer in this order; and

(22) irradiating the light-absorbing layer with a chemical active ray from a first substrate side of the light-absorbing layer while a gap is present between an

article provided on the first substrate and the second pressure-sensitive adhesive layer provided on the second substrate to transfer the article from the light-absorbing layer to the second pressure-sensitive adhesive layer (hereinafter referred to as step (22)),

wherein, in step (12z), a plurality of articles are in contact with the light-absorbing layer, and a recess is formed in the light-absorbing layer.

[Claim 11] a laminate comprising, in this order, a first substrate, a light-absorbing layer, and an article,

wherein a plurality of articles are in contact with the light-absorbing layer, the light-absorbing layer having a recess, and

light-absorbing layer has an indentation elastic modulus at 50°C of 1.0×10^3 to 2.0×10^9 Pa and/or a glass transition temperature of -50 to 150°C.

[Claim 12] The laminate according to claim 11,

wherein the light-absorbing layer is present, in a state of being in contact with the first substrate, as a plurality of convex-portion light-absorbing layers and a recess light-absorbing layer, and a thickness of the light-absorbing layer in the recess is smaller than a thickness of the light-absorbing layer in the plurality of convex

portions; and

the plurality of articles each independently contact at least one of the plurality of convex-portion light-absorbing layers.

[Claim 13] The laminate according to claim 11, wherein the light-absorbing layer is present in a state of being in contact with the first substrate as a plurality of island-shaped light-absorbing layers, and the plurality of articles each independently contact at least one of the plurality of island-shaped light-absorbing layers.

[Claim 14] The laminate according to claim 12 or 13, wherein the light-absorbing layer has a thickness of less than 5.0 μm .

[Claim 15] The laminate according to claim 12 or 13, wherein the light-absorbing layer is a layer formed from a positive photosensitive composition.

[Claim 16] the laminate according to claim 13, wherein the laminate satisfies a relationship of formula (S-1), where (S_{1a}) is an area of surface 1a on a first substrate side of the light-absorbing layer, and (S_{2a}) is an area of surface 2a opposite to surface 1a of the light-absorbing layer.

$$(S_{1a}) \geq (S_{2a}) \quad (S-1)$$

[Claim 17] The laminate according to claim 16, wherein $(S_{1a})/(S_{2a})$ is 1.10 or more and 3.00 or less, where $(S_{1a})/(S_{2a})$ is a ratio of area (S_{1a}) of surface 1a to area (S_{2a}) of surface 2a.

[Claim 18] The laminate according to claim 12 or 13, wherein a maximum value of absorbance per 1.0 μm of thickness of the light-absorbing layer at wavelengths of 180 to 550 nm is 0.3 to 10.0.

[Claim 19] The laminate according to claim 12 or 13, wherein the light-absorbing layer contains ultraviolet absorber (XD_a),

the ultraviolet absorber (XD_a) comprising a resin having a triazine structure and/or a benzotriazole structure in a structural unit of the resin.

[Claim 20] The laminate according to claim 12 or 13, wherein the light-absorbing layer satisfies any one of the following conditions (α) to (γ):

(α) the light-absorbing layer is a layer formed from a positive photosensitive composition, and the positive photosensitive composition satisfies at least one of

conditions (1), (3), and (4);

(β) the light-absorbing layer is a layer formed from a negative photosensitive composition, and the negative photosensitive composition satisfies at least one of conditions (2) to (4);

(γ) the light-absorbing layer is a layer formed from a non-photosensitive composition, and the non-photosensitive composition satisfies condition (5) and/or condition (6);

(1) containing a naphthoquinonediazide compound (C1) and a crosslinking agent (F);

(2) containing a photopolymerization initiator (C2) and a radical polymerizable compound (B);

(3) containing a photoacid generator (C3) and a crosslinking agent (F);

(4) containing a photobase generator (C4) and a crosslinking agent (F);

(5) containing a crosslinking agent (F); and

(6) containing a radical polymerizable compound (B).