

PROCESS METHOD FOR LASER REMOVAL OF
SUBSTRATE SOLDER MASK

BACKGROUND OF THE INVENTION

1. Field of the Invention:

5 The present invention relates to a method of manufacturing a substrate, and more particularly, to a method of manufacturing a substrate, especially a solder mask laser manufacturing method that processes the entire substrate through laser.

10 **2. Description of the Related Art:**

 The solder mask process of the general circuit substrate is usually to apply photosensitive solder mask resist on the surface of the circuit substrate to form a solder mask after the printed circuit is set up, then to pre-cure the solder mask until
15 semi-cured, then to use the photomask to perform exposure and development technology, so that the solder mask is cured against the part of the circuit other than the solder pads, and then to remove the uncured part of the solder mask, so that the solder pads expose the solder mask. Due to the necessary error caused
20 by exposure energy and development, the accuracy is limited, and the pitch of the solder pads cannot be reduced. In addition, direct imaging technology is introduced. Although the cost of

the mask is reduced, the equipment cost is extremely high, and the technology is also facing the same problem.

However, the circuit substrate and the photomask will be affected by environmental conditions such as temperature and humidity in the exposure part of the exposure device, which will cause changes in the positional accuracy of the positioning marks on the circuit substrate and the photomask and the positional accuracy of the exposure pattern, resulting in a problem that high-precision patterns cannot be formed, so that the solder pads cannot correctly expose the solder mask. Furthermore, for circuit substrates with different solder pad positions, a mask conforming to the circuit substrate must be produced first, which increases the production cost of the circuit substrate. In addition, the solder mask process of the general circuit substrate often requires the use of different inks, which makes the ink cost high. Moreover, the semi-cured solder mask has insufficient hardness or is sticky, which is easy to cause scrap during operation.

SUMMARY OF THE INVENTION

The present invention provides a process method for laser removal of substrate solder mask, which processes a substrate through a laser with controllable energy. The process

method for laser removal of substrate solder mask includes the steps of: providing a substrate and arranging solder pads on the surface of the substrate; covering the surface of the substrate and the solder pads with a solder mask, where the part of the

5 solder mask facing the surface of the substrate is the shielding part and the part of the solder mask facing the solder pads is the clearing part; using a camera module to read the QR-Code for plate production part number on the substrate; automatically importing the CAD/CAM data to the laser device, where the

10 CAD/CAM data corresponds to the plate production part number; sequentially stripping the cleaning part through a laser beam according to the CAD/CAM data; making the solder mask form a hollow portion; taking a picture of the substrate through the camera module and taking out the processed substrate picture;

15 comparing and judging whether the processed substrate picture and the CAD/CAM data are the same; completing the substrate processing job if they are the same.

In one embodiment of the present invention, in the step of comparing and judging whether the processed substrate

20 picture is the same as the CAD/CAM data, if they are not the same, then the laser beam is used to perform the stripping operation on the clearing part for the difference.

In one embodiment of the present invention, in step S104, according to a preset rule, the QR-Code of the production process code of each unit is generated and burned into the designated position of each unit at the same time when
5 construction starts.

In one embodiment of the present invention, the data of the solder mask is imported into the CAD/CAM data, and the data of the solder mask is converted into a positive image, a negative image or a graphic to obtain a construction graphic.

10 In one embodiment of the present invention, after obtaining the construction graphic, calculate the overlapping area of the laser spots according to the laser spot size and energy of the laser device, and then translate a laser dot matrix.

In one embodiment of the present invention, the
15 substrate is divided into multiple areas to be processed through the CAD/CAM data, and then the laser beam is used to remove the clearing part of each of the areas to be processed according to a preset rule.

In one embodiment of the present invention, the laser
20 light emitted by the laser beam is a high-frequency laser beam above the millisecond level (milliseconds, microseconds, nanoseconds or picoseconds).

In one embodiment of the present invention, the type of the laser beam is selectively to be CO₂, Yag or green laser according to the characteristics of the material to achieve the effect of removing solder mask without residue or
5 carbonization.

In one embodiment of the present invention, the laser beam is emitted by multiple laser light sources, which respectively perform stripping operations on the clearing part in sequence according to the CAD/CAM data, and each laser light
10 source is responsible for a different area.

In summary, the process method for laser removal of substrate solder mask disclosed in the present invention can achieve the following effects:

1. Significantly shorten the steps of the processing
15 process.

2. Improve process yield.

3. Laser beam with controllable energy.

4. Improve the pattern accuracy of the processing
process.

20 5. For circuit substrates with different solder pad positions, it is no longer necessary to make a mask that matches the circuit substrate first.

6. It will not be affected by environmental conditions such as temperature and humidity.

7. No development is required to greatly reduce wastewater pollution and save energy at the same time.

5 8. Unlimited ink, ink cost reduction.

9. Use CO₂, Yag or green laser to achieve the effect of removing solder mask without residue or carbonization.

10 10. Solve the problem in the previous technology that the semi-cured anti-soldering hardness is insufficient or sticky, which is easy to cause scrapping during operation.

11. Reduce environmental damage, comply with ESG standards, and contribute to sustainable development.

15 The specific examples are described in detail below, and it will be easier to understand the purpose, technical content, characteristics and effects of the present invention.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a flow chart of the process method for laser removal of substrate solder mask of the present invention.

20 FIG. 2 is a side view of the substrate of the present invention.

FIG. 3 is a side view of the substrate covered with the solder mask of the present invention.

FIG. 4 is a three-dimensional schematic diagram of the laser light processing the substrate of the present invention.

FIG. 5 is a side view of the substrate processed by the laser light of the present invention.

5 FIG. 6 is a schematic diagram of comparing the CAD/CAM data and the processed substrate picture in the present invention.

FIG. 7 is a schematic diagram of the translated laser dot matrix of the present invention.

10 FIG. 8 is a schematic diagram of the multi-source laser processing the substrate of the present invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

In order to solve many problems in the solder mask process of the existing circuit substrate, the inventor has done
15 many years of research and development to improve the criticism of the existing products. The following will introduce in detail how the present invention uses a process method for laser removal of substrate solder mask to achieve the most efficient functional demands.

20 Please refer to FIG. 1, which is a flow chart of the solder mask laser manufacturing method of the present invention. As shown in FIG. 1, the process method for laser removal of

substrate solder mask is to process all or part of a substrate through a laser with controllable energy, rather than just manually using a laser to perform circuit substrate local or single-point optimization. In the embodiment of the present invention, the process method for laser removal of substrate solder mask is mainly used to replace the complicated process of the previous technology and reduce environmental pollution, which meets the ESG standard. ESG is the abbreviation of environmental protection (E, Environmental), social responsibility (S, Social) and corporate governance (G, governance). The process method for laser removal of substrate solder mask 100 includes the following steps: Provide a substrate and arrange solder pads on the surface of the substrate (Step S101). Cover the surface of the substrate and the solder pads with a solder mask, where the part of the solder mask facing the surface of the substrate is defined as a shielding part and the part of the solder mask facing the solder pads is defined as a clearing part (Step S102). Use a camera module to read the QR-Code for plate production part number on the substrate (Step S103). Automatically import the CAD/CAM data to a laser device, where the CAD/CAM data corresponds to the plate production part number (Step S104). Sequentially strip the

cleaning part through the laser beam according to the CAD/CAM data (Step S105). Make the solder mask form at least a hollow portion (Step S106). Take a picture of the substrate through the camera module and take out the processed substrate picture (Step S107). Compare and judge whether the processed substrate picture and the CAD/CAM data are the same (Step S108). Complete the substrate processing job if they are the same (Step S109). If it is judged that the processed substrate picture is different from the CAD/CAM data, then the laser beam will perform a stripping operation on the clearing part for the difference, that is, return to Step S105.

The process method for laser removal of substrate solder mask will be further described in detail below. Please refer to FIGS. 1-7 at the same time, where FIG. 2 is a side view of the substrate of the present invention, FIG. 3 is a side view of the substrate covered with the solder mask of the present invention, FIG. 4 is a three-dimensional schematic diagram of the laser light processing the substrate of the present invention, FIG. 5 is a side view of the substrate processed by the laser light of the present invention, FIG. 6 is a schematic diagram of comparing the CAD/CAM data and the processed substrate picture in the present invention, and FIG. 7 is a schematic diagram of the

translated laser dot matrix of the present invention. As shown in the drawings, when performing the process method for laser removal of substrate solder mask **100**, in step S101, a substrate **200** is provided with solder pads **210** on its surface (as shown in FIG. 2). In step S102, the surface of the substrate **200** and the solder pads **210** is covered with a solder mask **220**, wherein the part of the solder mask **220** facing the surface of the substrate **200** is a shielding part **222**, and the part of the solder mask **220** facing the solder pads **210** is a clearing part **224**, as shown in FIG. 3. That is to say, at this time, the surface of the circuit substrate is covered with green paint, and then part of the green paint needs to be ablated or stripped. After that, as shown in FIG. 4, the substrate **200** will be fixed on the laser processing machine **MT**, and the initial positioning will be completed through the CCD on the laser processing machine **MT**. Next, in step S103, the QR-Code of the plate production part number on the substrate **200** will be read through a camera module. In step S104, the CAD/CAM data **TA** is automatically imported to a laser device **LE1**, wherein the CAD/CAM data **TA** corresponds to the plate production part number. At the same time, in step S104, according to a preset rule, the QR-Code of the production process code of each unit is generated and burned into the

designated position of each unit at the same time when construction starts. The above CAD/CAM data **TA** refers to the output through computer-aided design (CAD)/computer-aided manufacturing system (CAM), which is a graphic-oriented automation system for automatic design, draft, and display. It is worth noting that, in the embodiment of the present invention, during the translation process, the data of the solder mask **220** will be imported to the CAD/CAM data **TA**, which is to convert the data of the solder mask **220** into positive images, negative images or graphics to obtain construction graphics. After obtaining the construction graphic, calculate the overlapping area of the laser spot according to the size and energy of the laser spot of the laser device, and then translate a laser dot matrix, as shown in FIG. 7. In FIG. 7, it is illustrated by the translation of three kinds of graphics, and the resolution of the laser dot matrix can be set by the designer or the operator. Next, the laser device **LE1** on the laser processing machine **MT** in steps S105 and S106 will be connected to the host **HT**, and the clearing part **224** on the substrate **200** will be ablated or stripped in sequence according to the CAD/CAM data **TA**. That is to say, through the X-axis and Y-axis movement mechanisms, the laser device **LE1** can emit a laser beam **L1** with controllable energy to

the substrate **200** according to the CAD/CAM data **TA** to ablate or peel off the clearing part **224**, making the solder mask **220** forms at least one hollow portion **226**. It should be noted that the host **HT** and the laser device **LE1** will divide the substrate

5 **200** into multiple areas to be processed through the CAD/CAM data **TA**, and then the laser beam **L1** will ablate or strip the clearing part **224** of each area to be processed according to a preset rule. It will not proceed to the next step S170 until the whole process is run. The laser light emitted by the laser beam

10 **L1** is a high-frequency laser beam above the millisecond level (milliseconds, microseconds, nanoseconds or picoseconds). The type of laser beam can be CO₂, Yag or green laser according to the characteristics of the material to achieve the effect of removing solder mask without residue or carbonization. In the

15 embodiment of the present invention, for example, the laser beam **L1** is a picosecond laser beam, and the picosecond laser beam stays on the substrate **200** for a very short time, that is, it will not excessively ablate or strip off the solder pads **210** under the solder mask **220**. Next, in step S107, as shown in FIG. 5, the

20 laser device **LE1** will take pictures of the substrate **200** through the camera module **PA** and take out the processed substrate picture **DC**. The number of camera module **PA** is not limited to

one. The camera module **PA** can take pictures of one unit or processed area of the substrate **200** and take out the pictures, and can also take pictures of the whole substrate **200** and take out the pictures. This will be done according to preset rule. Next,
5 in step S108, as shown in FIG. 6, the host **HT** will use advanced image recognition technology and algorithms to compare and judge whether the processed substrate picture **DC** and the CAD/CAM data **TA** are the same. On the screen **SC** in FIG. 6, you can see that the processed substrate picture **DC** is being
10 compared with the CAD/CAM data **TA**. In another embodiment, the host **HT** can improve the quality of image recognition and the accuracy of comparison with the help of artificial intelligence (AI). Next, if the comparison result between the processed substrate picture **DC** and the CAD/CAM data **TA** is
15 the same, the substrate processing operation will be completed. If the comparison result between the processed substrate picture **DC** and the CAD/CAM data **TA** is not the same, it will return to step S105, and the laser beam **L1** emitted by laser device **LE1** will ablate or strip the clearing part **224** on the substrate **200** for
20 the difference. Accordingly, since the process method for laser removal of substrate solder mask **100** of the present invention does not use a photomask at all, for the circuit substrate **200**

with different positions of the solder pads **210**, it is no longer necessary to make a mask that conforms to the circuit substrate. In addition, the process method for laser removal of substrate solder mask **100** does not use the exposure device at all, so it
5 will not be affected by environmental conditions such as temperature and humidity in the exposure part of the exposure device, so it will not affect the positioning of the circuit substrate and the mask. Therefore, it will not change the position accuracy of the positioning marks on the circuit
10 substrate and the mask, and the position accuracy of the exposure pattern.

Finally, please refer to FIG. 8, which is a schematic diagram of a multi-source laser processing the substrate of the present invention. There are multiple laser devices **LE2**, **LE3**
15 and **LE4** on the laser processing machine **MT**, which are respectively connected to the host **HT** for multi-tasking. In addition, the multiple laser devices **LE2**, **LE3** and **LE4** respectively emit laser beams **L2**, **L3** and **L4** according to the CAD/CAM data **TA** and perform ablation or stripping operations
20 on the clearing part **224** on the substrate **200** in sequence. The area responsible for the laser light source of each laser device is different, which helps to further improve the efficiency of the

processing process. In this embodiment, three laser devices **LE2**,
LE3 and **LE4** are used as examples for illustration, but in
practical applications, the number of three is not limited. The
laser beams **L2**, **L3** and **L4** can be high-frequency laser beams
5 above the millisecond level (milliseconds, microseconds,
nanoseconds or picoseconds).

In summary, the process method for laser removal of
substrate solder mask disclosed in the present invention can
achieve the following effects:

- 10 1. Significantly shorten the steps of the processing
process.
2. Improve process yield.
3. Laser beam with controllable energy.
4. Improve the pattern accuracy of the processing
15 process.
5. For circuit substrates with different solder pad
positions, it is no longer necessary to make a mask that matches
the circuit substrate first.
6. It will not be affected by environmental conditions
20 such as temperature and humidity.
7. No development is required to greatly reduce
wastewater pollution and save energy at the same time.

8. Unlimited ink, ink cost reduction.

9. Use CO2, Yag or green laser to achieve the effect of removing solder mask without residue or carbonization.

10. Solve the problem in the previous technology that
5 the semi-cured anti-soldering hardness is insufficient or sticky, which is easy to cause scrapping during operation.

11. Reduce environmental damage, comply with ESG standards, and contribute to sustainable development.

What the invention claimed is:

1. A process method for laser removal of substrate solder mask, which is to process a substrate through a laser with controllable energy, the process method for laser removal of
5 substrate solder mask comprising the steps of:

S101: providing a substrate where the surface of said substrate is provided with solder pads;

S102: covering the surface of said substrate and said solder pads with a solder mask, where the part of said solder
10 mask facing the surface of said substrate is defined as a shielding part and the part of said solder mask facing said solder pads is defined as a clearing part;

S103: reading the QR-Code of a plate production part number on said substrate through at least one camera module;

15 S104: automatically importing data of a CAD/CAM data to a laser device, where said CAD/CAM data corresponds to said plate production part number;

S105: performing stripping operation on said clearing part sequentially according to said CAD/CAM data through a
20 laser beam;

S106: making said solder mask form at least one hollow portion;

S107: taking pictures of said substrate through said at least one camera module and taking out a processed substrate picture;

S108: comparing and judging whether said processed
5 substrate picture is the same as said CAD/CAM data; and

S109: completing the substrate processing operation if said processed substrate picture is the same as said CAD/CAM data.

2. The process method for laser removal of substrate
10 solder mask as claimed in claim 1, wherein in the step of comparing and judging whether said processed substrate picture is the same as said CAD/CAM data, if said processed substrate picture and said CAD/CAM data are different, use said laser beam to perform the stripping operation on the clearing part for
15 the difference.

3. The process method for laser removal of substrate solder mask as claimed in claim 1, wherein in step S104, according to a preset rule, generate a QR-Code of the production process code of each unit and burn the QR-Code into the
20 designated position of each unit at the same time when construction starts.

4. The process method for laser removal of substrate

solder mask as claimed in claim 1, wherein the data of said solder mask is imported into said CAD/CAM data, and the data of said solder mask is converted into a positive image, a negative image or a graphic to obtain a construction graphic.

5 5. The process method for laser removal of substrate solder mask as claimed in claim 4, wherein after obtaining said construction graphic, calculate the overlapping area of the laser spots according to the laser spot size and energy of said laser device, and then translate a laser dot matrix.

10 6. The process method for laser removal of substrate solder mask as claimed in claim 1, wherein said substrate is divided into multiple areas to be processed through said CAD/CAM data, and then said laser beam is used to remove the clearing part of each of the areas to be processed according to a
15 preset rule.

7. The process method for laser removal of substrate solder mask as claimed in claim 1, wherein the laser light emitted by said laser beam is a high-frequency laser beam above the millisecond level.

20 8. The process method for laser removal of substrate solder mask as claimed in claim 1, wherein the type of said laser beam is selectively to be CO₂, Yag or green laser according to

the characteristics of the material to achieve the effect of removing solder mask without residue or carbonization.

9. The process method for laser removal of substrate solder mask as claimed in claim 1, wherein said laser beam is
5 emitted by multiple laser light sources, which respectively perform stripping operations on said clearing part in sequence according to said CAD/CAM data, and each said laser light source is responsible for a different area.

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