[0005] In direct bonding, there is a problem that voids are more likely to occur due to microbumps, particles, and the like due to wiring and the like on the surface of substrates.

[0006] On the other hand, in the case of bonding with an adhesive, the adhesive is applied to the surface of a substrate, and then allowed to dry to become semi-cured, and then substrates are bonded together. At this time, there is a problem that substrate bonding displacement (misalignment) tends to occur.

[0007] ~~One embodiment of the invention has been made in view of the above-described problem, and an object~~Embodiments of the invention ~~is to~~ provide a method of manufacturing a substrate layered body and a layered body capable of producing a substrate layered body in which void generation and misalignment are suppressed.

Solution to Problem

[0008] Specific means for solving the above-described problems are as follows

[0009] ~~<1> A~~According to a first aspect of the present invention, there is provided a method of manufacturing a substrate layered body, the method ~~comprising~~including:

a step of applying a bonding material, comprising a polymerizable compound, to a surface of at least one of a first substrate or a second substrate;

a step of curing the bonding material applied to the surface, to form a bonding layer having a reduced modulus at 23°C of 10 GPa or less; and

a step of bonding the first substrate with the second substrate via the bonding layer.

~~<2> The method of manufacturing a substrate layered body according to <1>, wherein~~In an embodiment of the above method of manufacturing a substrate layered body, in the step of forming the bonding layer, the bonding material applied to the surface is heated at from 100°C to 450°C for curing.

~~<3> The method of manufacturing a substrate layered body according to <1> or <2>, wherein~~In an embodiment of the above method of manufacturing a substrate layered body, in the step of bonding the first substrate with the second substrate, the first substrate and the second substrate are bonded by heating the bonding layer at from 100°C to 450°C, in a state in which the first substrate and the second substrate are in contact with each other via the bonding layer.

~~<4> The method of manufacturing a substrate layered body according to any one of <1> to <3>, wherein~~In an embodiment of the above method of manufacturing a substrate layered body, a degree of curing of the bonding layer after the step of forming the bonding layer and before the step of bonding the first substrate with the second substrate is 70% or more.

~~<5> The method of manufacturing a substrate layered body according to any one of <1> to <4>, wherein~~In an embodiment of the above method of manufacturing a substrate layered body, the bonding layer includes a silanol group on a surface thereof.

~~<6> The method of manufacturing a substrate layered body according to any one of <1> to <5>, wherein~~In an embodiment of the above method of manufacturing a substrate layered body, the bonding layer includes a siloxane bond, and at least one of an amide bond or an imide bond.

~~<7> The method of manufacturing a substrate layered body according to any one of <1> to <6>, the method~~An embodiment of the above method of manufacturing a substrate layered body further ~~comprising~~comprises a step of forming a hydroxyl group by performing a surface treatment on a surface of at least one of the first substrate or the second substrate at a side at which the substrate is in contact with the bonding layer.

~~<8> The method of manufacturing a substrate layered body according to any one of <1> to <7>, wherein~~In an embodiment of the above method of manufacturing a substrate layered body, a thickness of the bonding layer in the substrate layered body is from 0.001 μm to 8.0 μm.

~~<9> The method of manufacturing a substrate layered body according to any one of <1> to <8>,~~

~~wherein~~In an embodiment of the above method of manufacturing a substrate layered body,, in the substrate layered body, a surface energy of a bonding interface between the first substrate and the second substrate is 2 J/m^2 or more.

~~<10> The method of manufacturing a substrate layered body according to any one of <1> to <9>, the method~~An embodiment of the above method of manufacturing a substrate layered body further ~~comprising~~comprises a step of temporarily fixing the first substrate and the second substrate via the bonding layer after the step of forming the bonding layer, wherein the surface energy of the bonding interface between the first substrate and the second substrate after the step of temporary fixing is 0.05 J/m^2 or more.

~~<11> A method of manufacturing a substrate layered body according to any one of <1> to <10>, the method further comprising a step of forming an electrode on the surface of the at least one of the first substrate or the second substrate to which the bonding material is applied, before the step of applying the bonding material.~~

According to a second aspect of the present invention, there is provided a method of manufacturing a substrate layered body, the method including:

a step of forming an electrode on a surface of at least one of the first substrate or the second substrate,

a step of applying a bonding material to the surface of at least one of the first substrate or the second substrate on which the electrode is formed,

a step of curing the bonding material applied to the surface, to form a bonding layer having a reduced modulus at 23°C of 10 GPa or less; and

a step of bonding the first substrate with the second substrate via the bonding layer.

~~<12> The method of manufacturing a substrate layered body according to <11>, the method~~ An embodiment of the above method of manufacturing a substrate layered body further ~~comprising~~comprises a step of removing the bonding material from the electrode after the step of applying the bonding material and before the step of forming the bonding layer.

~~<13> The method of manufacturing a substrate layered body according to <11>, the method~~ An embodiment of the above method of manufacturing a substrate layered body further ~~comprising~~comprise a step of removing the bonding layer from the electrode after the step of forming the bonding layer and before the step of bonding the first substrate and the second substrate.

~~<14> The method of manufacturing a substrate layered body according to any one of <1> to <13>, the method further comprising a step of forming an electrode on the surface on which the bonding layer has been formed after the step of forming the bonding layer and before the step of bonding the first substrate and the second substrate.~~

According to a third aspect of the present invention, there is provided a method of manufacturing a substrate layered body, the method including:

a step of applying a bonding material to a surface of at least one of a first substrate or a second substrate;

a step of curing the bonding material applied to the surface, to form a bonding layer having a reduced modulus at 23°C of 10 GPa or less;

a step of forming an electrode on the surface on which the bonding layer is formed; and

a step of bonding the first substrate with the second substrate via the bonding layer.

[0010] ~~<15> A layered body comprising:~~

~~a first substrate; and~~

~~a bonding layer formed on the first substrate, wherein:~~

~~the bonding layer is formed by curing a bonding material, and~~

~~the reduced modulus at 23°C is 10 GPa or less.~~

According to a fourth aspect of the present invention, there is provided a substrate layered body including:

a first substrate;

a bonding layer formed on the first substrate;

an electrode formed on a surface of the first substrate at which the bonding layer is formed; and

a second substrate that is bonded with the first substrate via the bonding layer and the electrode, wherein:

the bonding layer is formed by curing a bonding material, and

the reduced modulus at 23°C is 10 GPa or less.

Advantageous Effects of Invention

[0011] ~~One aspect~~Embodiments of the present invention can provide a method of manufacturing a substrate layered body, which can produce a substrate layered body in which void generation and misalignment are suppressed, and a layered body.

BRIEF DESCRIPTION OF DRAWINGS

[0012] Fig. 1 is a schematic diagram illustrating alignment marks formed on a first substrate and a second substrate in Example 2.

Fig. 2 is a schematic diagram illustrating misalignment of alignment marks when the first substrate and the second substrate are bonded in Example 2.

Fig. 3 is a diagram illustrating state of copper electrodes and a bonding layer in <Exposure of Copper Electrodes> in Example 4.

Fig. 4(a) is a diagram of a temporarily fixed substrate layered body in which a first substrate is temporarily fixed on a second substrate via a bonding layer, viewed from the opposite side of the surface where the bonding layer of the first substrate is formed, and Fig. 4(b) is a diagram of a substrate layered body in which the first substrate is joined to the second substrate via the bonding layer, viewed from the opposite side of the surface where the bonding layer of the first substrate is formed, in Example 9.

DESCRIPTION OF EMBODIMENTS

[0013] Herein, numerical ranges indicated using "to" mean a range including the numerical values described before and after "to" as the lower limit value and the upper limit value, respectively.

With regard to the stepwise numerical ranges described herein, the upper limit value or the lower limit value described in one numerical range may be replaced with the upper limit value or the lower limit value of another stepwise numerical range. In the numerical ranges described herein, upper limit values or lower limit values of the numerical value ranges may be replaced with values described in Examples.

As used herein, "substrate layered body" means a layered body having a structure in which two substrates are bonded together via a bonding layer formed by the method of manufacturing a substrate layered body in the present disclosure. The substrate layered body may include three or more substrates, and two of the three or more substrates may have a structure in which the two substrates are bonded via a bonding layer formed by the method of manufacturing a substrate layered body in the present disclosure.

[0014] [Method of Manufacturing Substrate Layered Body]

CLAIMS

1. A method of manufacturing a substrate layered body, the method comprising:

a step of applying a bonding material to a surface of at least one of a first substrate or a second substrate;

a step of curing the bonding material applied to the surface, to form a bonding layer having a reduced modulus at 23°C of 10 GPa or less; and

a step of bonding the first substrate with the second substrate via the bonding layer.

2. The method of manufacturing a substrate layered body according to claim 1, wherein, in the step of forming the bonding layer, the bonding material applied to the surface is heated at from 100°C to 450°C for curing.

3. The method of manufacturing a substrate layered body according to claim 1 or 2, wherein, in the step of bonding the first substrate with the second substrate, the first substrate and the second substrate are bonded by heating the bonding layer at from 100°C to 450°C, in a state in which the first substrate and the second substrate are in contact with each other via the bonding layer.

4. The method of manufacturing a substrate layered body according to any one of claims 1 to 3, wherein a degree of curing of the bonding layer after the step of forming the bonding layer and before the step of bonding the first substrate with the second substrate is 70% or more.

5. The method of manufacturing a substrate layered body according to any one of claims 1 to 4, wherein the bonding layer includes a silanol group on a surface thereof.

6. The method of manufacturing a substrate layered body according to any one of claims 1 to 5, wherein the bonding layer includes a siloxane bond, and at least one of an amide bond or an imide bond.

7. The method of manufacturing a substrate layered body according to any one of claims 1 to 6, the method further comprising a step of forming a hydroxyl group by performing a surface treatment on a surface of at least one of the first substrate or the second substrate at a side at which the substrate is in contact with the bonding layer.

8. The method of manufacturing a substrate layered body according to any one of claims 1 to 7, wherein a thickness of the bonding layer in the substrate layered body is from 0.001 μm to 8.0 μm.

9. The method of manufacturing a substrate layered body according to any one of claims 1 to 8, wherein, in the substrate layered body, a surface energy of a bonding interface between the first substrate and the second substrate is 2 J/m^2 or more.

10. The method of manufacturing a substrate layered body according to any one of claims 1 to 9, the method further comprising a step of temporarily fixing the first substrate and the second substrate via the bonding layer after the step of forming the bonding layer, wherein the surface energy of the bonding interface between the first substrate and the second substrate after the step of temporary fixing is 0.05 J/m^2 or more.

11. A method of manufacturing a substrate layered body according to any one of claims 1 to 10, the method further comprising a step of forming an electrode on the surface of the at least one of the first substrate or the second substrate to which the bonding material is applied, before the step of applying the bonding material.

12. The method of manufacturing a substrate layered body according to claim 11, the method further comprising a step of removing the bonding material from the electrode after the step of applying the bonding material and before the step of forming the bonding layer.

13. The method of manufacturing a substrate layered body according to claim 11, the method further comprising a step of removing the bonding layer from the electrode after the step of forming the bonding layer and before the step of bonding the first substrate and the second substrate.

14. The method of manufacturing a substrate layered body according to any one of claims 1 to 13, the method further comprising a step of forming an electrode on the surface on which the bonding layer has been formed after the step of forming the bonding layer and before the step of bonding the first substrate and the second substrate.

15. A layered body comprising:

~~a first substrate; and~~

~~a bonding layer formed on the first substrate, wherein:~~

~~the bonding layer is formed by curing a bonding material, and~~

~~the reduced modulus at 23°C is 10 GPa or less.~~

1. A method of manufacturing a substrate layered body, the method comprising:

a step of applying a bonding material, comprising a polymerizable compound, to a surface of at least one of a first substrate or a second substrate;

a step of curing the bonding material applied to the surface, to form a bonding layer having a reduced modulus at 23°C of 10 GPa or less; and

a step of bonding the first substrate with the second substrate via the bonding layer.

2. The method of manufacturing a substrate layered body according to claim 1, wherein, in the step of forming the bonding layer, the bonding material applied to the surface is heated at from 100°C to 450°C for curing.

3. The method of manufacturing a substrate layered body according to claim 1 or 2, wherein, in the step of bonding the first substrate with the second substrate, the first substrate and the second substrate are bonded by heating the bonding layer at from 100°C to 450°C, in a state in which the first substrate and the second substrate are in contact with each other via the bonding layer.

4. The method of manufacturing a substrate layered body according to any one of claims 1 to 3, wherein a degree of curing of the bonding layer after the step of forming the bonding layer and before the step of bonding the first substrate with the second substrate is 70% or more.

5. The method of manufacturing a substrate layered body according to any one of claims 1 to 4, wherein the bonding layer includes a silanol group on a surface thereof.

6. The method of manufacturing a substrate layered body according to any one of claims 1 to 5, wherein the bonding layer includes a siloxane bond, and at least one of an amide bond or an imide bond.

7. The method of manufacturing a substrate layered body according to any one of

claims 1 to 6, the method further comprising a step of forming a hydroxyl group by performing a surface treatment on a surface of at least one of the first substrate or the second substrate at a side at which the substrate is in contact with the bonding layer.

8. The method of manufacturing a substrate layered body according to any one of claims 1 to 7, wherein a thickness of the bonding layer in the substrate layered body is from 0.001 μm to 8.0 μm.

9. The method of manufacturing a substrate layered body according to any one of claims 1 to 8, wherein, in the substrate layered body, a surface energy of a bonding interface between the first substrate and the second substrate is 2 J/m^2 or more.

10. The method of manufacturing a substrate layered body according to any one of claims 1 to 9, the method further comprising a step of temporarily fixing the first substrate and the second substrate via the bonding layer after the step of forming the bonding layer, wherein the surface energy of the bonding interface between the first substrate and the second substrate after the step of temporary fixing is 0.05 J/m^2 or more.

11. A method of manufacturing a substrate layered body, the method comprising:

a step of forming an electrode on a surface of at least one of the first substrate or the second substrate,

a step of applying a bonding material to the surface of at least one of the first substrate or the second substrate on which the electrode is formed,

a step of curing the bonding material applied to the surface, to form a bonding layer having a reduced modulus at 23°C of 10 GPa or less; and

a step of bonding the first substrate with the second substrate via the bonding layer.

12. The method of manufacturing a substrate layered body according to claim 11, the method further comprising a step of removing the bonding material from the electrode after the step of applying the bonding material and before the step of forming the bonding layer.

13. The method of manufacturing a substrate layered body according to claim 11, the method further comprising a step of removing the bonding layer from the electrode after the step of forming the bonding layer and before the step of bonding the first substrate and the second substrate.

14. A method of manufacturing a substrate layered body, the method comprising:

a step of applying a bonding material to a surface of at least one of a first substrate or a second substrate;

a step of curing the bonding material applied to the surface, to form a bonding layer having a reduced modulus at 23°C of 10 GPa or less;

a step of forming an electrode on the surface on which the bonding layer is formed; and

a step of bonding the first substrate with the second substrate via the bonding layer.

15. A substrate layered body comprising:

a first substrate;

a bonding layer formed on the first substrate;

an electrode formed on a surface of the first substrate at which the bonding layer is formed; and

a second substrate that is bonded with the first substrate via the bonding layer and the electrode, wherein:

the bonding layer is formed by curing a bonding material, and

the reduced modulus at 23°C is 10 GPa or less.