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Probe card

Abstract

Suppresses reflection from a circuit board including a light-transparent insulating film formed on an interlayer wiring to easily identify an alignment mark formed on a probe. The probe card comprises a circuit board **103** on which an insulating film **304** and an electrode pad **3** are formed and a probe **5** attached onto the electrode pad **3**. The probe **5** has an alignment mark **7** identifiable from an opposite side of the circuit board **103**. The alignment mark **7** is positioned outside of the electrode pad **3** on the circuit board **103**. The insulating film **304** is a light-transmissive thin film covering an interlayer wiring **314**. An anti-reflection film **6** with lower light transmittance than the insulating film **304** is formed in some regions on the insulating film **304**. The anti-reflection film **6** is formed on a position corresponding to the alignment mark **7** and a region surrounding the position.

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Background/Summary

(1) This application is a National Stage Application of PCT/JP2021/022080, filed Jun. 10, 2021.

TECHNICAL FIELD

(2) The present invention relates to a probe card, and more particularly to an improvement of a probe card in which an alignment mark is formed on the probe.

BACKGROUND OF THE INVENTION

(3) A probe card is an inspection device used to inspect the electrical characteristics of semiconductor devices formed on a semiconductor wafer and is equipped with a number of probes on a circuit board that contact the electrode terminals on the semiconductor wafer respectively.

(4) Inspection of semiconductor devices is performed by bringing the semiconductor wafer close to the probe card, bringing the tip of the probe into contact with the electrode terminal on the semiconductor wafer, and allowing the tester device to conduct with the semiconductor device via the probe and the circuit board. The probe card and semiconductor wafer are aligned prior to inspection so that the probe tip can contact the corresponding electrode terminal.

(5) The alignment is performed by identifying an alignment mark on the probe card. For example, the position and posture of the probe card can be identified by photographing one or two or more alignment marks on the circuit board or on the probe, extracting each of the alignment marks from the photographed image, and identifying its position (see, e.g., Patent Literatures 1 to 4).

CITATION LIST

Patent Literatures

(6) [Patent Literature 1] JP 2011-27538 A [Patent Literature 2] JP 2005-533263 A [Patent Literature 3] JP 2010-182749 A [Patent Literature 4] JP 2004-138393 A

SUMMARY OF THE INVENTION

Technical Problem

(7) An insulating film is formed on the probe mounting surface of the circuit board to cover an interlayer wiring. If a photosensitive polymer is used for the insulating film, the insulating film can be patterned by exposure and development without forming a photoresist on the insulating film, simplifying the manufacturing process.

(8) However, the photosensitive polymer should be a material with light transmittance. Therefore, if the photosensitive polymer is used for the insulating film, reflected light from the circuit board increases when an alignment mark is photographed, making it difficult to identify the alignment mark. For example, there is a problem that the illumination light transmitted through the insulating film is directly reflected by the interlayer wiring, resulting in strong reflected light, and the

reflected light diffusely reflected by the edge of the interlayer wiring, etc., becomes stray light in the insulating film, making the entire insulating film bright due to diffuse reflection.

(9) In particular, when an alignment mark is formed on the probe, the insulating film that becomes the background of the alignment mark reflects illumination light and becomes bright, reducing the contrast of the alignment mark and making difficult to identify the alignment.

(10) The present invention is made in view of the above problems and the objective of the present invention is to enable easy identification of an alignment mark formed on a probe. In particular, the object of the present invention is to make it possible to easily identify an alignment mark formed on a probe by suppressing reflected light from a circuit board on which a light-transparent insulating film is formed over interlayer wiring. Moreover, the objective of the present invention is to simplify the manufacturing method of the probe card.

Solution to the Problem

(11) A probe card of a first embodiment comprising a circuit board on which an insulating film and an electrode pad are formed and a probe attached onto the electrode pad, wherein the probe includes an alignment mark identifiable from an opposite side of the circuit board, the alignment mark is positioned outside of the electrode pad on the circuit board, the insulating film is a light-transmissive thin film covering an interlayer wiring, an anti-reflection film with lower light transmittance than the insulating film being formed in some regions on the insulating film, and the anti-reflection film is formed on a position corresponding to the alignment mark and a region surrounding the position.

(12) According to this configuration, when illumination light is irradiated to capture an alignment mark, reflected light from the insulating film can be suppressed. Therefore, it is possible to prevent the alignment mark from being difficult to identify due to reflected light from the interlayer wiring covered by the insulating film or stray light in the insulating film.

(13) A probe card of a second embodiment is configured such that, in addition to the above configuration, the anti-reflection film is light-impermeable. With this configuration, it is possible to effectively prevent the alignment mark from becoming difficult to identify.

(14) A probe card of a third embodiment is configured such that, in addition to the above configuration, the insulating film is made of a photosensitive polymer and patterned by processes of exposure and development. With this configuration, it is possible to simplify the forming process of the insulating layer compared to patterning by photolithography process using photosensitive photoresist.

(15) A probe card of a fourth embodiment is configured such that, in addition to the above configuration, the anti-reflection film is formed by selective application using a fine nozzle. With this configuration, it is possible to simplify the forming process of the anti-reflection film compared to patterning by photolithography process using photosensitive photoresist.

(16) A probe card of a fifth embodiment is configured such that, in addition to the above configuration, the anti-reflection film has a lower reflectance than the insulating film. With this configuration, it is possible to easily identify the alignment mark.

(17) A probe card of a sixth embodiment is configured such that, in addition to the above configuration, the anti-reflection film is formed so that it does not overlap with the electrode pad. With this configuration, it is possible to prevent poor probe continuity due to the narrowing of the electrode pad.

(18) A probe card of a seventh embodiment is configured such that, in addition to the above configuration, a plurality of the probes is aligned in a predetermined direction to form a probe group, and the anti-reflection film has an elongated shape extending along the probe group and is formed on a position corresponding to the alignment mark of the plurality of the probes of the probe group and a region surrounding the position. With this configuration, it is possible to easily identify the alignment mark for each probe of the probe group. Moreover, it is possible to simplify the forming process of the antireflection film.

(19) A probe card of an eighth embodiment is configured such that, in addition to the above configuration, two of the probe groups are arranged parallel to each other, and the anti-reflection film is formed between the two probe groups and on a position corresponding to the alignment mark of the plurality of the probes of each of the two probe groups and a region surrounding the position. With this configuration, it is possible to easily identify the alignment mark for each probe of the two probe groups. Moreover, it is possible to simplify the forming process of the anti-reflective film.

(20) A probe card of a ninth embodiment is configured such that, in addition to the above configuration, a distance from both ends of the anti-reflection film in a longitudinal direction to a position corresponding to a nearest alignment mark is longer than a distance from both ends of the anti-reflection film in the shortitudinal direction to a position corresponding to the alignment mark. With this configuration, it is possible to identify more easily the alignment mark for each probe of the probe group.

Advantages of the Invention

(21) According to the present invention, an alignment mark formed on a probe can be easily identified. In particular, the alignment mark formed on the probe can be easily identified by suppressing reflected light from a circuit board, where a light-transmissive insulating film is formed on the interlayer wiring. Moreover, the manufacturing method of the probe card can be simplified.

Description

BRIEF DESCRIPTION OF DRAWINGS

- (1) FIG. 1 illustrates a schematic diagram of the entire system including a probe card **10** according to a first embodiment of the present invention.
- (2) FIG. 2 illustrates the situation during alignment.
- (3) FIG. 3 is a perspective view of a probe mounting surface **13** viewed from the bottom.
- (4) FIG. 4 illustrates a cross-sectional view (A-A cross-sectional view) cut by A-A cut line in (5) FIG. 3.
- (6) FIG. 5 illustrates an example of the forming process of insulating films **303**, **304** in chronological order.
- (7) FIG. 6 illustrates an example of the forming process of an anti-reflection film **6** in chronological order.
- (8) FIG. 7 is a plan view of a probe mounting surface **13**.
- (9) FIG. 8 illustrates a comparative example to be compared with the present invention.
- (10) FIG. 9 illustrates an example of the images taken of area R1 in FIG. 7 and area R2 in FIG. 8.
- (11) FIG. 10 illustrates another example of a probe card **10** according to the first embodiment of the present invention.
- (12) FIG. 11 is another perspective view of the probe mounting surface **13** viewed from the bottom, illustrating an example of a main part of a probe card **10** according to a second embodiment of the present invention.
- (13) FIG. 12 is another plan view of the probe mounting surface **13**.
- (14) FIG. 13 is another perspective view of the probe mounting surface **13** viewed from the bottom, illustrating an example of a main part of a probe card **10** according to a third embodiment of the present invention.
- (15) FIG. 14 is another plan view of the probe mounting surface **13**.
- (16) FIG. 15 is another perspective view of the probe mounting surface **13** viewed from the bottom, illustrating an another example of a main part of a probe card **10** according to the third embodiment of the present invention.

(17) FIG. 16 is another plan view of the probe mounting surface 13.

DETAILED DESCRIPTION OF THE INVENTION

First Embodiment

[A] System Overview

(18) FIG. 1 illustrates a schematic diagram of the entire system including a probe card 10 according to a first Embodiment of the present invention, illustrating a cross-section of the probe card 10 placed on a wafer prober, cut in the vertical plane. The probe card 10 is mounted on the wafer prober with the probe mounting surface 13, on which a probe 5 is mounted, facing down. The probe mounting surface 13 faces a semiconductor wafer 20 on a stage 200, and by moving the stage 200 up and down, the probe 5 can be brought into contact with an electrode terminal 21 on the semiconductor wafer 20.

(19) (1) Probe Card 10

(20) The probe card 10 has of a main board 100, a reinforcing plate 101, an interposer 102, an ST (Space Transformer) board 103, and two or more probes 5.

(21) The main board 100 is a circuit board that is removably attached to the wafer prober, for example, a disc-shaped glass epoxy board can be used. The main board 100 is supported by a card holder 201 of the wafer prober at the outer edge of its lower surface and is placed substantially horizontally. The outer edge of the upper surface of the main board 100 is provided with two or more external terminals 11 to which signal terminals of a tester device (not shown) are connected.

(22) The reinforcing plate 101 is a member for controlling distortion of the main board 100, for example, a stainless-steel metal block can be used. The reinforcing plate 101 is attached to the center of the top surface of the main board 100.

(23) The interposer 102 is a means for connecting the main board 100 and the ST board 103 each other. The interposer 102 is arranged on the lower surface side of the main board 100 and has a number of pogo pins that conduct the wiring of the main board 100 to the wiring of the ST board 103.

(24) The ST board 103 is a circuit board for converting a pitch between electrodes. Wirings are formed on the probe mounting surface 13 at a smaller pitch than the main board 100. The ST board 103 is an insulating multilayer wiring board, for example, a laminate of two or more ceramic boards can be used. The ST board 103 is arranged on the underside of the main board 100 via the interposer 102. The ST board 103 is supported by the main board 100 with a board holder 12 and is arranged substantially horizontally.

(25) The probe mounting surface 13 is the lower surface of the ST board 103, on which two or more electrode pads 3 are formed. The electrode pad 3 is an electrode to which the probe 5 is attached and is arranged to correspond to the electrode terminal 21 on the semiconductor wafer 20.

(26) (2) Stage 200

(27) The stage 200 is a platform on which the semiconductor wafer 20 is placed. The semiconductor wafers 20 as inspection object is placed on the stage 200 so that the electrode terminal 21 is on the top side. The stage 200 can move and rotate in the horizontal plane and move vertically. The stage 200 is also equipped with a camera 22 for alignment and an illuminator 23.

(28) The camera 22 is an imaging means for capturing an image of an alignment mark (not shown) formed on the probe 5, for example, a CCD or COMS image sensor can be used. The camera 22 is arranged so that its light receiving axis 24 is substantially perpendicular to the probe mounting surface 13.

(29) The illuminator 23 is an illuminating means for providing illumination light for camera photography, for example, an LED and a laser diode can be used. The illuminator 23 is arranged near the camera 22, directed in the same direction as the camera 22, and illuminates the alignment mark that is the subject of the camera 22. The light emitting axis of the illuminator 23 should be substantially coaxial with the light receiving axis 24 of the camera 22.

(30) (3) Alignment

(31) FIG. 2 illustrates the situation during alignment, illustrating, as in FIG. 1, a cross-sectional of the probe card **10** placed on the wafer prober, cut in the vertical plane. In order to bring the tip of the probe **5** into contact with the corresponding electrode terminal **21** during inspection, the probe card **10** and the semiconductor wafer **20** are aligned before inspection. The alignment is performed by identifying an alignment mark to identify the position and orientation of probe card **10**.

(32) The identification of an alignment mark is performed by sequentially capturing an image of the probe mounting surface **13** with the camera **22** while moving or rotating the stage **200** in the horizontal plane and extracting an alignment mark from the captured image. The position and orientation of the probe card **10** in the wafer prober can be identified by identifying one or two or more alignment marks. If the position of the electrode terminal **21** on the stage **200** is known, the tip of the probe **5** can be brought into contact with the corresponding electrode terminal **21** by moving or rotating the stage **200** based on the position and orientation of the probe card **10** thus identified. Then raising the stage **200**, the probe **5** can be brought into contact with the corresponding electrode terminal **21** and inspection can be performed.

(33) FIGS. 3 and 4 illustrate how the alignment is performed, focusing on one probe **5**. FIG. 3 is a perspective view of a probe mounting surface **13** viewed from the bottom. FIG. 4 illustrates a cross-sectional view (A-A cross-sectional view) cut by A-A cut line in FIG. 3. In FIGS. 3 and 4, the top and bottom are reversed from FIG. 1.

(34) (4) Probe **5**

(35) The probe **5** has a contact part **50**, a beam part **51**, and a base part **52**. The contact part **50** is the tip of the probe **5** that is brought into contact with the electrode terminal **21** of the inspection object and is provided at one end of the beam part **51**. The base part **52** is a support portion having a bonding surface to be bonded to the electrode pad **3** and is provided at the other end of the beam part **51**. The beam part **51** is a connecting portion connecting the contact part **50** and the base part **52** each other and has an elongated shape extending along the ST board **103**.

(36) By adopting such a cantilever structure, the probe **5** achieves overdrive by elastic deformation of beam part **51** due to the load that contact part **50** receives from electrode terminal **21**. When the base part **52** is attached onto the electrode pad **3**, the contact part **50** is positioned outside of the electrode pad **3**.

(37) The contact part **50** has a shape that protrudes toward the semiconductor wafer **20**. The cross-sectional shape near the tip of the contact part **50** is a trapezoidal shape narrowing toward the tip, and a contact surface **500** and tapered surfaces **501** and **502** are formed along its periphery. The contact surface **500** is a rectangular plane in contact with the electrode terminal **21** and is positioned substantially parallel to the probe mounting surface **13**. The tapered surfaces **501** and **502** are both rectangular planes adjacent to the contact surface **500** and are arranged at an angle to the probe mounting surface **13**. The tapered surfaces **501** and **502** are arranged to sandwich the contact surface **500** in the longitudinal direction of the beam part **51**.

(38) The contact surface **500** and tapered surfaces **501** and **502** are formed as smooth surfaces and reflect illumination light directly. Therefore, illumination light irradiated from a direction perpendicular to the probe mounting surface **13** is reflected in the same direction as the incident direction on the contact surface **500** but is reflected in a direction significantly different from the incident direction on the tapered surfaces **501** and **502**.

(39) Therefore, by substantially aligning the light receiving axis **24** of the camera **22** and the light emitting axis of the illuminator **23** and making them substantially perpendicular to the probe mounting surface **13**, strong reflected light from the contact surface **500** by normal reflection enters the camera **22**, while strong reflected light from the tapered surfaces **501** and **502** does not enter. Therefore, the contact surface **500** becomes a bright area in the captured image, while the tapered surfaces **501** and **502** become dark areas, and edges of contrast difference are generated at the boundaries of the contact surface **500** and the tapered surfaces **501** and **502**, enabling extraction by image processing. In other words, the contact surface **500** sandwiched by the tapered surfaces **501**

and **502** can be used as the alignment mark **7**.

(40) If the angles of the tapered surfaces **501** and **502** are sufficiently large relative to the contact surface **500**, the light receiving axis **24** of the camera **22** and the light emitting axis of the illuminator **23** need not be strictly coincident, nor do these axes need to be strictly vertical to the probe mounting surface **13**.

(41) (5) ST Board **103**

(42) The ST board **103** has one or two or more insulating films **303** and **304** laminated on a laminate of two or more ceramic boards **301** and **302**. Interlayer wirings **312** to **314** are formed between each of these layers **301** to **304** and are connected to via holes **321** to **324** that penetrate each layer **301** to **304**. On the outermost insulating film **304**, the electrode pad **3** and the anti-reflection film **6** are formed, and the electrode pad **3** is connected to the interlayer wiring **314** via the via hole **324** through the insulating film **304**. The interlayer wirings **312** to **314**, the via holes **321** to **324** and the electrode pad **3** may be made of metal materials with good conductivity, for example, copper (Cu), gold (Au) and aluminum (Al).

(43) Photosensitive polymers, e.g., photosensitive polyimide, are used for the insulating films **303** and **304**. Photosensitive polymers, which are patterned by exposure and development, are required to have transparency to photosensitive illumination light. Therefore, materials having transparency in the visible light wavelength range are used for the insulating films **303** and **304**. As a result, the interlayer wirings **313** and **314** buried in the insulating films **303** and **304** are visible from the outside.

(44) The anti-reflection film **6** is a light-impermeable thin film formed on the insulating film **304** and covers the insulating film **304** at a position corresponding to the alignment mark **7** and in a region surrounding the position. For example, it is formed in a circular region centered at a position **601** where a perpendicular line from the center of the alignment mark **7** intersects the insulating film **304**.

(45) By forming the anti-reflection film **6**, the reflected light from the insulating film **304** can be blocked during image capture by the camera. This prevents the background from becoming bright due to reflected light from the interlayer wirings **313** and **314** and stray light in the insulating films **303** and **304**, making it difficult to identify the alignment mark **7**. Instead of the light-impermeable thin film, a thin film with a lower light transmittance in the visible light region than the insulating film **304** can be used as the anti-reflection film **6**.

(46) The anti-reflection film **6** is formed as a thin film with sufficiently low light reflectance. For example, a black resin paint containing carbon can be used. By using such an anti-reflection film **6**, light reflected from the insulating film **304** can be suppressed, and reflection on the surface of the anti-reflection film **6** can also be suppressed. As a result, the anti-reflection film **6** can be darker than the insulating film **304** on the image taken by the camera **22**.

(47) The reflectance at the surface of the anti-reflective film **6** is preferably lower than the reflectance of the insulating film **304**. If the reflectance of the insulating film **304** varies from region to region, it is preferably lower than the average reflectance of the insulating film **304**.

(48) The anti-reflection film **6** is formed so that it does not overlap with the electrode pad **3**. By forming the anti-reflection film **6** in a region separated from the electrode pad **3**, it is possible to prevent the electrode pad **3** from becoming narrower and causing poor contact of the probe **5** with the electrode pad **3**.

(49) (6) Manufacturing Method

(50) FIG. 5, including parts (a) to (d), illustrates an example of the forming process of insulating films **303** and **304** in chronological order. The part (a) illustrates the ST board **103** before the insulating films **303** and **304** are formed.

(51) The part (b) illustrates the state in which a coating layer **800** is formed on the entire top surface of the ST board **103**. The coating layer **800** is formed by coating or film transfer of photosensitive polymer on the ST board **103** and pre-baking. For example, by applying the

photosensitive polymer by spin coating, the coating layer **800** is formed on the entire top surface of the ST board **103**. The coating layer **800** is then pre-baked to evaporate the solvent by heating to fix the coating layer **800** on the ST board **103**.

(52) The part (c) illustrates the situation during exposure. After pre-baking, the coating layer **800** is selectively exposed using a mask with a pattern or a direct writing device to photo-crosslink the photosensitive polymer. The coating layer **800** is divided into two regions: an exposed region **801** where a photosensitive illumination light **805** is irradiated and a non-exposed region **802** where the photosensitive illumination light **805** is not irradiated, and photo crosslinking is performed only within the exposed region **801**. Thereafter, post-exposure baking is performed to perform thermal crosslinking.

(53) The part (d) illustrates the post-development state. The coating layer **800**, which has been baked after exposure, is developed using a developer, and the coating layer **800** is selectively dissolved and removed. If the photosensitive polymer is a negative type, the non-exposed region **802** is dissolved and removed. Thereafter, curing is performed and the coating layer **800** is cured to form the insulating films **303** and **304**.

(54) By forming the insulating films **303** and **304** with photosensitive material, the insulating films **303** and **304** can be patterned by selective exposure and development without forming a photoresist on the insulating films **303** and **304**. Therefore, the process of applying and removing the photoresist becomes unnecessary, and the manufacturing process can be simplified.

(55) The photosensitive illumination light **805** must reach not only the surface of the coating layer **800** but also its interior, and the photosensitive material used for the coating layer **800** must have transparency to the photosensitive illumination light **805**. For this reason, photosensitive materials having transparency in the visible light wavelength range are used for the insulating films **303** and **304**.

(56) FIG. **6**, including parts (a) to (e), illustrates an example of the forming process of an anti-reflection film **6** in chronological order. Parts (a) and (b) illustrate the application of a resin paint **810** using a fine nozzle **815**. The part (a) illustrates the start of the application, and the part (b) illustrates the application in progress. The resin paint **810** is discharged from the tip of the fine nozzle **815**. By discharging the resin paint **810** while moving the fine nozzle **815** along the top surface of the ST board **103**, the resin film **811** is formed in the region where the anti-reflection film **6** is formed.

(57) The part (c) illustrates the end of the coating process. At the end of application, the resin paint **810** is stopped and the fine nozzle **815** is moved away from the ST board **103**. At this time, an angular protrusion **812** is formed in the resin film **811**, extending from the end of the coating toward the fine nozzle **815**.

(58) The parts (d) and (e) illustrate the removal of the protrusion **812**. After the end of the application, the fine nozzle **815** moves along the ST board **103** in the opposite direction of the direction of travel just before the end of the application, and then moves closer to the vicinity of the resin film **811** (see part (d)). Thereafter, the fine nozzle **815** moves in the same direction as the direction of travel just before the end of the application without discharging the resin paint **810**, passes the end of the application position, and moves to a position where it does not face the resin film **811**. At this time, the resin paint **810** of the protrusion **812** adheres to the tip of the fine nozzle **815**, and the resin film **811** from which the protrusion **812** is removed becomes the anti-reflection film **6** (see part (e)). The fine nozzle **815** is then subjected to a cleaning procedure, and the resin paint **810** adhering to the tip is removed.

(59) By employing such a method, the anti-reflection film **6** can be formed without patterning by exposure and development. Since the pattern of the anti-reflection film **6** does not require the same high precision as that of the interlayer wirings **312** to **314** and the via holes **321** to **324**, it can be formed by this method of applying the resin paint **810** with a nozzle.

(60) Moreover, by removing the protrusion **812** formed by application using a fine nozzle, the

maximum height of the anti-reflection film **6** can be controlled and the protrusion **812** can be prevented from contacting the probe **5** or the electrode terminal **21** of the object to be inspected.

[B] Advantages

(61) FIG. **7** is a plan view of a probe mounting surface **13**, which corresponds to the image taken by the camera **22**. Since the anti-reflection film **6** is formed on the background surrounding the alignment mark **7**, there is no bright area around the alignment mark **7**, and the alignment mark **7** can be easily identified.

(62) The anti-reflection film **6** is formed to cover the insulating film **304** in the region including the position corresponding to the alignment mark **7**. For example, the anti-reflection film **6** is formed in a circular region centered on the position corresponding to the alignment mark **7**.

(63) Since the insulating films **303** and **304** are light transmissive, when illumination light is irradiated, strong reflected light that is totally reflected on the main surfaces of the interlayer wirings **313** and **314** and diffusely reflected on the edges of the interlayer wirings **313** and **314** and the electrode pad **3**, etc. becomes stray light in the insulating films **303** and **304**, making the insulating films **303** and **304** bright overall. Therefore, except for the region where the anti-reflection film **6** is formed, the region is observed as a bright area.

(64) In contrast, in the region where the anti-reflection film **6** is formed, the reflected light from the insulating film **304** is blocked and the light reflectance from the surface of the anti-reflection film **6** is also small, so the region is observed as a sufficiently dark area. Therefore, there are no bright areas in the background adjacent to the alignment mark **7** that can be easily confused with the alignment mark **7**, and the contrast of the alignment mark **7** is not reduced, so the alignment mark **7** can be easily identified.

(65) Moreover, in the shortitudinal direction of the beam part **51**, the width **W1** of the anti-reflection film **6** can be sufficiently larger than the width **W2** of the probe **5**. It is difficult to significantly increase the width **W2** of the probe **5** because the shape of the probe **5** is constrained by various conditions such as elastic properties, conductive properties, and alignment pitch. Therefore, the identification of the alignment mark **7** can be improved more effectively than when an anti-reflection region is provided on the probe **5**.

(66) FIG. **8** illustrates a comparative example to be compared with the present invention. If FIG. **8** is compared with FIG. **7**, it differs in that it is not equipped with the antireflection film **6**. Without the antireflection film **6**, the background surrounding the alignment mark **7** becomes a bright area, making it difficult to identify the alignment mark **7**.

(67) FIG. **9**, including parts (a) and (b), illustrates an example of an image captured by the camera **22**. The part (a) illustrates the captured image corresponding to the area **R1** in FIG. **7**, and the part (b) illustrates the captured image corresponding to the area **R2** in FIG. **8**. By comparing the Part (a) and (b), it can be seen that the present invention facilitates identification of the alignment mark **7**.

[C] Other Configuration Example

(68) FIG. **10** illustrates another example of a probe card **10** according to the first embodiment of the present invention, similar to FIG. **4**, and a cross-sectional view (A-A cross-sectional view) cut by A-A cut line in FIG. **3**.

(69) In FIG. **4**, the electrode pad **3** is formed on the insulating film **304** formed on the top layer, whereas in FIG. **10**, it is formed on the insulating film **303** below the insulating film **304** and exposed through a through-hole **340** in the insulating film **304**.

(70) One or more insulating films **303** and **304** may be formed on the probe mounting surface **13** of the ST board **103**, as well as the electrode pad **3** may be exposed. In other words, the present invention is not limited only to the case where the electrode pad **3** is formed on the insulating film **304** formed on the top layer.

(71) Although the present embodiment describes a case in which the tip of the contact part **50** of the probe **5** is used as the alignment mark **7**, the present invention is not limited to only such a case. For example, the alignment mark **7** may be formed on the beam part **51** near the contact part **50**,

and the present invention can also be applied to such a probe card **10**.

Second Embodiment

(72) In the first embodiment, an example of a case in which the anti-reflection film **6** is formed corresponding to the probe **5** is described. In contrast, the present embodiment describes a case in which the anti-reflection film **6** is formed corresponding to a probe group **530** formed by two or more probes **5**.

(73) FIGS. **11** and **12** each illustrates an example of a main part of the probe card **10** according to the second embodiment, focusing on one probe group **530** and illustrating it during alignment. FIG. **11** is another perspective view of the probe mounting surface **13** viewed from the bottom. FIG. **12** is another plan view of the probe mounting surface **13**, which corresponds to the image taken by the camera **22**.

(74) The probe group **530** has two or more probes **5** corresponding to two or more electrode terminals **21** arranged on the same straight line. Each probe **5** is arranged at a certain distance so that they are parallel to each other and aligned in a direction that intersects the longitudinal direction of the beam part **51**. Therefore, the alignment mark **7** of each probe **5** is also located on the same straight line.

(75) The electrode pad group **330** has two or more electrode pads **3** to which each probe **5** of the probe group **530** is attached. In other words, each electrode pad **3** of the electrode pad group **330** is arranged with a certain distance in the same direction as the alignment direction of the probe group **530**.

(76) The anti-reflection film **6** is formed corresponding to probe group **530**. The anti-reflection film **6** has an elongated rectangle shape extending along the alignment direction of the probe group **530**. Within the region where the anti-reflection film **6** is formed, a position **601** corresponding to the alignment mark **7** of each probe **5** of the probe group **530** is included. In other words, for all alignment marks **7** of the probe group **530**, the anti-reflection film **6** is formed to cover the corresponding positions **601** on the probe mounting surface **13** and a region surrounding the positions.

(77) Therefore, for any of the alignment marks **7**, the anti-reflection film **6** is formed on the background surrounding the alignment marks **7**, and there are no bright areas around the alignment marks **7**, allowing all the alignment marks **7** to be easily identified.

(78) By forming one anti-reflection film **6** corresponding to two or more probes **5**, the number of times the resin paint is applied can be reduced and the number of cleaning processes of the fine nozzle **815** at the end of the application can be reduced compared to the case where the anti-reflection film **6** is formed for each alignment mark **7**.

(79) The anti-reflection film **6** is formed so that it does not overlap with the electrode pad **3**, preventing the electrode pad **3** from becoming narrower. The width of the anti-reflection film **6** in the shortitudinal direction is limited by the electrode pad **3**. In contrast, since no such limitation exists for the length of the anti-reflection film **6** in the longitudinal direction, the anti-reflection film **6** is formed so that both ends **620** and **621** in the longitudinal direction extend beyond the electrode pad group **330**. Therefore, for the longitudinal direction of the anti-reflection film **6**, compared to the shortitudinal direction, it is possible to prevent the alignment mark **7** from being more difficult to identify by the background farther from the alignment mark **7**.

(80) The distance **S1** in the figure is the distance from the position **601** corresponding to the alignment mark **7** to the shortitudinal end **610** of the anti-reflection film **6**, which is shorter than the distance to the electrode pad **3**. The distances **L1** and **L2** in the figure are the distances from the longitudinal ends **620** and **621** of the anti-reflection film **6** to the position **601** corresponding to the nearest alignment mark **7**, both longer than the distance **S1** from the shortitudinal end **610**.

Third Embodiment

(81) In the second embodiment, an example of a case in which the anti-reflection film **6** is formed corresponding to one probe group **530** is described. In contrast, the present embodiment describes a

case in which the anti-reflection film **6** is formed corresponding to two adjacent probe groups **531** and **532**.

(82) FIGS. **13** and **14** each illustrates an example of a main part of the probe card **10** according to the third embodiment, focusing on two probe groups **531** and **532** and illustrating it during alignment. FIG. **13** is another perspective view of the probe mounting surface **13** viewed from the bottom. FIG. **14** is another plan view of the probe mounting surface **13**, which corresponds to the image taken by the camera **22**.

(83) Each probe group **531** and **532** has the same configuration as the probe group **530** (of the second embodiment). That is, they have two or more probes **5** corresponding to two or more electrode terminals **21** arranged on the same straight line. The two probe groups **531** and **532** are arranged adjacent to each other so that they are parallel to each other, and the contact parts **50** of the different probe groups **531** and **532** are arranged facing each other.

(84) Electrode pad groups **331** and **332** each have the same configuration as electrode pad group **330** (of the second embodiment). The electrode pad groups **331** and **332** correspond to the probe groups **531** and **532**, respectively.

(85) The anti-reflection film **6** is formed corresponding to the two probe groups **531** and **532** and is positioned between the two electrode pad groups **331** and **332**. The region where the anti-reflection film **6** is formed has an elongated rectangle shape extending along the alignment direction of the probe groups **531** and **532**. Within the region, a position **601** corresponding to the alignment mark **7** of each probe **5** of the probe groups **531** and **532** is included. In other words, for all alignment marks **7** of the probe groups **531** and **532**, the anti-reflection film **6** is formed to cover the corresponding positions **601** on the probe mounting surface **13** and a region surrounding the positions.

(86) Therefore, for any of the alignment marks **7**, the anti-reflection film **6** is formed on the background surrounding the alignment marks **7**, and there are no bright areas around the alignment marks **7**, allowing all the alignment marks **7** to be easily identified.

(87) By forming one anti-reflection film **6** corresponding to two probe groups **531** and **532**, the number of times the resin paint is applied can be reduced and the number of cleaning processes of the fine nozzle **815** at the end of the application can be reduced compared to the case where the anti-reflection film **6** is formed for each of the probe groups **531** and **532**.

(88) The anti-reflection film **6** is formed so that it does not overlap with the electrode pad **3**, preventing the electrode pad **3** from becoming narrower. The anti-reflection film **6** is formed so that both ends **620** and **621** in the longitudinal direction extend beyond the electrode pad groups **331** and **332**. Therefore, for the longitudinal direction of the anti-reflection film **6**, compared to the shortitudinal direction, it is possible to prevent the alignment mark **7** from being more difficult to identify by the background farther from the alignment mark **7**.

(89) The distances **S1** and **S2** in the figure are the distances from the position **601** corresponding to the alignment mark **7** to the shortitudinal ends **610** and **611** of the anti-reflection film **6**, which are shorter than the distances to the electrode pad **3**. The distances **L1** and **L2** in the figure are the distances from the longitudinal ends **620** and **621** of the anti-reflection film **6** to the position **601** corresponding to the nearest alignment mark **7**, both longer than the distances **S1** and **S2** from the shortitudinal ends **610** and **611**.

(90) FIGS. **15** and **16** each illustrates another example of a main part of the probe card **10** according to the third embodiment, focusing on two probe groups **531** and **532** and illustrating it during alignment. FIG. **15** is another perspective view of the probe mounting surface **13** viewed from the bottom. FIG. **16** is another plan view of the probe mounting surface **13**, which corresponds to the image taken by the camera **22**.

(91) The probes **5** of different probe groups **531** and **532** are arranged alternately, and the contact part **50** of each probe **5** of the two probe groups **531** and **532** is arranged on the same straight line. The other configuration is exactly the same as in FIGS. **13** and **14**. The present invention can be

applied to such a probe card **10**.

REFERENCE SIGNS LIST

(92) **3** ELECTRODE PAD **5** PROBE **6** ANTI-REFLECTION FILM **7** ALIGNMENT MARK **10** PROBE CARD **11** EXTERNAL TERMINAL **12** BOARD HOLDER **13** PROBE MOUNTING SURFACE **20** SEMICONDUCTOR WAFER **21** ELECTRODE TERMINAL **22** CAMERA **23** ILLUMINATOR **24** LIGHT RECEIVING AXIS **50** CONTACT PART **51** BEAM PART **52** BASE PART **100** MAIN BOARD **101** REINFORCING PLATE **102** INTERPOSER **103** ST BOARD **200** STAGE **201** CARD HOLDER **301, 302** CERAMIC BOARD **303, 304** INSULATING FILM **312** to **314** INTERLAYER WIRING **321** to **324** VIA HOLE **330** to **332** ELECTRODE PAD GROUP **340** THROUGH-HOLE **500** CONTACT SURFACE **501, 502** TAPERED SURFACE **530** to **532** PROBE GROUP **601** POSITION CORRESPONDING TO ANTI-REFLECTION FILM **610, 611, 620, 621** END OF ANTI-REFLECTION FILM **800** COATING LAYER **801** EXPOSED REGION **802** NON-EXPOSED REGION **805** PHOTSENSITIVE ILLUMINATION LIGHT **810** RESIN PAINT **811** RESIN FILM **812** PROTRUSION **815** FINE NOZZLE **L1, L2** DISTANCE IN LONGITUDINAL DIRECTION **S1, S2** DISTANCE IN SHORTITUDINAL DIRECTION

Claims

1. A probe card comprising: a circuit board on which an insulating film and an electrode pad are formed; and a probe attached onto the electrode pad, wherein the probe includes an alignment mark identifiable from an opposite side of the circuit board, the alignment mark is positioned outside of the electrode pad on the circuit board, the insulating film is a light-transmissive thin film covering an interlayer wiring, an anti-reflection film with lower light transmittance than the insulating film being formed in some regions on the insulating film, and the anti-reflection film is formed on a position corresponding to the alignment mark and a region surrounding the position.
 2. The probe card of claim 1, wherein the anti-reflection film is light impermeable.
 3. The probe card of claim 1, wherein the insulating film is made of a photosensitive polymer and patterned by processes of exposure and development.
 4. The probe card of claim 1, wherein the anti-reflection film is formed by selective application using a fine nozzle.
 5. The probe card of claim 1, wherein the anti-reflection film has a lower reflectance than the insulating film.
 6. The probe card of claim 1, wherein the anti-reflection film is formed so that it does not overlap with the electrode pad.
 7. The probe card of claim 1, wherein a plurality of the probes is aligned in a predetermined direction to form a probe group, and the anti-reflection film has an elongated shape extending along the probe group and is formed on a position corresponding to the alignment mark of the plurality of the probes of the probe group and a region surrounding the position.
 8. The probe card of claim 7, wherein two of the probe groups are arranged parallel to each other, and the anti-reflection film is formed between the two probe groups and on a position corresponding to the alignment mark of the plurality of the probes of each of the two probe groups and a region surrounding the position.
 9. The probe card of claim 7, wherein a distance from both ends of the anti-reflection film in a longitudinal direction to a position corresponding to a nearest alignment mark is longer than a distance from both ends of the anti-reflection film in the shortitudinal direction to a position corresponding to the alignment mark.
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