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The invention concerns a card with electronic microcircuits and its method of manufacture. It applies more particularly to the manufacture of a portable card, the thickness of which satisfies the ISO standards (International Standard Organisation) for credit cards.

A card with electronic microcircuits is a rectangular small plate, in a single piece or multi-layered, of plastics material, which incorporates electronic microcircuits and presents contacts externally for the connection of the electronic microcircuits with an apparatus for the processing of cards. These microcircuits may be intended for very varied functions, such as, for example, the banking operations of debit and credit, the allocation of telephone units and confidential entry into a protected area. They generally constitute processing and/or memory circuits of greater or lesser complexity according to the use for which they are intended. In practice, they are formed on at least one small plate of silicon, currently termed an integrated circuit or chip.

The invention applies in particular to a card as described for example in the French patent No.2 337 381 of the applicant (U.S. patents No. 4 216 577 and No. 4 222 516). A printed circuit has one face provided with an integrated circuit and the other face presenting the contacts of the card. According to an example embodiment, the card is simply made from a small plate in a single piece, one face of which presents gradually, from a deep cavity, a peripheral recessed zone and a bearing surrounding the recessed zone. The integrated circuit is housed in the cavity and the printed circuit is laid out on the recessed zone. A sheet covering the printed circuit and thus forming a cover is fixed to the bearing. The sheet has its exterior face substantially coplanar with the corresponding face of the small plate and comprises openings corresponding with the contacts of the printed circuit. The use of the card is

therefore undertaken by connection of the contacts through the openings of the sheet.

According to a variant embodiment described in the prior patent indicated, the small plate does not have a reinforcement bearing and the sheet for covering the printed circuit covers the entire corresponding face of the small plate. The card is thus made of the small plate and the sheet. The contacts remain accessible through openings in the sheet.

Another variant embodiment is described for example in the European patent application No. 0 207 852 of the applicant. The printed circuit is made from a thin strip, the end of one face of which carries the integrated circuit and the other end of the other face of which presents the contacts of the card. Thus, the contacts are staggered relative to the integrated circuit. This arrangement may be preferred for several reasons, in particular that which aims to satisfy the standards of placement of the contacts on the large median of the card. Owing to the printed circuit with staggered contacts, the integrated circuit may remain in a corner of the card where the bending and torsional stresses are distinctly lower than at the level of the contacts. However, the simple and low-cost creation of the printed circuit requires that it be covered by a sheet provided with openings corresponding with the contacts. The sheet may only be a cover or may extend over the entire face of the small plate.

These example embodiments prove that often the manufacture of a card with electronic microcircuits requires the use of a sheet provided with openings for access to the contacts of the card carried by the printed circuit. The thickness of the sheet for gaining access to the contacts presents several disadvantages. On the one hand, numerous applications of the card necessitate the adding of a

finishing film to the sheet. On the other hand, to give the sheet a good mechanical resistance for the protection of the printed circuit, the sheet must have a relatively high minimum thickness. It follows that the contacts are at a relatively great distance from the surface of the card, for example greater than 0.1 millimetre. Taking into account the various ways of manufacture of cards which are able to be used by an apparatus, the connector of this apparatus should adapt itself to a large possible margin of depths whilst ensuring an efficient and reliable connection. Standards have been decreed to limit the maximum depth of the contacts to a relatively low value. The problem is therefore posed of raising the contacts in the openings to satisfy the standards and, if possible, putting the contacts practically at the level of the surface of the card.

A known solution described for example in the international patent application published under the number WO-A-87/00486, to raise the contacts in the openings consists in forming an addition of copper on the areas of the contacts which correspond with the openings. This addition is generally made by electrochemical deposition of copper, which requires the use of a technology which is little used, is long and costly. The document WO-A-87/00486 concerns a card with microcircuits and its method of manufacture according to the pre-characterising parts of claims 1 and 7.

The invention presents a simple and low-cost solution to the problem of raising the contacts in the openings of a card.

A card with microcircuits according to the invention comprises: a printed circuit, one face of which carries an integrated circuit and the other face of which has contacts; a small plate, one face of which has a recessed zone for the placement of the printed circuit and which is covered by said printed circuit, and a cavity to house the integrated circuit; and a sheet covering at least the printed circuit

and giving access to the contacts through at least one opening; characterised in that the recessed zone comprises a boss beneath each of the openings of the sheet, and that each boss has a height such that the contacts are approximately coplanar with the exterior face of the sheet.

A method of manufacture of a card according to the invention, comprising the putting in place of the printed circuit on a face of a small plate of plastics material provided with a cavity to house the integrated circuit, and the covering of the printed circuit by the sheet giving access to contacts of the printed circuit through at least one opening, is characterised in that before covering, it consists in providing the cavity in a uniformly flat area of said face of the small plate; in placing on said face of the small plate the printed circuit; in arranging on the upper face of the printed circuit a matrix formed of a flat sheet having good thermal conductivity, covering at least the printed circuit and provided with at least one opening corresponding to said contacts; in heating the small plate to a moulding temperature; in pressing the matrix until the upper face of the printed circuit is approximately coplanar with said area of the small plate, thus creating in the small plate a recessed zone for the placement of the printed circuit and provided with a boss beneath each opening of the matrix; and in withdrawing the matrix.

The characteristics and advantages of the invention will emerge from the description which follows, given by way of example and made with reference to the attached drawings.

In the drawings:

- figure 1 is a view in partial section along the line I-I indicated in figure 2, illustrating a form of embodiment of a card according to the invention;

- figure 2 is a top view partially cut away of the card represented in part in figure 1;
- figures 3A to 3E are views in section illustrating stages for the manufacture of the card represented in figures 1 and 2;
- figure 4 is a view similar to that of figure 1, illustrating a first variant embodiment of a card according to the invention;
- figure 5 is a view similar to that of figure 1, illustrating a second variant embodiment of a card according to the invention;
- figure 6 is a view similar to that of figure 1, illustrating a third variant embodiment of a card according to the invention.

Figures 1 and 2 illustrate the preferred form of embodiment of a card with electronic microcircuits 10 according to the invention, of the standardised credit card type. The electronic microcircuits are assumed to be included in a single integrated circuit 11 and accessible by six studs 11a. One face of the card 10 of rectangular shape has six contacts 12 for the connection of the integrated circuit 11 to an apparatus, not shown, for the processing of cards. The same face of the card comprises a magnetic data support strip 13. According to the standards selected as an example, the magnetic strip 13 is close to a large side of the card and the contacts 12 are placed in a zone intersecting or adjacent to the large median M of the card, close to a small side.

In a conventional manner, the card 10 includes a printed circuit 14, one face 14a of which carries the integrated circuit 11 and the other face 14b of which presents the

contacts 12. Conductors 15 on the face 14b connect respectively the six contacts 12 to the six studs 11a of the integrated circuit 11 according to the well-known TAB technology (Tape Automated Bonding). Thus, the studs 11a of the integrated circuit 11 are welded to the ends, mounted in overhung arrangement, of the conductors 15 around a window 16 of the insulating substrate 17 of the printed circuit 14. The substrate 17 is usually a plastics material such as that known under the trade mark "Kapton", in the order of 130 micrometres (μm). The contacts 12 and the conductors 15 are ordinarily made from the same metallic layer of copper applied on the substrate 16 of the printed circuit. The contacts 12 are then formed by deposition of a layer of gold on at least one intermediate compatible layer, the whole of these layers being represented by a solid line in figure 1. Assuming that the integrated circuit 11 is of the MOS type (Metal Oxide Semiconductor), one of the conductors 15 is extended by a polarisation tab 18 fixed to the rear face of the integrated circuit, for example by a silver-based conductive adhesive. The printed circuit 14 which is shown is therefore of the type with staggered contacts.

Likewise in a conventional manner, the card 10 is assumed to be formed by a central small plate 19, also termed the core, the two large faces 19a, 19b of which are respectively covered by two sheets 20, 21 and two films 22, 23. The small plate and the two sheets are generally made from a flexible plastics material such as PVC (polyvinyl chloride). The sheets are of equal thickness and are thin with respect to the small plate, for example according to the ratio $130\ \mu\text{m}/500\ \mu\text{m}$. In numerous uses, the sheets are printed so as to read thereon all the desired information such as the name and address of the owner of the card, the name of the service company, ... A solid line illustrates the printing made on the outer faces of the two sheets 20, 21 of figure 1. The two films 22, 23 are generally required for the protection of the printing and for the outer appearance of

the card. These films are ordinarily made from a transparent crystal of PVC, making the card glossy, and have a thickness in the order of $25\text{ }\mu\text{m}$. Ordinarily, the two sheets are covered with their respective films, then are applied and fixed to the small plate by thermocompression. Consequently, the term sheet generally extends to the sheet covered with its film and must thus be understood in the general sense of the word as indicated in the claims, in particular.

Still in the conventional manner, the printed circuit 14 is inserted between the small plate 19 and the sheet 20. The face 19a of the small plate 19 has a zone 24 covered by the face 14a of the printed circuit 14, and a cavity 25 to house the integrated circuit 11. In the example illustrated, the cavity 25 is a hole passing through the small plate 19. The sheet 20 covers the printed circuit 14 and comprises openings 26 corresponding with the contacts 12. In the example illustrated, only two openings 26 are arranged to each give access to a group of three contacts 12. In the prior art, the printed circuit 14 rested on the zone 24 made uniformly flat. Thus, the contacts 12 were placed approximately at the level of the face 19a of the small plate 19. Under these conditions, the contacts were only accessible through the entire thickness of the sheet 20 and of the film 22, forming a total of $155\text{ }\mu\text{m}$ approximately. As such a depth is not admissible, the problem was to raise the contacts 12 in the openings 26 to bring them close to the outer surface 22a of the card and, if possible, to place them at this level.

According to the invention, the zone 24 comprises a boss 27 under each of the two openings 26. The height of the boss will preferably have the thickness of the sheet 20 and possibly of the film 22 to put the contacts 12 at the level of the face 22a of the card 10.

The boss 27 represented is common to the three contacts 12

included in each opening 26. Naturally, a single boss would be sufficient if all the contacts 12 were included in the same opening 26.

It is clear that this boss 27 may be formed on the small plate 19 prior to the mounting of the printed circuit 14. For example, the small plate 19 may be moulded to obtain a zone 24 provided with two bosses 27. The hole 25 could be made during or after moulding. The printed circuit would then be put in place, then the sheets 20 and 21 provided with their respective films 22, 23 would be placed and pressed so as to be fixed to the small plate 19. The pressure would thus be such that the bosses 27 would raise the contacts 12 in the openings 26.

Figures 3A to 3E illustrate another method of manufacture of the card 10 represented in figures 1 and 2.

Figures 3A to 3E illustrate respectively intermediate phases of the method. At the initial stage of figure 3A, one only has the small plate 19 pierced with the hole 25 and provided with two faces 19a, 19b which are uniformly flat and parallel. In figure 3B, there has been placed on the face 19a of the small plate 19 the printed circuit 14 provided with the integrated circuit 11 housed in the cavity 25. In figure 3C, a matrix 28 has been placed on the printed circuit 14 and the whole of the small plate 19, the printed circuit 14 and the matrix 28 has been gripped in the jaws 29 of a heating press 30. The matrix 28 is a uniformly flat metallic sheet pierced with openings 31 corresponding to the openings 26 of the sheet 20 represented in figure 1. The matrix 28 which is illustrated has a larger surface than that of the printed circuit 14. The metal of the matrix 28 is a good thermal conductor. Consequently, the heat released by the jaws 29 of the press 30 will soften the material of the small plate 19 at the level of the printed circuit 14 and the force of pressing exerted by the jaws 29 will drive

the printed circuit 14 in the small plate 19. This operation lasts until the matrix 28 comes into contact with the face 19a of the small plate 19. By way of example, the operation of pressing for a small plate of ordinary PVC is carried out between 120° C and 140° C established in ten minutes and held for 10 minutes under a pressure of 60 bars. After having removed the press, one thus obtains the configuration represented in figure 3D. In this figure, it can be seen that the pressing has been carried out so as to place the upper face 14b of the printed circuit 14 approximately at the level of the face 19a of the small plate 19. The pressing has thus created the recessed zone 24 in the face 19a of the small plate. At the same time, the openings 31 of the matrix 28 have allowed the formation of the bosses 27. It is clear to the specialist in the art that the height of the bosses 27 obtained by this method depends on the thickness of the printed circuit, the thickness of the matrix 28 and the softening temperature of the PVC. At the stage of figure 3E, the matrix 28 has been withdrawn and the cavity 25 has been filled with an enclosing substance 32. It then suffices to place and fix the sheets 20 and 21 provided with their respective films 22, 23 to obtain the card illustrated in figures 1 and 2.

This method offers several variant embodiments. For example, to avoid heating the integrated circuit 11, it would suffice at the stage of figure 3B to simply place the printed circuit 14, without the integrated circuit 11, and to weld the latter at the stage of figure 3E, before enclosing. On the other hand, in figure 3A, one could start from the small plate 19 provided with the sheet 21 and possibly with its film 23 or, in a similar manner, from a small plate in a single piece with two parallel faces, one of which would be provided only with the cavity 25. Furthermore, the matrix 28 could be a flat sheet having good thermal conductivity, only covering the printed circuit 14. In this case, a device would have to be used to check and stop the depth of

depression of the printed circuit in the small plate 19. The advantage of having a sheet 28 projecting from the printed circuit, as illustrated, is to use the sheet as an abutment means against the face 19a of the small plate.

Figures 4 and 5 illustrate two variant embodiments of a card 10 according to the invention, which is able to be manufactured in accordance with the method which has just been described and with its variants. The elements of figure 1 which remain unchanged in the variants of figures 4 and 5 are designated by the same reference numbers. Figures 4 and 5 correspond to two variant embodiments of the printed circuit with staggered contacts 12. In figures 4 and 5, the printed circuit is designed for connection by wires, currently termed "wire bonding".

In figure 4, the printed circuit 114 only differs from the circuit 14 at the level of the integrated circuit 11. The tab 18 closes the opening 16 at the level of the face 114a. The integrated circuit 11 has its rear face adhered to the tab 18 and the studs 11a are connected to the corresponding conductors 15 by wires 33 passing through the substrate 17 in holes 34.

In figure 5, the printed circuit 11 is no longer connected through a window 16 as in figures 1 and 4, so that the conductors 15 and the contacts 12 are arranged on the face 214a of the printed circuit 214. Consequently, the contacts can only be accessible from the face 214b through a window 35 arranged in the substrate 17. Each boss 27 must therefore compensate for the thickness of the substrate 17 and of the sheet 20. Advantageously, the sheet 20 and/or the substrate 17 will be made thinner so as to not exert strong stresses in the conductors 15 or in the contacts 14, at the level of the angle formed by each boss 27.

Figure 6 illustrates another variant embodiment of a card 10

according to the invention. According to this variant, the printed circuit 314 is no longer a printed circuit with staggered contacts such as those previously described. It is a printed circuit as described in the above-mentioned French patent No.2 337 381. According to the example illustrated, the two rows of contacts 12 are placed on two opposite sides of the opening 16 arranged in the substrate 17 of the printed circuit 314. The conductors 15 are placed in overhung arrangement around the opening 16 and are welded to the studs 11a of the integrated circuit 11 according to the TAB technology. The card 10 is formed by a small plate 319 in a single piece, the face 319a of which presents in a coaxial manner the cavity 25, the zone 24 and a bearing 36. The printed circuit 314 rests on the zone 24 and the integrated circuit 11 is housed in the cavity 25. The sheet 20 of figures 1 to 5 is limited here to a cover 320 fixed to the bearing 36 and coplanar with the face 319a of the small plate 319. The cover 320 presents the two openings 26 to give access to the two rows of contacts 12. According to the invention, the zone 24 presents a boss 27 beneath each opening 26, in a manner similar to that of the preceding figures. Of course, the bearing 36 could be eliminated, and the sheet 20 could extend over the entire face 319a of the small plate 319.

The method of manufacture described with reference to figures 1 and 3A to 3E could likewise be applied according to the second variant mentioned. In fact, the whole of the small plate 19 and the sheets 20 and 21 of the card represented in figure 1 would constitute, in figure 3A, the bare small plate 319 of figure 6. In the case of the card 10 illustrated in figure 6, formed solely of the small plate 319 in a single piece, provided with the bearing 36 and the cover 20, it is clear that the initial state corresponding to figure 3A would be the small plate 319 in a single piece provided with its cavity 25 surrounded by a reinforcement area 37 having the depth of the bearing 36 and having the

surface of this bearing added to that of the face 314b of the printed circuit 314. The zone 24 and its bosses 27 would be formed on pressing of the printed circuit until the upper face 314b of the printed circuit 314 is approximately coplanar with the bearing 36. The area 37 mentioned above would obviously have the surface of the face 319a if the sheet 20 extended over this face.



Claims

1. A card with electronic microcircuits (10) comprising: a printed circuit (14, 114, 214, 314), one face (14a, 114a, 214a, 314a) of which carries an integrated circuit (11) and the other face (14b, 114b, 214b, 314b) of which has contacts (12); a small plate (19, 319), one face (19a, 319a) of which has a recessed zone (24) for the placement of the printed circuit (14) and which is covered by said printed circuit (14, 114, 214, 314), and a cavity (25) to house the integrated circuit (11); and a sheet (20) covering at least the printed circuit (14, 114, 214, 314) and giving access to the contacts (12) through at least one opening (26); characterised in that the recessed zone (24) comprises a boss (27) beneath each of the openings (26) of the sheet (20), and that each boss (27) has a height such that the contacts (12) are approximately coplanar with the exterior face (22a) of the sheet (20).

2. A card according to Claim 1, characterised in that the sheet (20) extends over the whole of said face (19a) of the small plate (19).

3. A card according to Claim 1, characterised in that the sheet is a cover (320) fixed to a bearing (36) surrounding the recessed zone (24) and mounted so as to be substantially coplanar with said face (319a) of the small plate (319).

4. A card according to one of Claims 1 to 3, characterised in that the printed circuit (14, 114, 314) is formed of a substrate (17) covering the recessed zone (24) of the small plate (19, 319) and carrying conductors (15) connecting the contacts (12) to the integrated circuit (11) placed in a window (16) of the substrate (17).

5. A card according to one of Claims 1 to 3, characterised in that the printed circuit (214) is formed originally of a



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substrate (17) covering the recessed zone (24) of the small plate (19) and the contacts (12) of which are accessible through a window (35) of the substrate (17).

6. A method for the manufacture of a card according to one of Claims 1 to 5, characterised in that the boss (27) is formed prior to the mounting of the printed circuit (14, 114, 214, 314) on the small plate (19, 319).

7. A method for the manufacture of a card defined by one of Claims 1 to 5, comprising the putting in place of the printed circuit (14) on a face (19a) of the small plate (19) of plastics material provided with a cavity (25) to house the integrated circuit (11), and the covering of the printed circuit (14) by the sheet (20) giving access to contacts (12) of the printed circuit (14) through at least one opening (26), characterised in that before covering, it consists in providing the cavity (25) in a uniformly flat area (37) of said face (19a) of the small plate (19); in placing on said face (19a) of the small plate (19) the printed circuit (14); in arranging on the upper face (14 ϕ) of the printed circuit (14) a matrix (28) formed of a flat sheet having good thermal conductivity, covering at least the printed circuit (14) and provided with at least one opening corresponding to said contacts (12); in heating the small plate (19) to a moulding temperature; in pressing the matrix (28) until the upper face (14b) of the printed circuit (14) is approximately coplanar with said area (37) of the small plate (19), thus creating in the small plate (19) a recessed zone (24) for the placement of the printed circuit (14) and provided with a boss (27) beneath each opening of the matrix (28); and in withdrawing the matrix (28).

8. A method according to Claim 7, characterised in that the area (37) has the surface of the face (19a) of the small plate (19).



9. A method according to Claim 7, characterised in that the sheet forms a cover (320) fixed to a bearing (36) surrounding the recessed zone (24) in the face (319a) of the small plate (319) and in that the area (37) has the depth of the bearing (36).

10. A method according to one of Claims 7 to 9, characterised in that the printed circuit (14) is equipped with the integrated circuit (11) before the printed circuit is placed on the small plate (19).

11. A method according to one of Claims 7 to 10, characterised in that the cavity (25) is a hole passing through the small plate (19).

12. A method according to Claim 11, characterised in that after the formation of the boss (27) it consists in connecting in the hole (25) of the small plate (19) the integrated circuit (11) to the printed circuit (14).

13. A method according to Claim 11 or 12, characterised in that it consists in filling the hole (25) with an enclosing substance (32).

14. A method according to Claim 11, 12 or 13, characterised in that it consists in covering the other face (19b) of the small plate (19) with a second sheet (21).