

## Description

Title of Invention: FILM BONDING METHOD

### Technical Field

[0001] The present invention relates to a film bonding method.

### Background Art

[0002] In an image display apparatus, for example, a liquid crystal display apparatus, a member formed of a plurality of bonded films has hitherto been used. For example, there has been known a touch panel sensor formed by laminating a sensor film, on which electrodes and lead wires connected to the electrodes are formed, and an optical film. Registration with high accuracy is required for bonding those films to each other. When the films are bonded to each other, the films are generally aligned with each other by forming registration marks in predetermined portions of the films and detecting the registration marks. For example, when the touch panel sensor is manufactured, registration marks are formed in a portion (for example, a bezel portion) other than a visual portion of the sensor film.

[0003] Meanwhile, in recent years, there has been a demand for achieving a narrower bezel in the image display apparatus. In a method of bonding a plurality of films by forming registration marks in a bezel portion as described above, formation of the registration

marks serves as a factor for preventing achievement of a narrower bezel.

#### Citation List

##### Patent Literature

[0004] [PTL 1] JP 2011-248207 A

#### Summary of Invention

##### Technical Problem

[0005] The present invention has been made so as to solve the above-mentioned related-art problem, and a primary object of the present invention is to provide a film bonding method suitable for achieving a narrower bezel in an image display apparatus.

##### Solution to Problem

[0006] A film bonding method according to one embodiment of the present invention is a film bonding method for bonding a sensor film and an optical film to each other, at least one surface of the sensor film having arranged thereon an electrode and a lead wire connected to the electrode, the method including: performing registration of the optical film with reference to the lead wire; and bonding the sensor film and the optical film to each other.

In one embodiment, the film bonding method includes: a reference line detection step including detecting a reference line

of the sensor film, the reference line being obtained by connecting two reference points set on the lead wire, and detecting a reference line of the optical film set on the optical film; a registration step of performing registration of the sensor film and the optical film; and a bonding step of bonding the sensor film and the optical film to each other, and the registration step includes: adjusting an angle formed by the reference line of the sensor film and the reference line of the optical film; and adjusting a plan view distance between the reference line of the sensor film and the reference line of the optical film.

In one embodiment, after the angle formed by the reference line of the sensor film and the reference line of the optical film is adjusted in the registration step, the angle formed by the reference line of the sensor film and the reference line of the optical film is from  $-0.5^{\circ}$  to  $0.5^{\circ}$ .

In one embodiment, after the angle formed by the reference line of the sensor film and the reference line of the optical film is adjusted in the registration step, the angle formed by the reference line of the sensor film and the reference line of the optical film is from  $89.5^{\circ}$  to  $90.5^{\circ}$ .

#### Advantageous Effects of Invention

[0007] According to the present invention, the film bonding

method suitable for achieving a narrower bezel in an image display apparatus can be provided by bonding the sensor film having the lead wire formed thereon and the optical film to each other through the registration of the optical film with reference to the lead wire.

#### Brief Description of Drawings

[0008] FIG. **1** is a schematic plan view for illustrating an example of a sensor film to be subjected to a film bonding method according to one embodiment of the present invention.

FIG. **2(a)** is a schematic plan view for illustrating an example of reference points and a reference line set on the sensor film. FIG. **2(b)** is a schematic plan view for illustrating an example of reference points and a reference line set on an optical film.

FIG. **3(a)** to FIG. **3(c)** are each a view for illustrating a registration step of the film bonding method according to one embodiment of the present invention.

FIG. **4** is a schematic plan view for illustrating an example of reference lines set on the sensor film and the optical film.

FIG. **5** is a schematic plan view for illustrating an example of the reference lines set on the sensor film and the optical film.

FIG. 6 is a schematic plan view for illustrating an example of the reference lines set on the sensor film and the optical film.

#### Description of Embodiments

[0009] A film bonding method of the present invention is a method of bonding a sensor film and an optical film to each other.

#### [0010] A. Sensor Film

FIG. 1 is a schematic plan view for illustrating an example of a sensor film to be subjected to a film bonding method according to one embodiment of the present invention. Electrodes **10** and lead wires **20** connected to the electrodes **10** are arranged on at least one surface of a sensor film **100**. Preferably, the electrodes **10** and the lead wires **20** are formed on a transparent base material **30**. The sensor film **100** is suitably used as a touch sensor for a touch panel. The sensor film to be used as the touch sensor generally includes a display region and a non-display region (specifically, a region corresponding to a bezel portion of an image display apparatus). The electrodes **10** are arranged in a region corresponding to the display region. Therefore, it is preferred that the electrodes **10** be transparent. For example, the electrodes **10** are formed of a transparent conductive layer formed to be patterned. The lead wires **20** may be formed in a peripheral portion of the sensor film **100**. When the sensor film **100** is used in an image display apparatus

including a touch panel, the lead wires **20** are generally arranged in a region corresponding to the non-display region. Although not shown, functional layers, such as a hard coat layer, an optical adjustment undercoat layer, and an antiblocking layer, may be formed between the transparent base material and the electrodes.

[0011]        The electrodes **10** may function as touch sensor electrodes configured to sense contact with the touch panel.

[0012]        The electrodes **10** may be formed by forming a metal oxide film on the transparent base material **30** by any appropriate film formation method (e.g., a vacuum deposition method, a sputtering method, a CVD method, an ion plating method, or a spraying method). The metal oxide film is preferably patterned by an etching method or the like.

[0013]        Examples of the metal oxide include indium oxide, tin oxide, zinc oxide, an indium-tin composite oxide, a tin-antimony composite oxide, a zinc-aluminum composite oxide, and an indium-zinc composite oxide. Of those, an indium-tin composite oxide (ITO) is preferred.

[0014]        Further, as other examples of the electrodes **10**, there are given a transparent conductive layer containing a conductive filler (for example, metal nanowires), a transparent conductive

layer containing a conductive resin, and the like.

[0015]        The lead wires **20** may have a function of sending an electric signal from the electrodes **10** to a control unit (not shown). In general, a plurality of the lead wires **20** are arranged.

[0016]        As a material for forming the lead wires **20**, any appropriate material may be used as long as the material has conductivity. For example, copper, a copper alloy, or a conductive silver paste is used.

[0017]        In one embodiment, the transparent base material **30** includes a touch panel substrate portion **31** and a connection portion **32**. The electrodes **10** and the lead wires **20** are arranged on the touch panel substrate portion **31**. End portions of the lead wires **20** are arranged on the connection portion **32**. The touch panel substrate portion **31** may have any appropriate shape. The touch panel substrate portion **31** has, for example, a substantially rectangular shape as in the illustrated example. Further, the connection portion **32** is formed so as to protrude from one side of the touch panel substrate portion **31**. In the illustrated example, the connection portion **32** is formed on a short side of the touch panel substrate portion **31**.

[0018]        In one embodiment, the lead wires **20** are arranged

substantially in parallel to any side of the touch panel substrate portion **31** having a substantially rectangular shape. More specifically, as in the illustrated example, the lead wires **20** may each be formed of a line segment that is substantially parallel to a long side of the touch panel substrate portion **31** and a line segment that is substantially parallel to a short side thereof.

[0019] As a material for forming the transparent base material **31**, any appropriate material may be used. Specifically, for example, a film or a polymer base material, for example, a plastic base material, is preferably used. This is because the smoothness of the transparent base material and the wettability with respect to a composition for forming the transparent conductive layer are excellent.

[0020] The material for forming the transparent base material **30** is typically a polymer film containing a thermoplastic resin as a main component. Examples of the thermoplastic resin include: a polyester-based resin, such as polyethylene terephthalate (PET); a cycloolefin-based resin, such as polynorbornene; an acrylic resin; a polycarbonate resin; and a cellulose-based resin. The thermoplastic resins may be used alone or in combination thereof.

[0021] B. Optical Film

As an optical film, there are given, for example, a polarizing plate, a retardation plate, and an isotropic film.

[0022]        The optical film may be a single layer or a multilayer. In one embodiment, a polarizing plate including a polarizer and a protective film arranged on at least one side of the polarizer is used as the optical film. Further, a multilayer optical film including a polarizing plate and another optical film (for example, a retardation plate) may be used. Preferably, the optical film includes any appropriate pressure-sensitive adhesive layer. In the polarizing plate, the pressure-sensitive adhesive layer may be arranged on an opposite side of the protective film to the polarizer. The sensor film and the optical film may be bonded to each other through intermediation of the pressure-sensitive adhesive layer. The pressure-sensitive adhesive layer may be protected by arranging a separator on an outer side of the pressure-sensitive adhesive layer until the optical film is bonded to the sensor film.

[0023]        It is preferred that the optical film has such a size as to cover at least an entire region of the sensor film in which the electrodes are formed. The optical film may have any appropriate shape. Preferably, the optical film has a substantially rectangular shape.

[0024]        C. Bonding of Sensor Film and Optical Film

              The bonding method of the present invention includes performing registration of the optical film with reference to lead wires arranged

on the sensor film. According to the bonding method of the present invention, the sensor film and the optical film can be bonded to each other without forming registration marks on the films. A region for forming the registration marks is a region that is not necessary from the viewpoint of a touch sensor function. In the present invention, such unnecessary region can be eliminated. More specifically, the registration marks have hitherto been formed in a non-display region, that is, a region corresponding to a bezel portion of the image display apparatus. However, according to the present invention, the registration marks are not necessary, and hence a narrower bezel can be achieved in the image display apparatus. Now, a typical example of the film bonding method of the present invention is described.

[0025] C-1. Reference Line Detection Step

First, a reference line of the sensor film and a reference line of the optical film are detected. For example, two or more (preferably three or more) reference points are set on each of the films and detected, and the reference line is detected as a line formed by connecting the reference points.

[0026] Preferably, the sensor film and the optical film are each held by a registration device and subjected to the detection step. As the registration device, any appropriate device is used as long as the device holds the films and has a function of moving

the held films in a plane direction and a perpendicular direction of the films. The registration device includes any appropriate control unit. After the reference line detection step, the registration device moves the sensor film and/or the optical film in the plane direction of the film in a registration step described later, and moves the sensor film and/or the optical film in the perpendicular direction of the film in a bonding step described later.

[0027] FIG. **2(a)** is a schematic plan view for illustrating an example of reference points and a reference line set on the sensor film. Reference points **101** and **102** of the sensor film are set on the lead wire **20** arranged on the sensor film **100**. A line formed by connecting the reference points **101** and **102** serves as a reference line **110**. Preferably, the reference points are set so that an angle formed by the reference line **110** and one side of the sensor film **100** is from  $-0.5^{\circ}$  to  $0.5^{\circ}$  (more preferably from  $-0.3^{\circ}$  to  $0.3^{\circ}$ , still more preferably  $0^{\circ}$ ) or from  $89.5^{\circ}$  to  $90.5^{\circ}$  (more preferably from  $89.7^{\circ}$  to  $90.3^{\circ}$ , still more preferably  $90^{\circ}$ ). In one embodiment, as in the illustrated example, both ends of a line segment forming the lead wire **20** are set to the reference points **101** and **102** of the sensor film.

[0028] In general, a plurality of the lead wires **20** are arranged, but the reference points may be set on any of the lead wires **20**.

Preferably, the reference points are set on the lead wire **20** on an outermost side or on the lead wire **20** on an innermost side, with an outer peripheral side of the sensor film being an outer side. The reference points set at such positions can be easily detected.

[0029]        The reference points **21** and **22** of the sensor film are typically detected through use of any appropriate camera. For example, the sensor film is photographed with a CCD camera, and the reference points set as described above are detected from the obtained photographed image.

[0030]        FIG. **2(b)** is a schematic plan view for illustrating an example of reference points and a reference line set on the optical film. As reference points **201** and **202** of an optical film **200**, for example, vertexes on an outer periphery defining the optical film may be selected. Preferably, as in the illustrated example, adjacent vertexes are set as the reference points **201** and **202**. In this case, one side of the optical film **200** serves as a reference line **210**.

[0031]        The reference points **201** and **202** of the optical film are typically detected through use of any appropriate camera. For example, the optical film and the periphery thereof are photographed with a CCD camera, and the reference points set as described above are detected from a contrast difference in the obtained photographed image.

[0032] When the optical film is a polarizing plate, an absorption axis or a transmission axis of a polarizer included in the polarizing plate may be used as a reference line without setting reference points.

[0033] C-2. Registration Step

FIGS. **3** are each a view for illustrating the registration step of the film bonding method according to one embodiment of the present invention. After the reference lines are detected as described above, registration between the sensor film **100** and the optical film **200** is performed as illustrated in FIG. **3(a)** to FIG. **3(c)**. In one embodiment, the registration is performed by bringing both the films close to each other so that one film is positioned above the other film, adjusting an angle formed by the reference lines of the sensor film **100** and the optical film **200**, and thereafter adjusting a distance between the reference lines. In another embodiment, the registration is performed by bringing both the films close to each other so that one film is positioned above the other film, adjusting a distance between the reference lines of the sensor film and the optical film, and thereafter adjusting an angle formed by the reference lines. Preferably, from the viewpoint of production efficiency, as in the illustrated example, the registration is performed by adjusting the angle formed by the reference lines, and thereafter adjusting the distance between the reference lines.

Movement of the films in association with the above-mentioned adjustment (and film bonding described later) is performed by the registration device holding the films.

[0034]           (Reference Line Angle Adjustment)

As illustrated in FIG. 3(a) and FIG. 3(b), an angle formed by the reference line **110** of the sensor film **100** and the reference line **210** of the optical film **200** is adjusted. The angle formed by the reference line **110** of the sensor film **100** and the reference line **210** of the optical film **200** is hereinafter sometimes simply referred to as "angle **A**". Further, the angle **A** before adjustment is also referred to as "initial angle **A1**", and the angle **A** after adjustment is also referred to as "angle **A2**".

[0035]           The angle **A** is adjusted by, for example, measuring the initial angle **A1** and rotating the sensor film **100** and/or the optical film **200** in the plane direction until the angle **A** reaches the desired angle **A2** with reference to the initial angle **A1**. The angle **A** is measured by, for example, imaging the reference points **101** and **102** of the sensor film **100** and the reference points **201** and **202** of the optical film **200**, converting the reference points **101** and **101** and the reference points **201** and **202** into coordinates on an identical plane, and calculating the angle **A** by an equation of the reference line **110** of the sensor film **100** and an equation of the reference line **210** of the optical film.

[0036] In one embodiment, the angle **A2** is preferably from  $-0.5^{\circ}$  to  $0.5^{\circ}$ , more preferably from  $-0.3^{\circ}$  to  $0.3^{\circ}$ , still more preferably  $0^{\circ}$  as illustrated in FIG. **3(b)**. In another embodiment, the angle **A2** is preferably from  $89.5^{\circ}$  to  $90.5^{\circ}$ , more preferably from  $89.7^{\circ}$  to  $90.3^{\circ}$ , still more preferably  $90^{\circ}$  (FIG. **4** and FIG. **5**).

[0037] (Reference Line Distance Adjustment)

Next, as illustrated in FIG. **3(b)** and FIG. **3(c)**, misregistration between the sensor film **100** and the optical film **200** is corrected. Misregistration is corrected by adjusting a distance (plan view distance) between the reference line of the sensor film **100** and the reference line of the optical film **200**.

[0038] Registration between the sensor film **100** and the optical film **200** is performed, for example, with reference to the reference line **110** of the sensor film **100** and a second reference line **120** orthogonal to the reference line **110** at one reference point (reference point **101** in the illustrated example) of the sensor film **100**. More specifically, with the reference line **110** direction being an **X** direction, and the second reference line **120** direction being a **Y** direction, the sensor film **100** and/or the optical film **200** are moved in the **X** direction or the **Y** direction until a plan view distance  $\Delta x$  between the sensor film **100** and the optical film **200** in the **X** direction and a plan view distance  $\Delta y$  between the sensor film **100**

and the optical film **200** in the **Y** direction each reach a desired distance. In the illustrated example, the "plan view distance  $\Delta x$  between the sensor film **100** and the optical film **200** in the **X** direction" is a plan view distance between the second reference line **120** of the sensor film **100** and a second reference line **220** of the optical film **200** orthogonal to the reference line **210** of the optical film **200** at one reference point (reference point **201** in the illustrated example) of the optical film **200**. Further, the "plan view distance  $\Delta y$  between the sensor film **100** and the optical film **200** in the **Y** direction" is a plan view distance between the reference line **110** of the sensor film **100** and the reference line **210** of the optical film **200**.

[0039] C-3. Bonding Step

Next, the sensor film and the optical film are bonded to each other. For example, when a film including a pressure-sensitive adhesive layer and a separator for protecting the pressure-sensitive adhesive layer is used as the optical film, after the separator is peeled, the sensor film and the optical film are brought close to each other to be bonded to each other. Further, the sensor film and the optical film may be bonded to each other while the optical film **200** is pressed with a bonding roll from one end to the other end.

[0040] In FIGS. **2** and FIGS. **3**, there is illustrated the example

in which the sensor film (in a precise sense, the touch panel substrate portion) and the optical film each have a rectangular shape, and the reference lines of the films are set in long side directions of the sensor film and the optical film and adjusted so as to be parallel to each other. However, the present invention is not limited to this embodiment. Typical examples of the embodiments of the present invention are described below.

[0041]        A1: The reference line **110** of the sensor film **100** is set in a long side direction of the sensor film **100**, the reference line **210** of the optical film **200** is set in a short side direction of the optical film, and an angle formed by the reference line **110** and the reference line **210** is adjusted to from  $89.5^{\circ}$  to  $90.5^{\circ}$  (more preferably from  $89.7^{\circ}$  to  $90.3^{\circ}$ , still more preferably  $90^{\circ}$ ) (FIG. **4**).

[0042]        B1: The reference line **110** of the sensor film **100** is set in a short side direction of the sensor film **100**, the reference line **210** of the optical film **200** is set in a long side direction of the optical film, and an angle formed by the reference line **110** and the reference line **210** is adjusted to from  $89.5^{\circ}$  to  $90.5^{\circ}$  (more preferably from  $89.7^{\circ}$  to  $90.3^{\circ}$ , still more preferably  $90^{\circ}$ ) (FIG. **5**).

[0043]        B2: The reference line **110** of the sensor film **100** is

set in a short side direction of the sensor film **100**, the reference line **210** of the optical film **200** is set in a short side direction of the optical film, and an angle formed by the reference line **110** and the reference line **210** is adjusted to from  $-0.5^{\circ}$  to  $0.5^{\circ}$  (more preferably from  $-0.3^{\circ}$  to  $0.3^{\circ}$ , still more preferably  $0^{\circ}$ ) (FIG. **6**).

#### Reference Signs List

|                 |           |                                 |
|-----------------|-----------|---------------------------------|
| [0044]          | <b>10</b> | electrode                       |
| <b>20</b>       |           | lead wire                       |
| <b>30</b>       |           | transparent base material       |
| <b>100</b>      |           | sensor film                     |
| <b>101, 102</b> |           | reference point of sensor film  |
| <b>110, 120</b> |           | reference line of sensor film   |
| <b>200</b>      |           | optical film                    |
| <b>201, 202</b> |           | reference point of optical film |
| <b>210, 220</b> |           | reference line of optical film  |

## Claims

[Claim 1] A film bonding method for bonding a sensor film and an optical film to each other, at least one surface of the sensor film having arranged thereon an electrode and a lead wire connected to the electrode,

the method comprising:

carrying out a reference line detection step including detecting a reference line of the sensor film, the reference line being obtained by connecting two reference points set on the lead wire, and detecting a reference line of the optical film set on the optical film;

performing registration of the optical film with reference to the sensor film, wherein the registration includes a registration step of:

adjusting an angle formed by the reference line of the sensor film and the reference line of the optical film; and

adjusting a plan view distance between the reference line of the sensor film and the reference line of the optical film; and

bonding the sensor film and the optical film to each other.

[Claim 2] The film bonding method according to claim 1, wherein, after the angle formed by the reference line of the sensor film and the reference line of the optical film is adjusted in the registration step, the angle formed by the reference line of the

sensor film and the reference line of the optical film is from  $-0.5^{\circ}$  to  $0.5^{\circ}$ .

[Claim 3] The film bonding method according to claim 1, wherein, after the angle formed by the reference line of the sensor film and the reference line of the optical film is adjusted in the registration step, the angle formed by the reference line of the sensor film and the reference line of the optical film is from  $89.5^{\circ}$  to  $90.5^{\circ}$ .