

Method for manufacturing an electronic module for a smart card

The invention relates to a manufacturing method for a contact electronic module, or an electronic module with a dual contact/contactless communication interface, and a smart card incorporating such a module.

Prior art

There are already a large number of microelectronic modules for contact smart cards, contactless smart cards and mixed contact/contactless smart cards in the prior art.

Most cards with a dual communication interface in the prior art comprise:

- an electronic module including a microelectronic chip, a contact connection terminal designed to be brought into contact with the corresponding terminals of a contact smart card reader, and two contacts arranged on the rear face to enable connection to the antenna,
- a plastic card with an antenna,
- an electrically conductive material enabling the connection between the electronic module and the antenna.

To make such a module, the chip has to be placed on a substrate, before the electrical connections are made between the corresponding terminals of the chip and the communication interface of the module, typically using very thin connection wires.

The contacts of the chip and the connection wires then have to be protected using a drop of polymerizable encapsulation resin . The drop of resin is then insulated to ensure the polymerization thereof. It is then necessary to wait approximately one day for reticulation of the resin to be completed, after which a heat treatment lasting several hours is applied.

Finally, an adhesive is applied to a face of the module and the module is glued into the cavity in the card.

The drop of encapsulation resin retains a convex shape once hardened. The module then has to be ground to attain the desired thickness.

Together, these operations are complex and time-consuming, potentially taking up to five days to complete.

Objectives of the invention

5 One general objective of the invention is therefore to propose a manufacturing method for an electronic module for a contact smart card or for a smart card with a dual contact/contactless communication interface that does not have the aforementioned drawbacks.

Another objective of the invention is to propose a manufacturing method for
10 an electronic module that substantially reduces the number of manufacturing steps, as well as the related costs and lead times, without adversely affecting the degree of reliability commonly attained using the known methods.

Summary of the invention

15 The principle of the invention involves, after the phase involving connection of the electrical contacts using connection wires, coating the projecting loops formed by the wires using a layer of material that is rigid enough to push down the loops and reduce the thickness of the product, but soft enough that the connection wires become embedded therein without increasing the overall thickness.

20 The invention therefore relates to a manufacturing method for an electronic module for a smart card, said module having a substrate in which at least one face has a metal layer, said substrate having a cavity in which is fastened a microelectronic chip with output terminals for connection to an electrical contact terminal or to an antenna of the smart
25 card, said connection being made by metal connection wires forming loops projecting from one face of the substrate, characterized in that it includes a step, following installation of the connection wires, that involves covering the face of the module including the cavity with a cover that coats the loops of the projecting wires in order to reduce the height
30 thereof and push same towards said face of the substrate.

The method according to the invention can also be applied to the manufacture of modules provided with two metal layers positioned on either side of the substrate, or a single metal layer positioned on just one face of the substrate.

Thus, where the electronic module has an upper metal layer and a lower metal layer positioned on either side of the substrate, the connection wires forming loops projecting from the upper metal layer, the method provides for the cover to press the wires against said upper metal layer.

However, where the electronic module only has a lower metal layer, the connection wires forming loops projecting from the substrate, the method provides for the cover to press the wires directly against said substrate.

According to one aspect of the invention, said cover is made of a malleable plastic material that is rigid enough to act as a cover and soft enough to enable a degree of embedding of the wires in the thickness of the cover, which helps to keep said wires in place.

The invention also relates to an electronic module obtained using the aforementioned method and a smart card comprising such an improved and simplified electronic module.

Other features and advantages of the invention are set out in the detailed description and in the attached drawings, in which:

- Figure 1 is a top view of an electronic module for a smart card,
- Figure 2 is a cross-section view of the electronic module in figure 1, showing a drop of resin ground according to the known manufacturing method,
- Figure 3 is a cross-section view of the electronic module in figure 1, before coating of the connection wires,
- Figure 4 is a cross-section view of the electronic module in figure 2, after coating of the connection wires using the method according to the invention,
- Figures 5A, 5B and 5C are respectively magnified cross-section views of three methods for embedding the connection wires in the closing layer of the module,

- Figure 6 is a cross-section view showing application of the method according to the invention to a variant of a module corresponding to a contact module with no antenna.

5 **Detailed description**

Figure 1 is a top view of a microelectronic module 1 for a contactless smart card. This module 1 conventionally has a cavity, at the bottom of which there is a receiving area for a microelectronic chip 2, the coils of an antenna 3, the connection wires 4, 5, 6 between the contacts of the communication interface of the chip and
10 the corresponding contacts of the antenna 3.

The cross-section view in figure 2 is taken along the connection wires 4, 5, 6 in figure 1. Figure 2 also shows the structure of the module, obtained using a conventional manufacturing method, in greater detail. Thus, the chip 2 is glued to a metal layer 8 that also includes the coils of the antenna 3.

15 In the example shown in figures 2 to 4, the module has two metal layers 7, 8, located on either side of an isolating substrate 11, and an adhesive 10. The terminals of the communication interface of the chip 2 (not shown) are connected by the wires 4, 5, 6 to the metal contacts of the module and/or to the terminals of the antenna 3. The connection wire 6 links a metal area of the upper metal layer 7
20 to a connection area of the lower metal layer 8. For this purpose, the wire passes through a hole 14.

This structure 7, 8 with two metal layers is typical of a smart-card module with a dual contact/contactless communication interface.

As shown, the connection wires 4, 5, 6 form loops that project beyond the
25 upper metal layer 7. This additional thickness is absorbed in the prior art by an encapsulation resin 12 that consequently protects the wires 4, 5, 6. As shown in figure 2, the encapsulation resin has a flat surface and is a drop of resin shown in a post-machining state, the module then being ready to be fastened in an appropriate cavity of a finished product such as a smart card, or in an insert for a contactless
30 product such as electronic passports or other official documents.

As shown, the thicknesses indicated on the left-hand side of figure 2 show a total thickness of the module of 280 microns. One of the objectives of the method

according to the invention is, in addition to simplifying the manufacturing steps, to enable a reduction of this thickness without reducing the thickness of the chip or of the other components.

Figure 3 is a cross-section view similar to the view in figure 2. The figure shows a wired module with metal wires 4, 5, 6 that form loops projecting beyond the upper face of the substrate carrying the upper metal layer 7, before any encapsulation of the chip.

At this stage of the manufacturing method, the invention specifies that the chip be protected using a cover 13, instead of a drop of encapsulation resin, said cover being applied directly to the upper face of the module located on the side of the cavity in order to cover the chip, the cavity and the upper metal plate 7. The cover 13 is applied such as to coat the connection wires 4, 5, 6 and to press said wires towards the substrate to bring said wires to the same height as the upper surface of the metal layer 7. Surprisingly, it has been found that the wires can be pressed in this way without breaking the connections thereof to the metal areas and without adversely affecting the reliability of the module.

As shown, the invention brings the thickness of the module down to 180 microns, one third less than in figure 2.

Advantageously, the cover is made of a thermoplastic material such as polyurethane that is rigid enough to act as a cover and soft enough to enable a degree of embedding of the wires 4, 5, 6 in the thickness of the cover 13, which helps to keep said wires in place.

An adhesive can also be applied to the two sides of the module to facilitate attachment thereof to a finished product such as a smart card.

Figures 5A, 5B and 5C show light crushing of the wires and greater or lesser embedding of the wires in the cover 13, the related deformation being shown in an exaggerated manner.

Figure 6 is a cross-section view of a module provided with a cover 13 as above, in which the module is a single-face contact module compatible with standard 7816-1. This module has a single metal layer 8 opposite the face of the substrate that receives the cover 13.

In this case, the cover 13 can press the loops of the wires 4, 5, 6 directly against the substrate 11.

The single metal layer 8 is used in this case to make the contacts of the terminal in the case of a contact card, or the tracks of an antenna. A similar
5 structure can be used for a module with a dual communication interface.

Advantages of the invention

In conclusion, the invention proposes a new and improved manufacturing
10 method for obtaining a module for a smart card that satisfies the objectives set.

This method obviates the need to encapsulate the chip with a resin, and all of the operations required to treat the encapsulation, such as curing the resin and grinding the additional thickness are no longer necessary.

This results in a time saving of approximately two days in manufacturing
15 time, which was previously approximately five days.

The simplicity of the operations required to manufacture the module with the positioning of the cover also results in a reduction in manufacturing costs.

Additionally, this method provides modules that are even thinner, approximately 180 microns (with equal parameters relating to the thickness of the
20 substrate, the chip and the wires), which further expands the usage possibilities for such modules and for the smart cards or documents incorporating such modules.

The new method can be applied to all types of smart card: contact, contactless and dual.

Finally, an appropriate choice of color for the upper layer enables optimal
25 integration in the finished product.

CLAIMS

1 - A manufacturing method for an electronic module for a smart card, said module having a substrate (11) in which at least one face has a metal layer (7, 8),
5 said substrate (11) having a cavity in which is fastened a microelectronic chip (2) with output terminals for connection to an electrical contact terminal or to an antenna of the smart card, said connection being made by metal connection wires (4, 5, 6) forming loops projecting from one face of the substrate, characterized in that it includes a step, following installation of the connection wires (4, 5, 6), that
10 involves covering the face of the module including the cavity with a cover (13) that coats the loops of the projecting wires (4, 5, 6) in order to reduce the height thereof and push same towards said face of the substrate.

2 - The method as claimed in claim 1, in which the electronic module
15 has an upper metal layer (7) and a lower metal layer (8) positioned on either side of the substrate (11), the connection wires (4, 5, 6) forming loops projecting from the upper metal layer (7), characterized in that the cover (13) presses the wires (4, 5, 6) against said upper metal layer (7).

20 3 - The method as claimed in claim 1, in which the electronic module only has a lower metal layer (8), the connection wires (4, 5, 6) forming loops projecting from the substrate (11), characterized in that the cover (13) presses the wires (4, 5, 6) against said substrate (11).

25 4 - The method as claimed in any one of the preceding claims, characterized in that said cover (13) is made of a malleable plastic material that is rigid enough to act as a cover and soft enough to enable a degree of embedding of the wires (4, 5, 6) in the thickness of the cover (13), which helps to keep said wires in place.

5 - The method as claimed in claim 4, characterized in that, said malleable plastic material is polyurethane.

6 - An electronic module, characterized in that it is obtained using the
5 method as claimed in any one of the preceding claims.

7 - A smart card with a dual contact/contactless communication interface, characterized in that it includes an electronic module as claimed in claim 6.