

GEM 350

METHOD FOR MAKING SMART CARD OR SIMILAR ELECTRONIC
DEVICE

5 The present invention concerns the making of
electronic units including at least one microcircuit
which is embedded in a carrier medium and linked to
interface elements consisting of a terminal block
and/or an antenna, such as integrated circuit cards
with or without contacts, also known as smart cards.

10 The invention also applies, in particular, to
electronic labels which are used to identify products
and which can be compared with smart cards without
contacts.

15 The present invention concerns more particularly
the making of connections between the microcircuit and
the interface elements, such as a terminal block and/or
antenna.

20 There are contact smart cards with interface
terminal blocks, smart cards without contacts with an
antenna housed in the carrier medium and hybrid cards
or combicards which have an interface terminal block
and an antenna.

There are numerous methods for making smart cards with contacts. Most of these methods are based on assembly of the chip in a sub-set called a micromodule which is assembled using traditional methods.

5 One method, illustrated in figure 1, involves first attaching the chip or microcircuit 20 ("die attach") which involves gluing a chip 20, cut from a board by sawing, arranging it with its active side with its exit hubs 22 upwards and by sticking the opposite
10 side on a dielectric support plate 28, using a glue which could be conducting, the gluing being done on a printed circuit or film.

 Then microcabling or soldering of connections is done ("wire bonding"), involving soldering the
15 connection of the exit hubs 22 of the chip 20 with the terminal block of contacts 24 of the printed circuit plate.

 Then the case is coated ("potting"), involving protecting the chip 20 and the soldered connection
20 wires 26 using a resin 30 which could be silicone or polyurethane based, for example.

 In a variation of this method illustrated in figure 2, a peripheral metallic ring 32 is used to rigidify the micromodule around the resin 30.

25 In another variation of this method ("flip chip"), a chip with bumps or protuberances placed with the active side downward is used, the electrical connection being provided either by metallic or polymer bumps or by an anisotropic adhesive.

30 In other variations, tape automated bonding (TAB) is used, as illustrated in figure 3, according to which the chip 34 is glued using an anisotropic glue 36 and the various contacts of the film 38 are soldered by thermocompression on the chip 34 which has bumps 39.

There are also methods for making smart cards with contacts without using micromodules. One method is based on using screen printing to form contacts and to provide chip interconnections.

5 Another method involves metallisation in three dimensions of the body of the card, followed by transfer of the chip using classic technology (gluing plus microcabling) or by the "flip chip" technique described above.

10 In the methods which use a micromodules, the associated costs are limited by the price of the film. In addition, it is often necessary, after the encapsulation operation, to mill the resin to reduce the thickness of the unit. This operation is difficult
15 because the resin is polymerised and thus very rigid. The milling is the main cause of production rejects.

 In the first method without micromodules described above, this latter is on the surface and thus subject to exterior stresses, greatly increasing the associated
20 cost. For the second method without micromodules the number of steps is high which also increases the cost.

 This technology would therefore not be suitable for making large chip cards.

 There are two large families of methods for making
25 smart cards without contacts. The first uses an antenna made by winding which is either soldered on a micromodule containing the chip, or directly on a chip with bumps. Such a technique can only be used for chips with simple operation.

30 The second family uses a "flat" antenna which can be in the form of a rectangular peripheral spiral or any other appropriate form. Such an antenna can be made by photogravure, mechanical cutting, stamp printing, screen printing, or offset printing with a conducting

ink. The chip is then transferred to the antenna using the "flip-chip" technique or a classic technique.

5 In these methods for making smart cards without contacts, micromodule manufacturing is used which, as mentioned above, involves numerous steps for assembling the chip and implies substantial costs, or the "flip-chip" technique for which the pace is limited and the installation costs particularly high.

10 The methods for hybrid smart cards combine the disadvantages previously mentioned for smart cards both with and without contacts.

15 The basic purpose of the invention is to provide a method for making connections between a microcircuit and the interface elements in an electronic unit (such as a smart card) including at least one microcircuit which is embedded in a carrier medium and which includes exit hubs linked to interface elements including a terminal block and/or an antenna which do not have the above mentioned disadvantages and which
20 make it possible in particular to reduce the cost and percentage of production rejects without making micromodules.

The method according to the invention is remarkable in that it involves depositing, using a
25 syringe or similar device, of a drop of a low-viscosity conducting substance between each exit hub and the corresponding interface element, the said conducting substance acting by polymerisation, including conducting charges and remaining flexible after
30 polymerisation.

This method makes it possible to eliminate the making of micromodules and to reduce the number of production steps.

In addition, flexible connections are obtained whereas the connections of the known type are rigid or semi-rigid and this sharply reduces the rate of production rejects.

5 Advantageously, the terminal block is also made by depositing a low-viscosity conducting substance.

This makes it possible to further simplify the method with the making of the terminal block and its connections done in a single operation.

10 Advantageously, the antenna is also made by depositing a low-viscosity conducting substance.

This makes it possible to simplify the production and to improve the antenna performance.

15 The substance should preferably be a polymer resin charged with conducting or intrinsically conducting particles.

20 Other characteristics and advantages of the invention will appear with the reading of the detailed description which follows. These will be more clearly understood by consulting the appended drawings in which:

- figure 1 is a cross-section diagram which illustrates a known method for making smart cards with contacts;
- 25 - figure 2 illustrates a variation of the method shown in figure 1;
- figure 3 illustrates another variation of the method shown in figure 1;
- figure 4 illustrates a system for the method
- 30 based on the invention applied to the making of smart cards with contacts;
- figure 5 illustrates a variation of the method shown in figure 4;

- figure 6 illustrates a system applied to the making of smart cards without contacts;

- figures 7 to 10 illustrate a variation of the method shown in figure 6;

5 - figure 11 illustrates a system applied to the making of hybrid smart cards; and

- figures 12 and 13 illustrate a system applied to the making of electronic labels.

10 Figure 4 shows a smart card with contacts made according to a method according to the invention.

Initially, a card body 40 is made which includes a cavity 42 which can be made by moulding by injection or by colamination of thermoplastic sheets followed by machining of the cavity.

15 In a second step, the chip 44 is placed in the cavity with its active side, and particularly its exit hubs 46 and 48, facing upwards, and it is attached by gluing, for example. Local heating of the cavity can also be done followed by placing the chip in the molten thermoplastic material. The active side of the chip
20 does not have to be on the same level as the bottom of the cavity.

In a third step, the contact terminal block and the connections with the exit hubs 46 and 48 are made
25 by depositing a low-viscosity conducting substance, for example a polymer resin charged with conducting or intrinsically conducting particles, by a technique called "dispensing" by which a liquid or low-viscosity substance is applied using a syringe or similar device
30 with controlled outflow and opening.

This depositing operation, hereafter referred to as dispensing, is done for example using a commercially-available unit called CAM/ALOT made by the American company Camelot Systems Inc. and used for on-

line production of electronic circuits. The movement and opening of the syringe is controlled by a computer program.

5 The conducting resin is thus deposited, making the
contacts 50 and 52 of the interface terminal block of
the smart card and connections 54 and 56 between the
contacts 50 and 52 and the exit hubs 46 and 48 of the
chip. The thickness of these deposits can be much
greater than by a screen printing method, allowing for
10 larger sections and thus low contact resistance.

Advantageously, the exit hubs 46 and 48 include non-oxidisable metal such as nickel, titanium or tungsten.

15 These hubs can also have bumps in order to improve
the electrical contact.

To correct chip positioning errors, regulation using an image of the chip provided by a computer visualising system will be used.

20 Resins with an activation temperature which is
below the temperature of softening of the thermoplastic material of the card body should preferably be used.

Figure 5 illustrates a variation of the previously mentioned method in which a two-level cavity is made, i.e. a cavity 58 with a recess 60 at its bottom. The
25 dimensions of this recess are sufficient for it to receive the chip 44 and its depth is essentially the same as the thickness of the chip so that its active side is at the bottom level 52 of the cavity 58. This arrangement avoids a second change of slope of the
30 resin cords in the cavity, which facilitates contact of the conducting resin with the exit hubs 46 and 48.

In the fourth and final step, an encapsulating (potting) is done which involves protecting the chip by

using a resin, for example a silicone or polyurethane based resin.

Figure 6 shows a smart card without contact made according to the invention method. It includes a "flat" antenna made of a track in, for example, the form of a rectangular spiral arranged on the periphery of the card as shown in figure 9.

In a first step, a chip 64 is glued with its active side facing up at the place chosen for the connection using classic "die attach" method and equipment and using a glue 66 which allows for gluing on a printed circuit or film. A glue is chosen which is compatible with the maximum use temperature of the antenna support, for example an adhesive which reticulates when exposed to ultraviolet rays. The pace of this gluing operation may be very high, for example five to six thousand pieces per hour with a single head. It is important that the fillet of glue be perfectly controlled in the perimeter of the chip located facing the antenna connection areas 68 and 70.

In a second step, the electrical connections 72 and 74 are made with a conducting resin between the exit hubs 76 and 78 of the chip 80 and the connection areas 68 and 70 of the antenna.

This second step can also be done at the same fast pace as the chip gluing step. These two steps can be done with the same equipment.

According to one variation, the flat antenna is made with a "dispensing" technique and the gluing of the chip is done by the "flip chip" technique described above.

According to another variation illustrated in figures 7 to 10, the chip is first glued and then the

antenna is made using a "dispensing" technique on the active side of the chip.

5 In the first step (figure 7), an insulating adhesive 82 (epoxy type for example) is dispensed onto a support 84 (vinyl polychloride or polyethylene for example) at the place where the chip with the contact bumps will then be attached.

Adhesives for the "die attach" technique adapted to the support can thus be used.

10 In a second step (figure 8), a chip 86 is set with its active side facing upwards on the adhesive 82 for a "die attach" type gluing. The contact bumps improve the electrical contact between the exit hubs 88 and 90 of the chip and the antenna. The non-operational exit hubs
15 may be insulated by applying a dielectric varnish.

In a third step (figure 9), the antenna 92 is applied by the technique of dispensing a conducting substance, for example an ink or glue, with movement of the syringe using, for example, the CAM/ALOT equipment
20 mentioned above.

Figure 10 shows that the extremities 94 and 96 of the rectangular spiral which makes up the antenna 92 cover the contact hubs 88 and 90 of the chip 86, respectively.

25 In the fourth and final step, colamination is done to finish the card.

Figure 11 shows a hybrid smart card made by a method based on the invention. In this case, the two previously described methods are combined.

30 In a first step, the card 98 body is made including an incorporated antenna 99 including two contact hubs 101 and 103. In a second step, a cavity 100 is made in the body of the card. In a third step, the chip 102 is attached with its active side and its

exit hubs 104, which preferably include non-oxidisable metal plating, in the cavity, by gluing for example.

5 In a fourth step, the contact terminal block 106 and its connections 108 with the exit hubs 104 of the chip and its connections 105 of the contact hubs 101 and 103 of the antenna with the exit hubs 104 are made by depositing a conducting resin 105 by a dispensing technique. The hubs 104 can include contact bumps.

10 The angular positioning errors of the chip 102 can be corrected as described above by using computer visualising equipment.

In the fifth and final step, the encapsulation of the chip is done.

15 The invention applies to the production of all electronic devices which have at least one microcircuit which is embedded in a carrier medium and which includes exit hubs linked to interface elements including a terminal block and/or an antenna. In particular, the invention allows for manufacturing of
20 electronic labels as shown in figures 12 and 13.

A support 110 includes a cavity 112 at the bottom of which an antenna 114 is installed. A microcircuit 116 is then attached here with its exit hubs 118 facing upwards. A conducting resin 120 is applied by a
25 dispensing technique to make the connections between the antenna 114 and the exit hubs 116 of the chip. Encapsulation is then done using an insulating resin 122.

30 The invention makes it possible to eliminate the making of a micromodule and particularly the milling operation. The rate of production rejects is thus greatly reduced.

The number of steps is reduced, greatly simplifying the production and substantially reducing

the cost price. These factors are further enhanced by the fact that some of the chip gluing and connection making operations can be done with the same equipment.

5 The invention does not use costly equipment, thereby reducing production costs.

The making of the antenna by the dispensing technique yields a maximum area, thereby improving antenna performance with respect to the classic incorporated wound antennae.

10 The invention allows for making complex and large cards in a simple and economical way.

The making of connections using the technique of "dispensing" a substance which remains flexible after its activation reduces rigidity and considerably
15 increases the smart cards' resistance to bending-torsion. Smart cards made according to the invention method have much higher resistance to stress than that required by the current standards.

20 As indicated above, the invention allows for very high production rates, on the order of 4000 smart cards per hour for example, with a very low reject rate.



CLAIMS

1. A method for making an electronic device such as a smart card including at least one microcircuit (20; 44; 80; 86; 102) which is embedded in a carrier medium (24; 40; 84; 98) and which includes exit hubs (22; 36; 46, 48; 76, 78; 88, 90; 104) linked to interface elements composed of a terminal block (28; 50, 52; 106) and/or an antenna (70; 92; 99; 103), characterised in that the connections (54, 56; 72, 74; 105; 108) between the exit hubs (46, 48; 76, 78; 88, 90; 104) and the interface elements are made by depositing, using a syringe or similar device, a low-viscosity conducting substance which remains flexible after its application.

2. A method according to claim 1, characterised in that the terminal block (106) is also made by depositing a low-viscosity conducting substance.

3. A method according to claim 1, characterised in that an antenna (92) is also made by depositing a low-viscosity conducting substance.

4. A method according to any of claims 1 to 3, characterised in that the substance is a polymer resin charged with conducting particles.

5. A method according to any of claims 1 to 3, characterised in that the substance is a polymer resin charged with intrinsically conducting particles.

6. A method according to any of claims 1 to 5, characterised in that the depositing of the low-viscosity conducting substance is done with relative displacement of a electronic device and a syringe.

7. A method according to claim 6, characterised in that the movement is controlled by a computer program.



8. A method according to claim 7, characterised in that the correction of the position is done by imaging using a computer visualisation system.

5 9. A method according to claim 4, characterised in that the activation temperature of the substance is lower than the softening temperature of the thermoplastic material of the card body.

10 10. A method according to any of claims 1 to 9, characterised in that the exit hubs have non-oxidisable metallisation.

11. A method according to claim 2, characterised in that the unit is a smart card with contacts, in that the card body (40) includes a cavity (42), in that a microcircuit (44) is attached with its active side
15 facing up in the cavity (42), in that the terminal block (50, 52) and the connections (54, 55) are made by depositing a conducting substance and in that the microcircuit is encapsulated.

20 12. A method for making a smart card with contacts according to claim 11, characterised in that the microcircuit has contact bumps.

25 13. A method for making a smart card with contacts according to claim 11, characterised in that the cavity (58) has a recess (60) at its bottom (62) to receive the microcircuit (44).

30 14. A method according to claim 1, characterised in that the unit is a smart card without contact or an electronic label, in that a flat antenna is made, in that the microcircuit (64) is attached to the card with its active side facing upward, and in that the connections (72, 74) between the exit hubs (76, 78) of the microcircuit and the hubs (68, 70) of the antenna are made by depositing a low-viscosity conducting substance.



15. A method according to claim 3, characterised
in that the unit is a smart card without contact or an
electronic label, in that a flat antenna (92) is made
by depositing a low-viscosity conducting substance, in
5 that there are contact bumps on the microcircuit and in
that the microcircuit is attached with its active side
facing downward.

16. A method according to claim 3, characterised
in that the unit is a smart card without contact or an
10 electronic label, in that an insulating adhesive (82)
is deposited on a support (84) using a syringe or
similar device, in that the microcircuit (86) is
attached with its active side facing upwards, in that a
flat antenna (92) is applied directly onto the
15 microcircuit (86) by depositing a low-viscosity
conducting substance and in that a final colamination
operation is done.

17. A method according to claim 2, characterised
in that the unit is a hybrid smart card, in that the
20 card body (98) includes an incorporated antenna (99),
in that a cavity (100) is made in the body of the card
(98), in that the microcircuit (102) is attached with
its active side facing upwards in the cavity, in that
the terminal block (106) and its connections (108) are
25 made by depositing a low-viscosity conducting substance
and in that encapsulation is done.

18. A method for making a hybrid smart card
according to claim 17, characterised in that the
microcircuit includes contact bumps.

30 19. A method for making a hybrid smart card
according to claim 17, characterised in that the
depositing of a low-viscosity conducting substance is
done with correction of microcircuit angular



positioning errors using a computer visualisation system.