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Circuit ^b Board for printed circuits, and method ^a of ^{making} manufacturing such ^a printed circuit boards.

The invention relates to a printed circuit board in which the desired conductor tracks and solder lands are provided in the form of electrically conductive sections on an insulator plate and in which the insulator plate and the conductor tracks, but not the lands, are masked with a solder-repellent lacquer mask, the lacquer mask consisting of two layers of lacquer, one layer of which covers at least part of the other layer. In such a printed circuit board, proposed in US-PS 4 088 828, the lacquer mask, often also termed solder-stop mask, is so constructed that it also masks parts of the lands in the region of their edges. In this case, the lacquer mask consists of a lacquer layer masking the insulator plate, the conductor tracks and the aforementioned edges of the lands, with a further lacquer layer on top of it, which is applied at those regions of the printed circuit board where the lands are positioned very close together. This further lacquer layer, which is raised with respect to the first-mentioned lacquer layer and which forms a wall between two adjacent lands, serves to prevent any solder bridges from forming between the adjacent lands during the soldering process. With such a lacquer mask, i.e. one which also masks parts of the lands, it is important that the lacquer mask be applied with an extremely high degree of precision so as to ensure that those regions of the lands where the soldering process is to take place have in fact been left unmasked, thus creating a reliable soldered joint. However, the need for such a high degree of precision in applying the lacquer mask gives rise in practice to considerable problems and requires complex and expensive methods for applying the lacquer mask. On the other hand, lacquer masks consisting of a single lacquer layer have been applied to insulator plates in such a way that they extend to the edges of the lands while masking the conductor tracks, as shown in the DE-OS 29 37 886. Here too the application of the lacquer mask requires a high degree of precision and therefore is again complex and expensive. With a view to obviating these difficulties,

single-layer lacquer masks, as known generally, are often applied in such a way that they surround the lands with a relatively large interspace in order to leave them unmasked. However, this has the disadvantage that the regions of the insulator plate situated between the edge of the lands and the edge of the lacquer mask are not masked.

It is an object of the invention to provide a printed circuit board of the type referred to in the opening paragraph, constructed in such a way that, while guaranteeing that the entire area of the lands is left unmasked, both the insulator plate and the conductor tracks are flawlessly masked. To this end, according to the invention, one lacquer layer extending to the edges of the electrically conductive sections and directly masking the insulator plate is provided at least in the region of the lands, and the other lacquer layer, leaving the lands unmasked, masks the conductor tracks and extends to the region occupied by the lacquer layer extending to the edges of the electrically conductive sections, the two layers overlapping. In this manner, one lacquer layer ensures that the insulator plate is masked up to the edges of the lands, and the other lacquer layer, leaving the lands unmasked, ensures that the conductor tracks are masked, the overlap of the two layers of lacquer thus guaranteeing that all parts of the insulator plate, too, are flawlessly masked. In this case, the lands can be left unmasked with a relatively large interspace between the edge of the lands and the edge of the lacquer layer masking the conductor tracks, since in this region the insulator plate is masked by the first-mentioned lacquer layer. Moreover, the application of the two layers of lacquer no longer poses any tolerance problems and the degrees of precision to be met are uncritical.

It has proved advantageous if the lacquer layer extending to the edges of the electrically conductive sections extensively masks the insulator plate and is extensively covered by the other lacquer layer, the lands being left uncovered. In this way, the application of the lacquer layers is made simple and uncritical, and as a result of the extensive mutual overlap of the two lacquer layers the lacquer mask masks the entire printed circuit board flawlessly, while guaranteeing that the lands are left unmasked.

It has also proved advantageous if the other lacquer layer, while

leaving the lands unmasked, extensively masks the conductor tracks and the insulator plate and is at least partially covered by the lacquer layer extending to the edges of the electrically conductive sections. This too results in a simple, uncritical application of the lacquer layers, since the lacquer layer which leaves the lands uncovered is applied in the usual fashion, surrounding the lands with a relatively large interspace, and the parts of the insulator plate still unmasked are masked by the layer of lacquer which extends to the edges of the lands, thus at least partially covering the lacquer layer which leaves the lands uncovered. Here again the printed circuit board is completely masked by the lacquer mask, while guaranteeing that the lands are left unmasked.

The invention further relates to methods of manufacturing printed circuit boards according to the invention. In these methods, the desired conductor tracks and lands in the form of electrically conductive sections are manufactured on an insulator plate, whereupon the insulator plate and the conductor tracks, but not the lands, are masked with a solder-repellent lacquer mask, as is generally known. It is an object of the invention to provide particularly simple methods of manufacturing printed circuit boards according to the invention.

To this end, a first method according to the invention proposes that after the conductor tracks and lands have been manufactured, a solder-repellent lacquer layer which bonds firmly only to the insulator plate is applied to the insulator plate and to the electrically conductive sections, at least in the region of the lands, that this lacquer layer is cured, that the lacquer layer is then removed from the electrically conductive sections by chemical means, that next a further solder-repellent lacquer layer which bonds firmly and indiscriminately is applied so as to partially cover the electrically conductive sections and the lacquer layer first applied, to leave the lands uncovered and to surround the lands with an interspace, and is then cured, whereupon the printed circuit board is completed in the usual manner. In this way, the application of both lacquer layers is completely uncritical, since the lacquer layer first applied entirely covers at least the regions of the lands, so that no problems whatsoever arise with regard to the degree of precision to be met and when the further lacquer layer is applied the lands can be left uncovered by maintaining a relatively large

safety interspace, so that in this case too there are no special precision requirements. By using two different types of lacquer, one of which bonds firmly only to the insulator plate and the other indiscriminately, the lacquer layer formed by the first-mentioned type of lacquer and which covers the electrically conductive sections and, in particular, the lands can again easily be removed by chemical means from the electrically conductive sections and in particular from the lands, thus ensuring that the lacquer layer remaining extends exactly flush to the edges of the electrically conductive sections and, in particular, the lands. Such a chemical removal of a lacquer layer is often used in the manufacture of printed circuit boards and is also termed stripping. The partial mutual overlap of the two lacquer layers again means that, apart from the lands, the lacquer mask completely masks the printed circuit board. In a process such as this, it has also proved advantageous if after the chemical removal of the lacquer layer from the electrically conductive sections the remaining lacquer layer is cured again. This ensures that the lacquer layer remaining on the insulator plate has in fact cured completely, since the chemical removal of the lacquer layer from the electrically conductive sections may possibly result in a softening of the remaining lacquer layer.

According to a second method of the invention, it is proposed that after the conductor tracks and the lands have been manufactured a solder-repellent lacquer layer which bonds firmly and indiscriminately is applied to the insulator plate and the conductor tracks, leaving the lands uncovered and surrounded with an interspace, that this lacquer layer is cured, that next a further solder-repellent lacquer layer which, however, bonds firmly only to the insulator plate and the lacquer layer first applied and which covers the lands, the parts of the insulator plate still unmasked and at least partially the lacquer layer first applied is applied and then cured and that then the further lacquer layer is removed from the lands by chemical means, whereupon the printed circuit board is completed in the usual manner. In this way, the application of both lacquer layers is again completely uncritical, since in this case there are no special precision requirements. Moreover, the at least partial mutual overlap of the two lacquer layers again guarantees that the entire insulator plate is flawlessly masked

and that the further lacquer layer extends exactly flush to the edges of the lands. In this method, it is again essential that two different types of lacquer be used for the two lacquer layers, of which the lacquer layer first applied bonds firmly and indiscriminately and the further lacquer layer bonds firmly only to the insulator plate and to the lacquer layer first applied, so that the further lacquer layer covering the lands can again easily be chemically removed from them.

In this method, too, it has proved advantageous if after the chemical removal of the further lacquer layer from the lands the remaining lacquer layer is again cured. This again ensures that the remaining lacquer layer has cured completely.

The invention will be explained in greater detail by means of two exemplary embodiments and with reference to the accompanying drawings, the exemplary embodiments serving to describe two methods of manufacture, though the invention will not be restricted to these. Fig. 1 shows a plan of a printed circuit board insulator plate provided with the desired conductor tracks and lands. Fig. 2 shows a sectional view, taken along the line II-II in Fig. 1, of the printed circuit board represented in Fig. 1. In order to illustrate a first method of manufacturing a printed circuit board embodying the invention, Fig. 3 shows, using the same projection as in Fig. 2, the printed circuit board represented in Fig. 2, after application of a solder-repellent lacquer layer which bonds firmly only to the insulator plate. Fig. 4 shows, using the same projection as in Fig. 2, the printed circuit board represented in Fig. 3, after the applied lacquer layer has been removed chemically from the conductor tracks and lands. Fig. 5 shows, using the same projection as in Fig. 2, the printed circuit board represented in Fig. 4, after a further solder-repellent lacquer layer which bonds firmly and indiscriminately has been applied so as to leave the lands uncovered and to substantially cover the conductor tracks and partially cover the lacquer layer first applied. Fig. 6 shows a plan of the printed circuit board represented in Fig. 5. In order to illustrate a second method of manufacturing a printed circuit board embodying the invention, Fig. 7 shows, using the same projection as in Fig. 2, the printed circuit board represented in Fig. 2, with a solder-repellent lacquer layer which leaves the lands uncovered and which bonds firmly and

indiscriminately. Fig. 8 shows, using the same projection as in Fig. 2, the printed circuit board represented in Fig. 7, provided with a further lacquer layer which bonds firmly only to the insulator plate and to the lacquer layer first applied and which covers the lands, the parts of the insulator plate still unmasked and, partially, the lacquer layer first applied. Fig. 9 shows, using the same projection as in Fig. 2, the printed circuit board represented in Fig. 8, after the further lacquer layer has been removed from the lands by chemical means. Fig. 10 shows a plan of the printed circuit board represented in Fig. 9.

In Figures 1 and 2, reference 1 denotes a insulator plate on which various conductor tracks 2 and lands 3 consisting of electrically conductive sections are provided, which can be formed on the insulator plate by means of the usual state-of-the-art process. With reference to Figures 3 to 6, a process will be described whereby the insulator plate 1 and the conductor tracks 2 are masked with a solder-repellent lacquer mass consisting of two lacquer layers, with the lands being left unmasked, and whereby one lacquer layer of the lacquer mask extends directly to the edges of the lands 3, the lands themselves, however, being left completely unmasked. To this end, in a first stage of the process the entire printed circuit board as shown in Figures 1 and 2, viz. the insulator plate, the conductor tracks and the lands, is coated with a solder-repellent lacquer layer 4, which may be carried out, for example, by means of the known screen-printing technique. In fact, however, a photographic printing process, for example, could just as well be used instead. For this lacquer layer 4, moreover, a type of lacquer is used which bonds firmly only to the insulator plate and hence does not bond firmly to the electrically conductive sections, namely the conductor tracks and the lands 3.

Such lacquers are of a type that, because of the composition, bonds firmly to thermoplastic organic synthetic resins, but not to metals. Among such synthetic resins are the adhesives which are used to cover the insulator plate with the electrically conductive laminate. The remains of the adhesive on the parts of the insulator plate which are free from electrically conductive sections, provides a strong adhesion of the lacquer layer 4 to the insulator plate. A solder-repellent lacquer which has such properties is for example commercially

available from the firm of Pangolin under type designation 15.89/5 TA. This is a so-called UV-curable one-component lacquer which is based on acrylate and which can be cured upon irradiation with ultraviolet light, which is in fact done after this lacquer layer 4 has been applied. In a subsequent process step, the

5 lacquer layer 4 is removed by chemical means from the electrically conductive sections, namely the interconnections 2 and the lands 3, as shown in Fig. 4. Such a chemical removal of the lacquer layer, also termed stripping in printed circuit board technology, can be carried out by immersing the printed circuit board for a certain period in a bath containing potassium hydroxide or sodium hydroxide.

10 In this process, the lacquer layer 4 saponifies much faster at places where it does not bond firmly, therefore on the electrically conductive parts, than at places where it bonds strongly, thus making it possible to free the electrically conductive parts from the lacquer layer. After this, the lacquer layer 4, which now remains only on the insulator plate 1, should preferably be cured again so as to

15 harden again any regions of this lacquer layer that may have softened during the chemical treatment.

In this way, the lacquer layer 4 coating the insulator plate 1 extends exactly flush to the edges of the electrically conductive sections, and in particular to the lands 3. Clearly, the application of the lacquer layer 4 is

20 completely uncritical since it is simply applied extensively to the entire printed circuit board. In fact, however, it would also be possible to apply the lacquer layer 4 only in the region of the lands 3, thus saving lacquering material. In this case too the application of the lacquer layer 4 would be completely uncritical since the lacquered regions could surround the lands 3 with a fairly large

25 interspace and could possibly also merge into one another and thus join up.

In a subsequent process step, a further solder-repellent lacquer layer 5 is applied which partially covers the remaining electrically conductive sections, namely the essential parts of the conductor tracks 2 and the lacquer layer 4 first applied, leaving the lands 3 uncovered and surrounded by this

30 lacquer layer 5 with an interspace. This lacquer layer 5 thus masks the conductor tracks 2 up to the regions around the lands 3. For this solder-repellent lacquer layer 5, moreover, a type of lacquer is applied such as is commonly used for

solder-repellent lacquer layers and which bonds firmly and indiscriminately, in other words which also bonds firmly to the conductor tracks 2 and to the lacquer layer 4 first applied. A solder-repellent lacquer which has such properties is for example commercially available from the firm of Dynachem under type
5 designation SM 15 LV. This too is a UV-curable one-component lacquer which is based on acrylate and which can be cured upon irradiation with ultraviolet light, which is in fact carried out after this lacquer layer 5 has been applied.

Clearly, the application of the lacquer layer 5, which can be done, for example, by means of screen-printing, is also completely uncritical as
10 regards applicable tolerances, since the lacquer layer 5 can surround the lands 3 with a relatively large interspace, so that there are no special precision requirements for applying this lacquer layer 5. It is possible for the lacquer layer 5 to surround the lands 3 in this way, with a relatively large interspace, because in this region the insulator plate 1 is already masked by the solder-repellent
15 lacquer layer 4 and is thus protected. In this way, only the lands 3 are kept completely unmasked by lacquer material. On the other hand, as a result of the mutual overlap of the two lacquer layers 4 and 5, the remaining parts of the printed circuit board are, as desired, completely and flawlessly masked by the lacquer mask. The manufacturing process is very simple, moreover, since no
20 special precision requirements need be met when applying the lacquer layers. As a consequence of the extensive application of the two lacquer layers 4 and 5, they can be easily applied and as a consequence of the extensive overlap which thus ensues between the two lacquer layers, a particularly flawless masking of the printed circuit board, excluding the lands, is achieved by the lacquer mask.

25 After the solder-repellent lacquer layer 5 has been applied and cured, the printed circuit board is completed in the usual manner. In the course of this completion process, the printed circuit board can be provided with printing, the lands can be rid of oxide layers, a protective coating of lacquer can be applied and the mechanical operations, such as drilling or punching the
30 feedthrough holes, can be carried out.

A second method of manufacturing a printed circuit board provided with a solder-repellent lacquer mask which in the region of the lands

extends to their edges is again based on a printed circuit board as represented in figures 1 and 2, in which the conductor tracks 2 and the lands 3 are provided in the form of electrically conductive sections on an insulator plate 1. On such a printed circuit board, a solder-repellent lacquer layer 6 which bonds firmly and indiscriminately is applied to the insulator plate 1 and to the conductor tracks 2, while leaving the lands unmasked, and thus surrounds the lands 3 with an interspace, as shown in Fig. 7. The interspace between the edge of the lands 3 and the edge of the lacquer layer 6 surrounding the lands 3 is selected so as to be relatively large, so that the application of this lacquer layer 6 is completely uncritical and not subject to any special precision requirements. It is thus a matter of applying a solder-repellent lacquer layer using a generally known technique.

After this lacquer layer 6 has been cured, a further solder-repellent lacquer layer 7 is applied which, however, bonds firmly only to the insulator plate 1 and to the lacquer layer 6 first applied and which covers the lands 3, the parts of the insulator plate 1 still unmasked and, at least partially, the lacquer layer 6 first applied, as shown in Fig. 8.

The choice of the lacquer for the lacquer layer 7 is made from the same viewpoints as the choice of the lacquer layer 4 in the method described before. The exclusive adhesion of the lacquer layer 7 to the insulator plate 1 and the first applied lacquer layer 6 is again attained by the use of a type of lacquer which bonds firmly to thermoplastic organic synthetic resins, which includes the lacquers usually applied in the art for the lacquer layer 6, but which does not bond to metals. In the present embodiment of the invention, this lacquer layer 7 is applied only in the region of the lands 3 in order to save lacquering material. If preferred, however, the entire printed circuit board as shown in Fig. 7 could be masked extensively with the lacquer layer 7. After the lacquer layer 7 has been cured this further lacquer layer is removed by chemically treating the lands 3 as described earlier, which again is made possible by the fact that for this lacquer layer 7 a type of lacquer is used which bonds firmly only to the insulator plate 1 and to the lacquer layer 6 first applied, and therefore does not bond firmly to the parts of the electrically conductive sections not masked by the

lacquer layer 6, in this case substantially the lands 3. The printed circuit board obtained in this manner is shown in figures 9 and 10.

5 Curing should preferably be carried out again after the chemical treatment in order to guarantee that the remaining lacquer layer 7 has been cured flawlessly. Following this, the printed circuit board is completed in the usual manner.

10 In this way, one lacquer layer of the lacquer mask, in this case the further lacquer layer 7, again extends exactly flush to the edges of the lands 3 and furthermore, owing to the at least partial mutual overlap of the two lacquer layers 6 and 7, the remaining parts of the printed circuit board are flawlessly masked. Clearly, the application of the two lacquer layers 6 and 7 is again completely uncritical, since in this case there are no special precision requirements to be met, so that this method of manufacturing the printed circuit board is also shown to be very simple.

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CLAIMS:

1. Printed circuit board in which the desired conductor tracks and solder lands are provided in the form of electrically conductive sections on an insulator plate and in which the insulator plate and the conductor tracks, though not the lands, are masked with a solder-repellent lacquer mask, the lacquer mask consisting of two layers of lacquer, one layer of which covers at least part of the other lacquer layer, characterized in that one lacquer layer extending to the edges of the electrically conductive sections and directly masking the insulator plate is provided at least in the region of the lands and the other lacquer layer, leaving the lands unmasked, masks the conductor tracks and extends to the region occupied by the lacquer layer extending to the edges of the electrically conductive sections, the two layers overlapping.
2. Printed circuit board as claimed in Claim 1, characterized in that the lacquer layer extending to the edges of the electrically conductive sections extensively masks the insulator plate and is extensively covered by the other lacquer layer, the lands being left uncovered.
3. Printed circuit board as claimed in Claim 1, characterized in that the other lacquer layer, leaving the lands uncovered, extensively masks the conductor tracks and the insulator plate and is at least partially covered by the lacquer layer extending to the edges of the electrically conductive sections.
4. Method of manufacturing a printed circuit board as claimed in Claim 1 or 2, in which the desired conductor tracks and lands in the form of electrically conductive sections are manufactured on an insulator plate, whereupon the insulator plate and the conductor tracks, though not the lands, are masked with a solder-repellent lacquer mask, characterized in that after the conductor tracks and lands have been manufactured a solder-repellent lacquer layer which bonds firmly only to the insulator plate is applied to the insulator plate and the electrically conductive sections, at least in the region of the lands, in that this lacquer layer is cured, in that the lacquer layer is then removed from the electrically conductive sections by chemical means, in that next a further solder-repellent lacquer layer which bonds firmly and indiscriminately is applied so as to partially cover the electrically conductive sections and the lacquer layer



first applied, to leave the lands uncovered and to surround them with an interspace, and is then cured, whereupon the printed circuit board is completed in the usual manner.

5. Method as claimed in Claim 4, characterized in that after the
5 chemical removal of the lacquer layer from the electrically conductive sections the remaining lacquer layer is cured again.

6. Method of manufacturing a printed circuit board as claimed in
Claim 1 or 3, in which the desired conductor tracks and lands in the form of
electrically conductive sections are manufactured on an insulator plate,
10 whereupon the insulator plate and the conductor tracks, though not the lands, are
masked by a solder-repellent lacquer mask, characterized in that after the
conductor tracks and the lands have been manufactured a solder-repellent lacquer
layer which bonds firmly and indiscriminately is applied to the insulator plate and
the conductor tracks, the lands being left unmasked, and surrounds the lands with
15 an interspace, in that this lacquer layer is cured, in that next a further solder-
repellent lacquer layer which, however, bonds firmly only to the insulator plate
and the lacquer layer first applied and which covers the lands, the parts of the
insulator plate still unmasked and at least partially the lacquer layer first applied
is applied and then cured, and in that then the further lacquer layer is removed
20 from the lands by chemical means, whereupon the printed circuit board is
completed in the usual manner.

7. Method as claimed in Claim 6, characterized in that after the
chemical removal of the further lacquer layer from the lands, the remaining
lacquer layer is cured again.

