

Alignment device, method and equipment for double-sided exposure

Technical Field

[0001] The disclosure relates to an alignment device, method and equipment for double-sided exposure, and belongs to the technical field of printed circuit boards.

Background

[0002] When producing inner circuit boards, a laser direct imaging (LDI) exposure machine needs to accurately align the images on the two sides of a printed circuit board (PCB), so as to ensure accurate alignment of the patterns on the two sides of the PCB.

[0003] In the production process, laser marking is usually used to autonomously make two marks for accurate alignment of the inner PCB. A mark exposure diaphragm exists at the bottom of a vacuum chuck. When a first side of the inner PCB is subjected to exposure printing, two marks are made in a non-exposure area of an edge of the other side of the PCB by laser marking through the mark exposure diaphragm. After the board is turned over, the rotation and translation of the PCB are calculated according to the coordinates of the 2 marks made by laser marking on the PCB and the coordinates of the diaphragm for making the two marks, thus completing the accurate alignment of the patterns on the two sides of the PCB. Therefore, in order to realize the accurate alignment of the inner PCB, the position of the mark exposure diaphragm needs to be accurately located.

[0004] However, the mark exposure diaphragm is fixed on the metal vacuum chuck, and the side length of the vacuum chuck is ≥ 500 mm. As the production proceeds, if the internal temperature of a machine changes significantly, the metal vacuum chuck expands with heat and contracts with cold under the influence of the temperature. Moreover, there is a vacuum

cavity in the middle of the vacuum chuck, and the vacuum degree in the cavity reaches -20 kpa when vacuumizing and adsorbing the PCB. Under the air pressure of 20 kpa, the vacuum chuck body deforms in an irregular and non-linear manner. Because the vacuum chuck deforms with temperature changes and under vacuum adsorption, the position of the mark exposure diaphragm installed on an edge of the chuck also changes. As the mark exposure diaphragm is covered by the PCB to be exposed during exposure, the mark exposure diaphragm cannot be calibrated at the same time or in real time. Therefore, the existing positioning method for the mark exposure diaphragm is to calibrate the mark exposure diaphragm at regular intervals. If the vacuum chuck expands, contracts or deforms during the calibration interval, the position of the mark exposure diaphragm will change. Therefore, the traditional positioning method cannot accurately position the mark exposure diaphragm at the same time or in real time when the PCB is subjected to continuous exposure.

Summary

[0005] In order to solve the problem of inaccurate alignment caused by the change of the position of a mark exposure diaphragm resulting from expansion, contraction or deformation of a vacuum chuck during the calibration interval, the disclosure provides an alignment device and method for double-sided exposure and exposure equipment comprising the alignment device for double-sided exposure.

[0006] A first objective of the disclosure is to provide an alignment device for double-sided exposure, wherein the device comprises:

[0007] positioning signs, marking signs and a position acquisition device;

[0008] wherein the positioning signs are used for determining the positions of the marking signs in real time, so as to determine the position of an exposure pattern of a sample to be exposed according to the positions of the marking signs;

[0009] the marking signs are used for marking the sample to be exposed; and

[0010] the position acquisition device is used for acquiring the position information of the positioning signs in real time.

[0011] Alternatively, the relative position variation of the positioning signs and the marking signs is less than a predetermined value, and the predetermined value is set according to the alignment accuracy required when the sample to be exposed is subjected to double-sided exposure.

[0012] Alternatively, the distance between the positioning signs and the marking signs is less than 20 mm and/or the positioning signs and the marking signs are connected by an anti-deformation material.

[0013] Alternatively, the device further comprises:

[0014] a sample carrier and a marking device, wherein the sample carrier is used for bearing the sample to be exposed, the marking device is used for marking the sample to be exposed through the marking signs, and

[0015] the marking signs are located on the sample carrier.

[0016] Alternatively, the marking signs are located on an edge of the sample carrier.

[0017] Alternatively, the marking signs are in one-to-one correspondence to the positioning signs, and the positioning signs are used for determining the positions of the marking signs corresponding thereto.

[0018] A second objective of the disclosure is to provide an alignment method for double-sided exposure, the method is applied to the above alignment device for double-sided exposure, and the method comprises:

[0019] exposing one side of a sample to be exposed;

[0020] marking the other side of the sample to be exposed with marking signs;

[0021] acquiring the position information of positioning signs in real time;

[0022] determining the position information of the marking signs according to the position information of the positioning signs acquired in real time; and

[0023] conducting alignment exposure on the other side of the sample according to the position information of the marking signs.

[0024] Alternatively, before exposing one side of the sample to be exposed, the method further comprises:

[0025] acquiring the position information of the positioning signs when exposing one side of the sample to be exposed in real time, and exposing an intermediate mark on one side of the sample to be exposed according to the acquired position information of the positioning signs, the intermediate mark being used for determining the position of an exposure pattern on the side where the intermediate mark is located.

[0026] Alternatively, before marking the other side of the sample to be exposed with the marking signs, the method further comprises:

[0027] selecting at least two marking signs according to the size of the sample to be exposed; and

[0028] covering the marking signs with the sample to be exposed without covering the positioning signs corresponding to the selected marking signs.

[0029] Alternatively, the alignment exposure of the other side of the sample according to the position information of the marking signs comprises:

[0030] determining the position of an exposure pattern on the other side of the sample to be exposed in real time according to the position information of the marking signs; and

[0031] exposing the other side of the sample to be exposed according to the position of the exposure pattern on the other side of the sample to be exposed determined in real time.

[0032] A third objective of the disclosure is to provide exposure equipment, wherein the exposure equipment comprises the above alignment device for double-sided exposure.

[0033] The disclosure has the following beneficial effects:

[0034] The alignment device for double-sided exposure comprises the positioning signs, the marking signs and the position acquisition device. Before each sample to be exposed is exposed, appropriate marking signs are selected according to the size of the sample to be exposed. The position acquisition device acquires the position information of the positioning signs corresponding to the selected marking signs, and then acquires the position information of the marking signs, thus determining the variation of the positions of the marking signs relative to a predetermined position when the sample is exposed. According to the variation, the position of the exposure pattern on the other side of the predetermined sample to be exposed is adjusted in real time, solving the problem of inaccurate exposure alignment caused by the fact that the marking signs cannot be positioned in real time in the prior art, and improving the accuracy of double-sided alignment of the sample to be exposed. The distance between the positioning

signs and the marking signs is less than 20 mm and/or the positioning signs and the marking signs are connected by an anti-deformation material, ensuring that the relative position variation of the positioning signs and the marking signs in the exposure process is less than the predetermined value set according to the alignment accuracy required by the exposure of the sample to be exposed, thereby improving the accuracy of double-sided alignment of the sample to be exposed. Before each sample to be exposed is exposed, the position information of the positioning signs is acquired by the position acquisition device, and then the position information of the marking signs is acquired, so as to determine the variation of the positions of the marking signs relative to the predetermined position when the sample is exposed. According to the variation, the position of the exposure pattern on the other side of the predetermined sample to be exposed is adjusted in real time, thus improving the accuracy of double-sided alignment of the sample to be exposed.

Brief Description of Figures

[0035] In order to more clearly illustrate the technical solutions of the examples of the disclosure, the drawings to be used in the description of the examples are briefly described below, and it is obvious that the drawings in the description below are only some examples of the disclosure, and a person of ordinary skill in the art can obtain other drawings from these drawings without any creative effort.

[0036] FIG. 1 is a schematic diagram of an alignment device for double-sided exposure provided in Example I of the disclosure;

[0037] FIG. 2 is a schematic diagram of an alignment device for double-sided exposure provided in Examples II and III of the disclosure;

[0038] FIG. 3 is a schematic position diagram showing positioning signs and marking signs located at a lower part of an edge of a loading chuck in an example of the disclosure;

[0039] FIG. 4 is a schematic position diagram showing positioning signs and marking signs located on one side and at a lower part of an edge of a loading chuck in an example of the disclosure;

[0040] FIG. 5 is a schematic position diagram showing a sample to be exposed being placed on a loading chuck for exposure;

[0041] FIG. 6 is a schematic diagram of exposure equipment comprising an alignment device for double-sided exposure provided in Example IV of the disclosure;

[0042] FIG. 7 is a schematic diagram of the front positions of positioning signs and marking signs in the disclosure, wherein 1 represents the marking sign and 3 represents the positioning sign;

[0043] FIG. 8 is a sectional view of the position relationship among a 405 laser source, marking signs and positioning signs in the disclosure, wherein 1 represents the marking sign, 3 represents the positioning sign, 4 represents a lens, 5 represents 405 laser and 6 represents a laser controller;

[0044] FIG. 9 is a schematic diagram showing the connection between positioning signs and marking signs through an anti-deformation material in an example of the disclosure, wherein 1 represents the marking sign, 2 represents the anti-deformation material and 3 represents the positioning sign;

[0045] FIG. 10 is a schematic diagram showing the placement of a sample to be exposed in a double-sided exposure method provided in Example V of the disclosure; and

[0046] FIG. 11 is a schematic diagram showing the exposure process of the sample to be exposed in the double-sided exposure method provided in Example V of the disclosure.

Detailed Description

[0047] In the process of industrial production, the alignment accuracy of the front and back sides of an inner holeless PCB is required to be within 10 μm . The factors that affect this alignment accuracy include the repeated positioning accuracy of a system shafting, the accuracy of a loading chuck system and the image processing accuracy. The loading chuck system has a great impact on the alignment accuracy of the front and back sides of the inner holeless PCB due to the following two reasons: (1) a chuck body is made of aluminum alloy, expanding with heat and contracting with cold; and (2) the loading chuck needs to conduct vacuum adsorption on the PCB, causing deformation of the chuck. In practical application, the coefficient of thermal expansion of aluminum alloy is $23\ \mu\text{m}/^{\circ}\text{C}\cdot\text{m}$, the temperature fluctuation is $\pm 2^{\circ}\text{C}$, and when the size of the loading chuck is 650 mm (width) * 850 mm (length), the edge deformations are respectively:

[0048] $23 \times 4 \times 0.85 = 78.2\ \mu\text{m}$ (length); $23 \times 4 \times 0.65 = 59.8\ \mu\text{m}$ (width);

[0049] that is, when the temperature fluctuation is $\pm 2^{\circ}\text{C}$, the width direction of the chuck body changes by $59.8\ \mu\text{m}$ and the length direction changes by $78.2\ \mu\text{m}$. With the fluctuation of temperature, the alignment accuracy of the front and back sides will change, far exceeding the norm of 10 μm .

[0050] When vacuum absorption is performed on the PCB, the loading chuck body is an aluminum alloy part with a size of 650 mm (width) * 850 mm (length) * 23 mm (thickness), and there is a vacuum cavity in the middle. During the vacuum adsorption, the vacuum degree

inside the cavity reaches -20 kpa, and under the air pressure of 20 kpa, irregular and nonlinear deformation of the chuck body is caused. An actual test shows that the deformation is about 5 μm , contributing as high as 50% to the alignment accuracy of the system even though it does not exceed the norm of 10 μm .

[0051] For the above reason (1), someone suggests using materials with low coefficients of thermal expansion instead, such as invar, marble and silicon carbide. However, these materials are hard to process, marble and silicon carbide are fragile, and the cost is 5-10 times that of aluminum alloy. Therefore, these materials are not suitable.

[0052] For the above reason (2), the deformation of the chuck body is irregular and nonlinear, so it is impossible to find its change rule and solve it.

[0053] In the production process, a mark hole is covered with the PCB, so a common way used currently is to compensate the deformation of the chuck body caused by the change of temperature and vacuum adsorption through regular calibration and positioning. However, this method cannot determine the deformation of the loading chuck body in real time.

[0054] In order to make objectives, technical solutions, and advantages of the disclosure more apparent, implementations of the disclosure will be described in further detail with reference to the drawings.

[0055] Example I

[0056] The present example provides an alignment device for double-sided exposure. Referring to FIG. 1, the device comprises:

[0057] positioning signs 11, marking signs 12 and a position acquisition device 13;

[0058] wherein the positioning signs 11 are used for determining the positions of the marking signs 12 in real time, so as to determine the position of an exposure pattern of a sample to be exposed according to the positions of the marking signs 12;

[0059] the marking signs 12 are used for marking the sample to be exposed; and

[0060] the position acquisition device 13 is used for acquiring the position information of the positioning signs in real time.

[0061] The example of the disclosure provides the alignment device for double-sided exposure, comprising the positioning signs, the marking signs and the position acquisition device. The position information of the positioning signs is acquired in real time through the position acquisition device, so that the real-time position information of the marking signs is acquired, and then alignment exposure is conducted on the other side of the sample to be exposed according to the real-time position information of the marking signs, thereby solving the problem of inaccurate exposure alignment caused by the fact that the marking signs cannot be positioned in real time in the prior art, and improving the accuracy of double-sided alignment of the sample to be exposed.

[0062] Example II

[0063] The present example provides an alignment device and method for double-sided exposure. Referring to FIG. 2, the device comprises:

[0064] positioning signs 11, marking signs 12, a position acquisition device 13, a sample carrier 14 and a marking device 15;

[0065] the positioning signs 11 are used for determining the positions of the marking signs 12 in real time, so as to determine the position of an exposure pattern of a sample to be exposed according to the positions of the marking signs 12;

[0066] the marking signs 12 are used for marking the sample to be exposed; and

[0067] the position acquisition device 13 is used for acquiring the position information of the positioning signs in real time;

[0068] wherein the relative position variation of the positioning signs 11 and the marking signs 12 is less than a predetermined value, the predetermined value is set according to the alignment accuracy required when the sample to be exposed is subjected to double-sided exposure, and the distance between the positioning signs 11 and the marking signs 12 is less than 20 mm and/or the positioning signs and the marking signs are connected by an anti-deformation material;

[0069] the sample carrier 14 is used for bearing the sample to be exposed; the marking device 15 is used for marking the sample to be exposed through the marking signs 12; and

[0070] the marking signs 12 are located on the sample carrier 14.

[0071] In the present example, the sample to be exposed is a PCB, the sample carrier is a loading chuck for bearing and fixing the PCB, the loading chuck is made of aluminum alloy, the marking signs 12 are marking holes on the loading chuck, the position acquisition device 13 is a CCD camera, and the marking device 15 is a 405 laser source.

[0072] Specifically, when placed on the loading chuck, the PCB covers the marking holes, so that the 405 laser source can mark one side of the PCB facing this direction while ensuring that the PCB does not cover the positioning signs, so that the CCD camera can obtain the position

information of the positioning signs. The positioning signs can be positioning holes on the loading chuck, the distance between the positioning hole and the marking hole is less than 20 mm, or the positioning sign is a marker connected with the marking hole through an anti-deformation material, as shown in FIG. 9, as long as the relative position variation between the positioning signs and the marking holes in the working process is less than a predetermined value, wherein the predetermined value is set according to the alignment accuracy required when the PCB is subjected to double-sided exposure.

[0073] For example, if the alignment accuracy between the front and back sides of the PCB is required to be within 10 μm , the predetermined value is set to be 2 μm . If the positioning sign is a positioning hole on the loading chuck, the distance between the positioning hole and the marking hole is set to be less than 20 mm, and in the exposure process of the PCB, according to the coefficient of thermal expansion 23 $\mu\text{m}/^{\circ}\text{C}\cdot\text{m}$ of aluminum alloy as the material of the loading chuck, the temperature fluctuation during exposure is $\pm 2^{\circ}\text{C}$, then the relative position variation between the positioning hole and the marking hole is $23 \times 4 \times 0.02 = 1.8 \mu\text{m} < 2 \mu\text{m}$. Because the local rigidity of aluminum alloy is greater than overall rigidity, when the distance between the positioning hole and the marking hole is small, the vacuum influence is very small and can be ignored. An actual test shows that the relative position variation between the positioning hole and the marking hole satisfies the standard of being less than the predetermined value of 2 μm .

[0074] Similarly, if the positioning sign is a marker connected with the marking hole through the anti-deformation material, the relative position variation between the positioning signs and

the marking holes can be ignored because the anti-deformation material is rarely affected by temperature.

[0075] In practical application, the anti-deformation material can be invar, marble, ceramic and other materials with small coefficients of thermal expansion, and these materials are rarely affected by temperature. For example, the coefficient of thermal expansion of invar is $0.8 \mu\text{m}/^{\circ}\text{C}/\text{m}$, that of marble is $5 \mu\text{m}/^{\circ}\text{C}/\text{m}$, and that of ceramic is $7 \mu\text{m}/^{\circ}\text{C}/\text{m}$. Even if the length of the anti-deformation material connecting the positioning sign with the marking hole is as long as 100 mm, the deformations of the anti-deformation materials are $0.8 \times 4 \times 0.1 = 0.32 \mu\text{m}$, $5 \times 4 \times 0.1 = 2 \mu\text{m}$ and $7 \times 4 \times 0.1 = 2.8 \mu\text{m}$ respectively within the temperature fluctuation of $\pm 2^{\circ}\text{C}$. In practical application, the anti-deformation material will not be as long as 100 mm at all; for example, if the distance between the positioning sign and the marking hole is 20 mm, the deformations of the anti-deformation materials are $0.8 \times 4 \times 0.02 = 0.064 \mu\text{m}$, $5 \times 4 \times 0.02 = 0.4 \mu\text{m}$ and $7 \times 4 \times 0.02 = 0.56 \mu\text{m}$ respectively within the temperature fluctuation of $\pm 2^{\circ}\text{C}$, so the relative position variation between the positioning signs and the marking holes can be ignored.

[0076] In order to meet the requirement for higher alignment accuracy, the distance between the positioning signs and the marking signs can be set to be any value less than 20 mm.

[0077] In the exposure process, when the other side of the PCB is exposed, the position information of the marking holes is determined according to the position information of the positioning signs obtained by the CCD camera, so as to determine the position of the exposure pattern on the other side of the PCB according to the position information of the marking holes for exposure.

[0078] For the convenience of description, the two sides of the PCB are marked as side A and side B respectively.

[0079] For example, the initial calibration position of the marking holes recorded in the system is (X_s^0, Y_s^0) , and the initial calibration position of the positioning signs is (X_r^0, Y_r^0) . When a PCB is exposed, the real-time position of the positioning signs is (X_r^1, Y_r^1) , and the position change of the positioning signs obtained by the CCD camera relative to the initial position recorded in the system is:

$$\Delta X_r = X_r^1 - X_r^0$$

$$\Delta Y_r = Y_r^1 - Y_r^0$$

[0080] as the relative position variation between the positioning signs and the marking holes can be ignored, it can be known that the position change of the marking holes is also as follows:

$$\Delta X_s = X_r^1 - X_r^0$$

$$\Delta Y_s = Y_r^1 - Y_r^0$$

[0081] the theoretical value of the marking hole at a marking position on the side B is recorded as $(X_s^1, Y_s^1) = (X_s^0 + X_r^1 - X_r^0, Y_s^0 + Y_r^1 - Y_r^0)$;

[0082] when the board is turned over, the height of the PCB is recorded as H, and the coordinates of a bottom edge X of the board are X_{bottom} ;

[0083] according to the theoretical value of the marking hole at the marking position on the side B, the expected position of the marking hole on the side B is $(\overline{X_s^1}, \overline{Y_s^1}) = (H - (X_s^1 - X_{bottom}), Y_s^1)$;

[0084] the position of the marking hole actually captured on the side B after turning over the board is (X_{SB}^1, Y_{SB}^1) ;

[0085] alignment result $(\theta \quad ShiftX \quad ShiftY) = (X_{sB}^1, Y_{sB}^1) / (\overline{X_s^1}, \overline{Y_s^1})$;

[0086] the side A position of the exposure pattern (X_g^A, X_g^A) is subjected to Y mirroring to obtain $(\overline{X_g^B}, \overline{Y_g^B})$;

[0087] that is, the side B position of the pattern is $(X_g^B, X_g^B) = (\theta \quad ShiftX \quad ShiftY) \times (\overline{X_g^B}, \overline{Y_g^B})$.

[0088] The example of the disclosure provides the alignment device for double-sided exposure, comprising the positioning signs, the marking signs and the position acquisition device. The position information of the positioning signs is acquired in real time through the position acquisition device, so that the real-time position information of the marking signs is acquired, and then alignment exposure is conducted on the other side of the sample to be exposed according to the real-time position information of the marking signs, thereby solving the problem of inaccurate exposure alignment caused by the fact that the marking signs cannot be positioned in real time in the prior art. The distance between the positioning signs and the marking signs is less than 20 mm and/or the positioning signs and the marking signs are connected by the anti-deformation material, ensuring that the relative position variation between the positioning signs and the marking signs in the exposure process is less than the predetermined value set according to the alignment accuracy required by the exposure of the sample to be exposed, thereby improving the accuracy of double-sided alignment of the sample to be exposed.

[0089] In the actual exposure process, the marking signs and the positioning signs can be in one-to-one correspondence, and the positioning signs are used to determine the positions of the corresponding marking signs. They can also be in one-to-many correspondence. For

example, one marking sign corresponds to two or more positioning signs, and the position information of the marking signs is comprehensively determined. Alternatively, a plurality of marking signs can correspond to one positioning sign, and the positioning sign correspondingly determines the positions of the plurality of marking signs.

[0090] The Examples III and IV of the disclosure below are described by assuming that the marking signs and the positioning signs are in one-to-one correspondence, and the position relationship between the marking signs and the positioning signs is shown in FIG. 7.

[0091] Example III

[0092] The present example provides an alignment device and method for double-sided exposure. Referring to FIG. 2, the device comprises:

[0093] positioning signs 11, marking signs 12, a position acquisition device 13, a sample carrier 14 and a marking device 15;

[0094] the positioning signs 11 are used for determining the positions of the marking signs 12 in real time, so as to determine the position of an exposure pattern of a sample to be exposed according to the positions of the marking signs 12;

[0095] the marking signs 12 are used for marking the sample to be exposed; and

[0096] the position acquisition device 13 is used for acquiring the position information of the positioning signs in real time;

[0097] wherein the relative position variation of the positioning signs 11 and the marking signs 12 is less than a predetermined value, the predetermined value is set according to the alignment accuracy required when the sample to be exposed is subjected to double-sided exposure, and the distance between the positioning signs 11 and the marking signs 12 is less

than 20 mm and/or the positioning signs and the marking signs are connected by an anti-deformation material;

[0098] the sample carrier 14 is used for bearing the sample to be exposed; the marking device 15 is used for marking the sample to be exposed through the marking signs 12; and

[0099] the marking signs 12 are located on the sample carrier 14.

[00100] In the present example, the sample to be exposed is a PCB, the sample carrier is a loading chuck for bearing and fixing the PCB, the loading chuck is made of aluminum alloy, the marking signs 12 are marking holes on the loading chuck, the position acquisition device 13 is a CCD camera, and the marking device 15 is a 405 laser source.

[00101] The sectional view of the position relationship among the marking device 405 laser source, the marking signs and the positioning signs is shown in FIG. 8.

[00102] Specifically, when placed on the loading chuck, the PCB covers the marking holes, so that the 405 laser source can mark one side of the PCB facing this direction while ensuring that the PCB does not cover the positioning signs, so that the CCD camera can obtain the position information of the positioning signs. The positioning signs can be positioning holes on the loading chuck, the distance between the positioning hole and the marking hole is less than 20 mm, or the positioning sign is a marker connected with the marking hole through an anti-deformation material, as long as the relative position variation between the positioning signs and the marking holes in the working process is less than a predetermined value, wherein the predetermined value is set according to the alignment accuracy required when the PCB is subjected to double-sided exposure.

[00103] For example, if the alignment accuracy between the front and back sides of the PCB is required to be within 10 μm , the predetermined value is set to be 2 μm . If the positioning sign is a positioning hole on the loading chuck, the distance between the positioning hole and the marking hole is set to be less than 20 mm, and in the exposure process of the PCB, according to the coefficient of thermal expansion $23 \mu\text{m}/^{\circ}\text{C}\cdot\text{m}$ of aluminum alloy as the material of the loading chuck, the temperature fluctuation during exposure is $\pm 2^{\circ}\text{C}$, then the relative position variation between the positioning hole and the marking hole is $23 \times 4 \times 0.02 = 1.8 \mu\text{m} < 2 \mu\text{m}$. Because the local rigidity of aluminum alloy is greater than overall rigidity, when the distance between the positioning hole and the marking hole is small, the vacuum influence is very small and can be ignored. An actual test shows that the relative position variation between the positioning hole and the marking hole satisfies the standard of being less than the predetermined value of 2 μm .

[00104] Similarly, if the positioning sign is a marker connected with the marking hole through the anti-deformation material, the relative position variation between the positioning signs and the marking holes can be ignored because the anti-deformation material is rarely affected by temperature.

[00105] In practical application, the anti-deformation material can be invar, marble, ceramic and other materials with small coefficients of thermal expansion, and these materials are rarely affected by temperature. For example, the coefficient of thermal expansion of invar is $0.8 \mu\text{m}/^{\circ}\text{C}/\text{m}$, that of marble is $5 \mu\text{m}/^{\circ}\text{C}/\text{m}$, and that of ceramic is $7 \mu\text{m}/^{\circ}\text{C}/\text{m}$. Even if the length of the anti-deformation material connecting the positioning sign with the marking hole is as long as 100 mm, the deformations of the anti-deformation materials are $0.8 \times 4 \times 0.1 = 0.32 \mu\text{m}$,

$5*4*0.1=2\text{ }\mu\text{m}$ and $7*4*0.1=2.8\text{ }\mu\text{m}$ respectively within the temperature fluctuation of $\pm 2^{\circ}\text{C}$. In practical application, the anti-deformation material will not be as long as 100 mm at all; for example, if the distance between the positioning sign and the marking hole is 10 mm, the deformations of the anti-deformation materials are $0.8*4*0.02=0.064\text{ }\mu\text{m}$, $5*4*0.02=0.4\text{ }\mu\text{m}$ and $7*4*0.02=0.56\text{ }\mu\text{m}$ respectively within the temperature fluctuation of $\pm 2^{\circ}\text{C}$, so the relative position variation between the positioning signs and the marking holes can be ignored.

[00106] In order to meet the requirement for higher alignment accuracy, the distance between the positioning signs and the marking signs can be set to be any value less than 20 mm.

[00107] The marking signs are selected according to the size of the PCB during exposure. As shown in FIGS. 3, 4 and 5, the marking signs are freely selected according to the size of the PCB.

[00108] The marking signs can be located at any position of the loading chuck.

[00109] In the exposure process, when the other side of the PCB is exposed, the position information of the marking holes is determined according to the position information of the positioning signs obtained by the CCD camera, so as to determine the position of the exposure pattern on the other side of the PCB according to the position information of the marking holes for exposure.

[00110] For the convenience of description, the two sides of the PCB are marked as side A and side B respectively.

[00111] For example, the initial calibration position of the marking holes recorded in the system is (X_s^0, Y_s^0) , and the initial calibration position of the positioning signs is (X_r^0, Y_r^0) .

When a PCB is exposed, the real-time position of the positioning signs is (X_r^1, Y_r^1) , and the

position change of the positioning signs obtained by the CCD camera relative to the initial position recorded in the system is:

$$\Delta X_r = X_r^1 - X_r^0$$

$$\Delta Y_r = Y_r^1 - Y_r^0$$

[00112] as the relative position variation between the positioning signs and the marking holes can be ignored, it can be known that the position change of the marking holes is also as follows:

$$\Delta X_s = X_s^1 - X_s^0$$

$$\Delta Y_s = Y_s^1 - Y_s^0$$

[00113] the theoretical value of the marking hole at a marking position on the side B is recorded as $(X_s^1, Y_s^1) = (X_s^0 + X_r^1 - X_r^0, Y_s^0 + Y_r^1 - Y_r^0)$;

[00114] when the board is turned over, the height of the PCB is recorded as H, and the coordinates of a bottom edge X of the board are X_{bottom} ;

[00115] according to the theoretical value of the marking hole at the marking position on the side B, the expected position of the marking hole on the side B is $(\overline{X_s^1}, \overline{Y_s^1}) = (H - (X_s^1 - X_{bottom}), Y_s^1)$;

[00116] the position of the marking hole actually captured on the side B after turning over the board is (X_{sB}^1, Y_{sB}^1) ;

[00117] alignment result $(\theta \quad ShiftX \quad ShiftY) = (X_{sB}^1, Y_{sB}^1) / (\overline{X_s^1}, \overline{Y_s^1})$;

[00118] the side A position of the exposure pattern (X_g^A, Y_g^A) is subjected to Y mirroring to obtain $(\overline{X_g^B}, \overline{Y_g^B})$;

[00119] that is, the side B position of the pattern is $(X_g^B, Y_g^B) = (\theta \quad ShiftX \quad ShiftY) \times (\overline{X_g^B}, \overline{Y_g^B})$.

[00120] The example of the disclosure provides the alignment device for double-sided exposure, comprising the positioning signs, the marking signs and the position acquisition device. Before each sample to be exposed is exposed, the position information of the positioning signs is acquired by the position acquisition device, and then the position information of the marking signs is acquired, so as to determine the variation of the positions of the marking signs relative to the predetermined position when the sample is exposed. According to the variation, the position of the exposure pattern on the other side of the predetermined sample to be exposed is adjusted in real time, thereby solving the problem of inaccurate exposure alignment caused by the fact that the marking signs cannot be positioned in real time in the prior art, and improving the accuracy of double-sided alignment of the sample to be exposed. The distance between the positioning signs and the marking signs is less than 20 mm and/or the positioning signs and the marking signs are connected by an anti-deformation material, ensuring that the relative position variation of the positioning signs and the marking signs in the exposure process is less than the predetermined value set according to the alignment accuracy required by the exposure of the sample to be exposed, thereby improving the accuracy of double-sided alignment of the sample to be exposed. Before each sample to be exposed is exposed, the position information of the positioning signs is acquired by the position acquisition device, and then the position information of the marking signs is acquired, so as to determine the variation of the positions of the marking signs relative to the predetermined position when the sample is exposed. According to the variation, the position of

the exposure pattern on the other side of the predetermined sample to be exposed is adjusted in real time, thus improving the accuracy of double-sided alignment of the sample to be exposed.

[00121] Example IV

[00122] The present example provides exposure equipment comprising an alignment device for double-sided exposure. Referring to FIG. 6 exposure, the device comprises:

[00123] positioning signs 11, marking signs 12, a position acquisition device 13, a sample carrier 14, a marking device 15 and exposure equipment 16;

[00124] the positioning signs 11 are used for determining the positions of the marking signs 12 in real time, so as to determine the position of an exposure pattern of a sample to be exposed according to the positions of the marking signs 12;

[00125] the marking signs 12 are used for marking the sample to be exposed;

[00126] the position acquisition device 13 is used for acquiring the position information of the positioning signs in real time; and

[00127] the exposure equipment 16 is used for exposing the sample to be exposed;

[00128] wherein the relative position variation of the positioning signs 11 and the marking signs 12 is less than a predetermined value, the predetermined value is set according to the alignment accuracy required when the sample to be exposed is subjected to double-sided exposure, and the distance between the positioning signs 11 and the marking signs 12 is less than 20 mm and/or the positioning signs and the marking signs are connected by an anti-deformation material;

[00129] the sample carrier 14 is used for bearing the sample to be exposed; the marking device 15 is used for marking the sample to be exposed through the marking signs 12; and

[00130] the marking signs 12 are located on the sample carrier 14.

[00131] In the present example, the sample to be exposed is a PCB, the sample carrier is a loading chuck for bearing and fixing the PCB, the loading chuck is made of aluminum alloy, the marking signs 12 are marking holes on the loading chuck, the position acquisition device 13 is a CCD camera, and the marking device 15 is a 405 laser source.

[00132] Specifically, when placed on the loading chuck, the PCB covers the marking holes, so that the 405 laser source can mark one side of the PCB facing this direction while ensuring that the PCB does not cover the positioning signs, so that the CCD camera can obtain the position information of the positioning signs. The positioning signs can be positioning holes on the loading chuck, the distance between the positioning hole and the marking hole is less than 20 mm, or the positioning sign is a marker connected with the marking hole through an anti-deformation material, as long as the relative position variation between the positioning signs and the marking holes in the working process is less than a predetermined value, wherein the predetermined value is set according to the alignment accuracy required when the PCB is subjected to double-sided exposure.

[00133] For example, if the alignment accuracy between the front and back sides of the PCB is required to be within 10 μm , the predetermined value is set to be 2 μm . If the positioning sign is a positioning hole on the loading chuck, the distance between the positioning hole and the marking hole is set to be less than 20 mm, and in the exposure process of the PCB, according to the coefficient of thermal expansion 23 $\mu\text{m}/^{\circ}\text{C}\cdot\text{m}$ of aluminum alloy as the material

of the loading chuck, the temperature fluctuation during exposure is $\pm 2^{\circ}\text{C}$, then the relative position variation between the positioning hole and the marking hole is $23 \times 4 \times 0.02 = 1.8 \mu\text{m} < 2 \mu\text{m}$. Because the local rigidity of aluminum alloy is greater than overall rigidity, when the distance between the positioning hole and the marking hole is small, the vacuum influence is very small and can be ignored. An actual test shows that the relative position variation between the positioning hole and the marking hole satisfies the standard of being less than the predetermined value of $2 \mu\text{m}$.

[00134] Similarly, if the positioning sign is a marker connected with the marking hole through the anti-deformation material, the relative position variation between the positioning signs and the marking holes can be ignored because the anti-deformation material is rarely affected by temperature.

[00135] In practical application, the anti-deformation material can be invar, marble, ceramic and other materials with small coefficients of thermal expansion, and these materials are rarely affected by temperature. For example, the coefficient of thermal expansion of invar is $0.8 \mu\text{m}/^{\circ}\text{C}/\text{m}$, that of marble is $5 \mu\text{m}/^{\circ}\text{C}/\text{m}$, and that of ceramic is $7 \mu\text{m}/^{\circ}\text{C}/\text{m}$. Even if the length of the anti-deformation material connecting the positioning sign with the marking hole is as long as 100 mm, the deformations of the anti-deformation materials are $0.8 \times 4 \times 0.1 = 0.32 \mu\text{m}$, $5 \times 4 \times 0.1 = 2 \mu\text{m}$ and $7 \times 4 \times 0.1 = 2.8 \mu\text{m}$ respectively within the temperature fluctuation of $\pm 2^{\circ}\text{C}$. In practical application, the anti-deformation material will not be as long as 100 mm at all; for example, if the distance between the positioning sign and the marking hole is 10 mm, the deformations of the anti-deformation materials are $0.8 \times 4 \times 0.02 = 0.064 \mu\text{m}$, $5 \times 4 \times 0.02 = 0.4 \mu\text{m}$

and $7*4*0.02=0.56\text{ }\mu\text{m}$ respectively within the temperature fluctuation of $\pm 2^{\circ}\text{C}$, so the relative position variation between the positioning signs and the marking holes can be ignored.

[00136] In order to meet the requirement for higher alignment accuracy, the distance between the positioning signs and the marking signs can be set to be any value less than 20 mm.

[00137] In the exposure process, when the PCB is placed on the loading chuck for exposure, at least two marking signs are selected according to the size of the PCB. The marking signs are located at any part of an edge of the loading chuck, as shown in FIGS. 3, 4 and 5.

[00138] The marking signs are covered with the PCB, but the positioning signs corresponding to the selected marking signs cannot be covered.

[00139] In the exposure process, when the other side of the PCB is exposed, the position information of the marking holes is determined according to the position information of the positioning signs obtained by the CCD camera, so as to determine the position of the exposure pattern on the other side of the PCB according to the position information of the marking holes for exposure.

[00140] For the convenience of description, the two sides of the PCB are marked as side A and side B respectively.

[00141] For example, the initial calibration position of the marking holes recorded in the system is (X_s^0, Y_s^0) , and the initial calibration position of the positioning signs is (X_r^0, Y_r^0) . When a PCB is exposed, the real-time position of the positioning signs is (X_r^1, Y_r^1) , and the position change of the positioning signs obtained by the CCD camera relative to the initial position recorded in the system is:

$$\Delta X_r = X_r^1 - X_r^0$$

$$\Delta Y_r = Y_r^1 - Y_r^0$$

[00142] as the relative position variation between the positioning signs and the marking holes can be ignored, it can be known that the position change of the marking holes is also as follows:

$$\Delta X_r = X_s^1 - X_r^0$$

$$\Delta Y_r = Y_s^1 - Y_r^0$$

[00143] the theoretical value of the marking hole at a marking position on the side B is recorded as $(X_s^1, Y_s^1) = (X_s^0 + X_r^1 - X_r^0, Y_s^0 + Y_r^1 - Y_r^0)$;

[00144] when the board is turned over, the height of the PCB is recorded as H, and the coordinates of a bottom edge X of the board are X_{bottom} ;

[00145] according to the theoretical value of the marking hole at the marking position on the side B, the expected position of the marking hole on the side B is $(\overline{X_s^1}, \overline{Y_s^1}) = (H - (X_s^1 - X_{bottom}), Y_s^1)$;

[00146] the position of the marking hole actually captured on the side B after turning over the board is (X_{sB}^1, Y_{sB}^1) ;

[00147] alignment result $(\theta \quad ShiftX \quad ShiftY) = (X_{sB}^1, Y_{sB}^1) / (\overline{X_s^1}, \overline{Y_s^1})$;

[00148] the side A position of the exposure pattern (X_g^A, Y_g^A) is subjected to Y mirroring to obtain $(\overline{X_g^B}, \overline{Y_g^B})$;

[00149] that is, the side B position of the pattern is $(X_g^B, Y_g^B) = (\theta \quad ShiftX \quad ShiftY) \times (\overline{X_g^B}, \overline{Y_g^B})$.

[00150] An actual test shows that on the premise that the repeated positioning accuracy of the system shafting reaches 1 μm and the image processing accuracy reaches 1 μm , it can be

ensured that the positioning accuracy of the front and back sides of the inner holeless PCB is within 10 μm .

[00151] The example of the disclosure provides the alignment device for double-sided exposure, comprising the positioning signs, the marking signs and the position acquisition device. Before each sample to be exposed is exposed, appropriate marking signs are selected according to the size of the sample to be exposed, the position information of the positioning signs corresponding to the selected marking signs is acquired by the position acquisition device, and then the position information of the marking signs is acquired, so as to determine the variation of the positions of the marking signs relative to the predetermined position when the sample is exposed. According to the variation, the position of the exposure pattern on the other side of the predetermined sample to be exposed is adjusted in real time, thereby solving the problem of inaccurate exposure alignment caused by the fact that the marking signs cannot be positioned in real time in the prior art, and improving the accuracy of double-sided alignment of the sample to be exposed. The distance between the positioning signs and the marking signs is less than 20 mm and/or the positioning signs and the marking signs are connected by an anti-deformation material, ensuring that the relative position variation of the positioning signs and the marking signs in the exposure process is less than the predetermined value set according to the alignment accuracy required by the exposure of the sample to be exposed, thereby improving the accuracy of double-sided alignment of the sample to be exposed. Before each sample to be exposed is exposed, the position information of the positioning signs is acquired by the position acquisition device, and then the position information of the marking signs is acquired, so as to determine the variation of the positions of the marking signs relative to the

predetermined position when the sample is exposed. According to the variation, the position of the exposure pattern on the other side of the predetermined sample to be exposed is adjusted in real time, thus improving the accuracy of double-sided alignment of the sample to be exposed.

[00152] Example V

[00153] Referring to FIGS. 10 and 11, the present example provides an exposure method for double-sided exposure.

[00154] As shown in FIG. 10, a substrate 20 to be exposed is placed on the sample carrier 14, and the position acquisition device 13 acquires the position information of the selected positioning signs 11.

[00155] As shown in FIG. 11, the position information of the selected positioning signs 11 is acquired by the position acquisition device 13, positioning marks 21 are exposed on the substrate 20 to be exposed by using the exposure equipment 16, so that the positioning marks 21 and the marks printed by the marking signs 12 can establish a one-to-one correspondence relationship, and at the same time, the positioning marks 21 are used for pattern position orientation and marking when the front side of the substrate is exposed, and the marks printed by the marking signs 12 are used for pattern position orientation and marking when the back side of the substrate is exposed, so that an accurate position relationship can be established between the patterns on the two sides.

[00156] For the convenience of description, the two sides of the PCB are marked as side A and side B respectively.

[00157] For example, the initial calibration position of the marking holes recorded in the system is (X_s^0, Y_s^0) , and the initial calibration position of the positioning signs is (X_r^0, Y_r^0) .

When a PCB is exposed, the real-time position of the positioning signs is (X_r^1, Y_r^1) , and the position change of the positioning signs obtained by the CCD camera relative to the initial position recorded in the system is:

$$\Delta X_r = X_r^1 - X_r^0$$

$$\Delta Y_r = Y_r^1 - Y_r^0$$

[00158] as the relative position variation between the positioning signs and the marking holes can be ignored, it can be known that the position change of the marking holes is also as follows:

$$\Delta X_s = X_r^1 - X_r^0$$

$$\Delta Y_s = Y_r^1 - Y_r^0$$

[00159] the theoretical value of the marking hole at a marking position on the side B is recorded as $(X_s^1, Y_s^1) = (X_s^0 + X_r^1 - X_r^0, Y_s^0 + Y_r^1 - Y_r^0)$;

[00160] the exposure equipment 16 exposes the positioning marks 21 as intermediate marks on the side A by using a theoretical value (X_s^1, Y_s^1) of a mark position, and the positioning marks 21 are used to determine the pattern position when the side A of the substrate is exposed;

[00161] when the board is turned over, the height of the PCB is recorded as H, and the coordinates of a bottom edge X of the board are X_{bottom} ;

[00162] according to the theoretical value of the marking hole at the marking position on the side B, the expected position of the marking hole on the side B is $(\overline{X_s^1}, \overline{Y_s^1}) = (H - (X_s^0 - X_{bottom}), Y_s^0)$;

[00163] the position of the marking hole actually captured on the side B after turning over the board is (X_{sB}^1, Y_{sB}^1) ;

[00164] alignment result $(\theta \quad ShiftX \quad ShiftY) = (X_{sB}^1, Y_{sB}^1) / (\overline{X_s^1}, \overline{Y_s^1})$;

[00165] the side A position of the exposure pattern (X_g^A, Y_g^A) is subjected to Y mirroring to obtain $(\overline{X_g^B}, \overline{Y_g^B})$;

[00166] that is, the side B position of the pattern is $(X_g^B, Y_g^B) = (\theta \quad ShiftX \quad ShiftY) \times (\overline{X_g^B}, \overline{Y_g^B})$.

[00167] An actual test shows that on the premise that the repeated positioning accuracy of the system shafting reaches 1 μm and the image processing accuracy reaches 1 μm , it can be ensured that the positioning accuracy of the front and back sides of the inner holeless PCB is within 10 μm .

[00168] Some steps in the examples of the disclosure may be implemented through software, and corresponding software programs may be stored in a readable storage medium, such as an optical disk or a hard disk.

[00169] The foregoing descriptions are merely preferred examples of the disclosure, but are not intended to limit the disclosure. Any modification, equivalent substitution, improvement and the like made within the spirit and principle of the disclosure shall fall within the protection scope of the disclosure.

What is claimed is:

1. An alignment device for double-sided exposure, wherein the device comprises:
positioning signs, marking signs, a position acquisition device and a sample carrier for placing a sample to be exposed;
wherein the marking signs are located on the sample carrier and are covered by the sample to be exposed;
the positioning signs are located on the sample carrier and are not covered by the sample to be exposed;
the distance between the positioning signs and the marking signs on the sample carrier is less than 20 mm and/or the positioning signs and the marking signs are connected by an anti-deformation material;
the positioning signs are used for determining the positions of the marking signs in real time;
the marking signs are used for marking the sample to be exposed;
the position acquisition device is used for acquiring position information of the positioning signs in real time,
the position acquisition device acquires the position information of the positioning signs,
according to the position information of the positioning signs, one side of the sample to be exposed is aligned and exposed;
when exposing the other side of the sample to be exposed, the position acquisition device acquires position information of the positioning signs in real time, and the position

information of the marking signs is determined according to the position information of the positioning signs acquired in real time,

according to the position information of the marking signs, the position of the exposure pattern on the other side of the sample to be exposed is determined, aligned, and exposed;

the sample carrier is made of aluminum alloy material, or the anti-deformation material is made of material with low coefficient of thermal expansion.

2. The device according to claim 1, wherein the relative position variation of the positioning signs and the marking signs is less than a predetermined value, and the predetermined value is set according to the alignment accuracy required when the sample to be exposed is subjected to double-sided exposure.

3. The device according to claim 1, wherein the device further comprises:
the marking device is used for marking the sample to be exposed through the marking signs.

4. The device according to claim 3, wherein the marking signs are located on an edge of the sample carrier.

5. An alignment method for double-sided exposure, wherein the method is applied to the alignment device according to any one of claims 1 to 4 for double-sided exposure, and the method comprises:

acquiring position information of the positioning signs located on the sample carrier and at a position not covered by the sample to be exposed;

aligning and exposing one side of the sample to be exposed according to the position information of the positioning signs;

acquiring position information of the positioning signs in real time when exposing the other side of the sample to be exposed;

determining the position information of the marking signs located on the sample carrier and covered by the sample to be exposed according to the position information of the positioning signs acquired in real time; and

aligning and exposing the other side of the sample to be exposed according to the position information of the marking signs;

the distance between the positioning signs and the marking signs on the sample carrier is less than 20 mm and/or the positioning signs and the marking signs are connected by an anti-deformation material; and

the sample carrier is made of aluminum alloy material, or the anti-deformation material is made of material with low coefficient of thermal expansion.

6. The method according to claim 5, wherein before exposing one side of the sample to be exposed, the method further comprises:

acquiring the position information of the positioning signs when exposing one side of the sample to be exposed in real time, and exposing an intermediate mark on one side of the sample to be exposed according to the acquired position information of the positioning signs, the intermediate mark being used for determining the position of an exposure pattern on the side where the intermediate mark is located.

7. The method according to claim 6, wherein before marking the other side of the sample to be exposed with the marking signs, the method further comprises:

selecting at least two marking signs according to the size of the sample to be exposed;
and

covering the marking signs with the sample to be exposed without covering the
positioning signs corresponding to the selected marking signs.

8. The method according to claim 7, wherein the alignment exposure of the other side
of the sample to be exposed according to the position information of the marking signs
comprises:

determining the position of an exposure pattern on the other side of the sample to be
exposed in real time according to the position information of the marking signs; and
exposing the other side of the sample to be exposed according to the position of the exposure
pattern on the other side of the sample to be exposed determined in real time.

9. The method according to any one of claims 5 to 8, wherein marking the other side of
the sample to be exposed through the marking signs.

10. An exposure equipment, comprising the alignment device for double-sided exposure
according to any one of claims 1 to 4.