## DESCRIPTION

Title of the invention: PROCESS FOR PRODUCING A FLEXIBLE MODULE AND MODULE OBTAINED

The invention relates to a method for manufacturing a module on a flexible substrate and the associated module, intended for use in the field of portable objects having a contact and contactless function.

In the field of portable objects having a contactless and contact function, it is known practice to use copper/epoxy glass carriers. However, such modules are expensive.

The concept of the present invention is to produce a flexible module at low cost, for example on a flexible substrate of PET (polyethylene terephthalate) type or any other equivalent carrier comprising an antenna made of aluminum.

The invention relates to a method for manufacturing a module intended for a portable object having at least a contact function and a contactless function comprising at least the following steps in combination:

- providing an assembly comprising a flexible carrier on which are arranged, on at least one of its faces, a conductive layer and, on at least an opposite face, a conductive region of contacts,
- etching the conductive layer with a laser beam in order to define a shape configured to form one or more conductive surfaces,
- using a laser beam to make, in the flexible carrier, one or more openings adapted for connections between an integrated circuit and said contacts, without perforating the conductive region bearing the contacts,
- depositing an integrated circuit on the face opposite the face bearing the contacts,
- electrically connecting the integrated circuit to the conductive region bearing the contacts and/or to the conductive layer.

The conductive layer may be etched with a laser beam in order to produce an antenna composed of a plurality of turns and of conductive pads located at each end of the antenna.

According to another embodiment, the conductive layer is etched with a laser beam in order to produce conductive lands capable of being coupled or connected to an antenna arranged in the portable object.

The contacts and/or the conductive layer may be produced beforehand by chemical etching.

According to one variant, the integrated circuit is placed directly on the flexible carrier and said integrated circuit is connected by connections via the connection openings.

It is also possible to place (secure) the integrated circuit on a conductive layer of the flexible carrier.

Aluminum is used to form the conductive region and/or the conductive layer.

As the flexible carrier, the method uses a material chosen from the following list: PET, polyimide PI, polyvinyl chloride PVC.

The invention also relates to a module obtained by implementing the method according to the invention, the module being intended to be incorporated into a portable object, characterized in that it comprises at least the following elements:

- an assembly comprising a flexible carrier on which are arranged, on at least one of its faces, a conductive layer and, on at least an opposite face, a conductive region bearing contacts, the conductive layer being etched using a laser beam in order to define a shape configured to form one or more conductive surfaces,
- one or more openings intended for connections, said openings being obtained with a laser beam,
- an integrated circuit positioned on the face opposite the face bearing the contacts, said integrated circuit being electrically connected to the conductive layer and/or to the contacts.

The integrated circuit is, for example, a chip and the conductive region is an antenna comprising a plurality of turns made of aluminum.

According to another variant, the integrated circuit is a chip and the conductive region is formed of conductive lands adapted for being coupled or connected to an antenna arranged in the portable object.

The material forming the flexible carrier is chosen from the following list: PET, polyimide PI, polyvinyl chloride PVC.

Other features and advantages of the present invention will become more clearly apparent from reading the description of exemplary embodiments alongside the figures, in which:

- figure 1 shows a view from above of a module obtained by means of the method according to the invention,
- figures 2, 3A, 3B, 4 and 5 show the result of a succession of steps for manufacturing a module according to the invention by chemical etching,
- figure 6 is a flowchart illustrating the main steps of the method according to the invention, and
- figures 7, 8 and 9 show three other variant embodiments.

In order to better understand the steps of the method according to the invention and the specific features of the module obtained by implementing this method, the following description explains a plurality of variants for the production of a module intended for use in a payment card comprising a contact function and a contactless function.

Figure 1 is a view from above of a module 10 obtained by means of the method according to the invention comprising contacts 5 on the upper face of a carrier 3 and an antenna 4.

Figure 2 illustrates a first step of the method which uses a two-sided aluminum material 1, 2 separated by a layer of polyethylene terephthalate or PET 3, or an equivalent. The first step consists in using a chemical (or electrochemical) method to obtain a rough antenna shape, notably the inner and outer contours of the final antenna 4 (figure 3A). This is performed, for example, on a face 3i of

the PET carrier. When the base material consists of a PET film comprising a single layer of aluminum, the method will attack only this single layer.

Instead of the PET layer, it is possible to use a layer of polyvinyl chloride or PVC, of epoxy glass, of polyimide or PI or any other material having equivalent properties allowing the piercing of openings and the adhesion of the material which will form the one or more conductive regions, notably an antenna.

The production of the contacts 5 positioned on the second face 3s of the PET carrier 3 is described below.

The second step illustrated in figure 3A consists in using a device, such as a laser (not shown) having a adapted wavelength, in order to remove aluminum material according to a design corresponding to the design of the desired antenna. In figure 3A, the tracks 4i of the antenna 4 are thus produced, with a contact pad 4p1, 4p2 located at each of the ends of the antenna. The laser removes the aluminum material required to form the tracks and the intertracks of the module antenna, without damaging the PET carrier.

This second step could also be performed mechanically using an appropriate tool designed and configured to remove only the aluminum according to the design of the antenna.

The antenna may also be produced by depositing conductive ink, or mechanically.

The ISO contacts 5 located on the second face 3s of the PET carrier may have been previously etched using chemical baths, the resolution of these contacts not needing to be high.

It is also possible to use etching by laser, similar to that used to produce the design of the antenna.

The antenna 4 may also be replaced with two metal regions or surfaces 4a, 4b, figure 3B; the regions will be connected to an antenna (not shown) arranged in the body of the portable object allowing capacitive coupling.

Figure 4 illustrates the formation of pre-holes 6 or of holes at sites intended for the formation of bonding wells. These holes or openings could also have been made beforehand by chemical etching.

For example, a second pass of the laser configured with parameters chosen according to the flexible carrier and potentially the aluminum (power, pass speed, laser beam width, etc.) allows the partial ablation of the PET in order to form bonding holes in the PET, without attacking the face comprising the ISO contacts.

The PET carrier comprising the contact pads 5, the antenna 4 and the passages 6 for electrical connection produced using the "bonding" technique 8 is ready to receive an integrated circuit such as a chip 7, as illustrated in figure 5.

Prior to the operation of putting the chip 7 in place, the film thus produced may be immersed in one or more electrolytic baths, in order to facilitate wiring and improve its hardness and its resistance to corrosion. The chip may then be put in place.

This will be done directly on the PET, if an opening has been provided by chemical etching. The chip may also be "glued" directly to the aluminum layer deposited on the PET film.

In summary, the flowchart of figure 6 illustrates the basic steps of the method according to the invention.

- In a first step, the antenna 4 or the one or more conductive regions are etched, for example by means of a laser, 501, first in order to roughly outline a shape, and then with greater precision to obtain the final design 4 of the antenna or of the conductive regions,
- next, in a second step, the ISO contacts 5 are formed, 502,
- in a third step 503, the bonding wells 6 are formed by laser, for example,
- in a fourth step 504, the chip 7 is glued, for example, directly to the PET layer and the connections are made with the ISO contacts using conductive wires or "wire bonding" 8.

The order of the first and second steps could be switched.

The laser may be replaced with any means allowing the execution of the steps presented above.

To produce the antenna, instead of aluminum, it is also possible to use any material allowing an antenna to be produced.

The chip 7 may be mounted on the flexible carrier 3 using the flip-chip technique, not shown.

Figure 7 illustrates one variant embodiment, in which the chip 7 is glued directly to a site 9 on the metal layer, in the example, made of aluminum.

Figure 8 illustrates one module variant for which the ISO contacts and the antenna are produced by metal ablation. In this variant embodiment, the aluminum "A" is present over the entire surface and the intertrack is etched by laser, allowing an antenna to be formed.

Figure 9 illustrates a variant of a module of figure 8 having a grating G etched at the location where the chip will be glued.

The shape and dimensions of the antenna or of the conductive layer forming the antenna will be defined with respect to an application of a given portable object. The shape of the antenna may include a "notch" in order to facilitate the cutting of the modules produced simultaneously on a width of PET.

Any flexible, inexpensive material having properties similar to those of PET or properties allowing the deposition of a conductive layer in order to produce the antenna and the contacts, resist the laser or the chemical etches implemented in order to produce the module, may be used.

The parameters of the laser, choice of wavelength, power, beam width, depth of penetration into the material, will be chosen according to the material forming the flexible layer and the material used to produce the contacts and the antenna.

The parameters for the chemical etch will be defined similarly to those of the laser.

The method according to the invention may be used to produce chip cards, both/either contact and/or contactless, passports, payment cards, identity cards, etc.

The method according to the invention and the module obtained by implementing same allow production to be less expensive.

## CLAIMS

1. A method for manufacturing a module intended for a portable object having at least a contact function and a contactless function comprising at least the following steps:

- providing an assembly comprising a flexible carrier on which are arranged, on at least one of its faces, a conductive layer and, on at least an opposite face, a conductive region of contacts,
- etching the conductive layer with a laser beam in order to define a shape configured to form one or more conductive surfaces to produce an antenna composed of a plurality of turns and conductive pads located at each end of the antenna,
- using said laser beam to make, in the flexible carrier, one or more openings intended for connections between an integrated circuit and said contacts, without perforating the conductive region bearing the contacts,
- depositing said integrated circuit on the face opposite the face bearing the contacts,
- electrically connecting the integrated circuit to the conductive region bearing the contacts and/or to the conductive layer.

2. The method as claimed in claim 1, characterized in that the conductive layer is etched with said laser beam in order to produce conductive lands capable of being coupled or connected to the antenna arranged in the portable object.

3. The method as claimed in claim 1 or 2, characterized in that the contacts are produced beforehand by chemical etching.

4. The method as claimed in one of the preceding claims, characterized in that the conductive layer is produced beforehand by chemical etching.

5. The method as claimed in one of the preceding claims, characterized in that the integrated circuit is deposited directly on the flexible carrier and the integrated circuit is connected by connections via the openings.

6. The method as claimed in one of the preceding claims, characterized in that the integrated circuit is deposited on the conductive layer of the flexible carrier.

7. The method as claimed in one of the preceding claims, characterized in that aluminum is used to form the conductive region and/or the conductive layer.

8. The method as claimed in one of the preceding claims, characterized in that a material chosen from the following list is used as the flexible carrier: PET, PI, PVC.

9. A module obtained by implementing the method as claimed in one of claims 1 to 8 and intended to be incorporated into a portable object, characterized in that it comprises at least the following elements:

- an assembly comprising a flexible carrier on which are arranged, on at least one of its faces, a conductive layer and, on at least an opposite face, a conductive region bearing contacts, the conductive layer being etched using a laser beam in order to define a shape configured to form one or more conductive surfaces to produce an antenna comprising a plurality of turns made of aluminum and two connection pads,
- one or more openings intended for connections, said openings being obtained with said laser beam,
- an integrated circuit positioned on the face opposite the face bearing the contacts, said integrated circuit being electrically connected to the conductive layer and/or to the contacts.

10. The module as claimed in claim 9, characterized in that the integrated circuit is a chip and in that the conductive region is formed of conductive lands capable of being coupled or connected to the antenna arranged in the portable object.

11. The module as claimed in claim 9 or 10, characterized in that the flexible carrier is made of a material chosen from the following list: PET, PI, PVC.