

shows multiple IC modules, having contact pad layouts according to ISO 7816, being assembled on a flexible substrate);

2(b) laminating a few substrate layers, which comprise two substrates of equal thickness, to produce a laminated carrier core;

5 2(c) milling the laminated carrier core to provide a plurality of first cavities wherein each first cavity is to receive an IC module;

2(d) disposing an IC module into each first cavity such that a hot-melt tape on the underside of the IC module is applied to the laminated carrier core;

10 2(e) applying heat and pressure to the IC module to embed the IC module in the laminated carrier core.

Figure 1B shows a cross-sectional view of a smart card device 100 having a wire-bonded encapsulated IC module 110 embedded in a laminated arrangement. In the IC module 110, the IC chip 150 is provided with encapsulation 152 and
15 located directly underside of the contact pad 160.

EP 2750082 A1 discloses a card and card manufacturing method that enable clear visual recognition of a display in a display portion even if the card surface has been provided with a matte finish.

20 **Summary**

According to a first aspect of the invention, a method for fabricating a smart card device is provided. The method comprises:

providing a carrier core in which a flexible film having a plurality of conductor patterns is interposed between a first substrate and a second
25 substrate, characterised in that each of the conductor patterns includes:

at least one flip chip,

at least one contact pad arranged at an offset relative to the at least one flip chip,

at least one conductor path electrically coupling the at least one
30 contact pad to the at least one flip chip, wherein the at least one conductor path and the at least one contact pad are formed on the flexible film,

wherein the step of providing a carrier core in which a flexible film having a plurality of conductor patterns is interposed between a first substrate and a second substrate further includes: exposing the at least one contact pad through at least one cavity in the second substrate; and

5 laminating the carrier core to produce a laminated carrier core in which the at least one contact pad is projected through the at least one cavity in the second substrate to form a continuous even plane from an outer surface of the laminated carrier core to the at least one contact pad such that a region between the contact pad and the outer surface of the
10 laminated carrier core is devoid of gap.

In one embodiment of the first aspect of the invention, the step of providing a carrier core in which a flexible film having a plurality of conductor patterns is interposed between a first substrate and a second substrate further includes:

15 overlaying the flexible film on the first substrate to produce a temporary core;
 laminating the temporary core to produce a laminated temporary core; and
 overlaying a second substrate on the laminated temporary core to
20 produce the carrier core.

In one embodiment of the first aspect of the invention, the step of providing a carrier core in which a flexible film having a plurality of conductor patterns is interposed between a first substrate and a second substrate further includes:

25 abutting the at least one flip chip to the first substrate, wherein the at least one flip chip and the at least one contact pad are arranged on opposite sides of the flexible film,

and the step of laminating the carrier core to produce a laminated carrier core further includes:

30 embedding the at least one flip chip into the first substrate.

In one embodiment of the first aspect of the invention, the first substrate is devoid of cavity.

In one embodiment of the first aspect of the invention, the first substrate is provided with at least one cavity having at least one dimensional measurement no greater than at least one dimensional measurement of the at least one flip chip, and wherein the at least one cavity of the first substrate is dimensioned to at least partially receive the at least one flip chip therein. The at least one dimensional measurement is selected from the group consisting of height, length and width.

In one embodiment of the first aspect of the invention, the step of providing a carrier core in which a flexible film having a plurality of conductor patterns is interposed between a first substrate and a second substrate further includes:

abutting the at least one flip chip to the second substrate, wherein the at least one flip chip and the at least one contact pad are arranged on same side of the flexible film,

and the step of laminating the carrier core to produce a laminated core further includes:

embedding the at least one flip chip into the second substrate.

In one embodiment of the first aspect of the invention, the step of laminating the carrier core to produce a laminated core further includes:

subjecting the carrier core to a hot cycle, wherein subjecting the carrier core to a hot cycle includes subjecting the carrier core to high temperature of at least 80°C and applying pressure of at least 20×10^5 pascal (Pa) to the carrier core; and

subjecting the carrier core to a cold cycle, wherein subjecting the carrier core to a cold cycle includes subjecting the core to low temperature of no more than 30°C and applying pressure of at least 20×10^5 pascal (Pa) to the carrier core.

In one embodiment of the first aspect of the invention, the method further comprises: cutting the laminated carrier core into a plurality of individual sections.

In one embodiment of the first aspect of the invention, the step of cutting the laminated carrier core into a plurality of individual sections further includes:

5 cutting each of the individual sections as ID-1 size according to ISO 7810, wherein each of the individual sections includes at most one of the at least one conductor pattern.

In one embodiment of the first aspect of the invention, the at least one contact pad is dimensioned according to ISO 7816.

10 In one embodiment of the first aspect of the invention, an embossing area is designated on each of the individual section according to ISO 7811.

In one embodiment of the first aspect of the invention, a thickness of the first substrate is greater than a thickness of the second substrate.

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In one embodiment of the first aspect of the invention, each of the conductor patterns further includes at least one antenna coil formed on the flexible film, and wherein the at least one antenna coil is electrically coupled to the at least one flip chip.

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According to a second aspect of the invention, a smart card device is provided. The smart card device comprises:

a laminated carrier core comprising:

a first substrate;

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a second substrate; and

a flexible film having a conductor pattern and interposed between the first and the second substrate, characterised in that the conductor pattern includes:

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at least one flip chip embedded into the first or the second substrate,

a contact pad arranged offset relative to the at least one flip chip,

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at least one conductor path electrically coupling the contact pad to the at least one flip chip, wherein the at least one conductor path and the contact pad are formed on the flexible film and wherein

the contact pad is projected through a cavity in the second substrate to form a continuous even plane from an outer surface of the laminated carrier core to the contact pad such that a region between the contact pad and the outer surface of the laminated carrier core is devoid of gap.

In one embodiment of the second aspect of the invention, the laminated carrier core is dimensioned as ID-1 size according to ISO 7810.

In one embodiment of the second aspect of the invention, the contact pad is dimensioned according to ISO 7816.

In one embodiment of the second aspect of the invention, the outer surface of the laminated core includes an embossing area which is designated on the laminated carrier core according to ISO 7811.

In one embodiment of the second aspect of the invention, the embossing area is configured to be embossed with information being at least one selected from the group consisting of identification number, name and address.

In one embodiment of the second aspect of the invention, the at least one flip chip and the contact pad are arranged on opposite sides of the flexible film.

In one embodiment of the second aspect of the invention, the at least one flip chip and the contact pad are arranged on same side of the flexible film.

In one embodiment of the second aspect of the invention, the conductor pattern further includes at least one antenna coil electrically coupled to the at least one flip chip, wherein the at least one antenna coil is formed on the flexible film.

In one embodiment of the second aspect of the invention, the first or the second substrate provides an encapsulation to the at least one flip chip, the encapsulation having an area and a volume which are greater than the contact pad.

Brief Description of Drawings

The invention will be described in detail with reference to the accompanying drawings, in which:

Figure 1A shows an assembly of IC modules to be used in an existing
5 method for fabrication of smart card device;

Figure 1B shows a cross-sectional view of a prior art smart card device;

Figures 2A to 2C show a first substrate, a flexible film and a second substrate, respectively, according one embodiment of the invention;

Figure 2D shows overlaying the flexible film of Figure 2B on the first
10 substrate of Figure 2A to produce a temporary core;

Figure 2E shows overlaying of the second substrate of Figure 2C on a laminated temporary core to produce a carrier core;

Figure 2F shows a laminated carrier core prior to cutting into individual sections;

15 Figure 2G shows a cross-sectional view of a smart card device which is obtained from a cut section of the laminated carrier core of Figure 2F;

Figure 2H is a partial close-up view of the flexible film of Figure 2B and shows one conductor pattern in which a contact pad and conductor paths are arranged on a top surface of the film and a flip chip is arranged at a bottom
20 surface of the film;

Figure 2I shows another example of a flexible film having one conductor pattern in which a contact pad and conductor paths are arranged on a top surface of the film while a flip chip module is arranged at a bottom surface of the film;

Claims

1. A method for fabricating a smart card device, the method comprising:

5 providing a carrier core in which a flexible film having a plurality of conductor patterns is interposed between a first substrate and a second substrate, characterised in that each of the conductor patterns includes:

at least one flip chip,

at least one contact pad arranged at an offset relative to the at least one flip chip,

10 at least one conductor path electrically coupling the at least one contact pad to the at least one flip chip, wherein the at least one conductor path and the at least one contact pad are formed on the flexible film,

wherein the step of providing a carrier core in which a flexible film having a plurality of conductor patterns is interposed between a first substrate and a second substrate further includes: exposing the at least one contact pad through
15 at least one cavity in the second substrate; and

laminating the carrier core to produce a laminated carrier core in which the at least one contact pad is projected through the at least one cavity in the second substrate to form a continuous even plane from an outer surface of the laminated
20 carrier core to the at least one contact pad such that a region between the contact pad and the outer surface of the laminated carrier core is devoid of gap.

2. The method of claim 1, wherein providing a carrier core in which a flexible film having a plurality of conductor patterns is interposed between a first substrate and
25 a second substrate further includes:

overlaying the flexible film on the first substrate to produce a temporary core;

laminating the temporary core to produce a laminated temporary core; and

30 overlaying a second substrate on the laminated temporary core to produce the carrier core.

3. The method of any one of claims 1 to 2, wherein providing a carrier core in which a flexible film having a plurality of conductor patterns is interposed between a first substrate and a second substrate further includes:

abutting the at least one flip chip to the first substrate, wherein the at least
5 one flip chip and the at least one contact pad are arranged on opposite sides of the flexible film,

wherein laminating the carrier core to produce a laminated carrier core further includes:

embedding the at least one flip chip into the first substrate.

10 4. The method of claim 3, wherein the first substrate is devoid of cavity.

5. The method of claim 3, wherein the first substrate is provided with at least one cavity having at least one dimensional measurement no greater than at least one dimensional measurement of the at least one flip chip, and wherein the at least
15 one cavity of the first substrate is dimensioned to at least partially receive the at least one flip chip therein.

6. The method of claim 5, wherein the at least one dimensional measurement is selected from the group consisting of height, length and width.

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7. The method of any one of claims 1 to 2, wherein providing a carrier core in which a flexible film having a plurality of conductor patterns is interposed between a first substrate and a second substrate further includes:

abutting the at least one flip chip to the second substrate, wherein the at
25 least one flip chip and the at least one contact pad are arranged on same side of the flexible film,

wherein laminating the carrier core to produce a laminated carrier core further includes:

embedding the at least one flip chip into the second substrate.

8. The method of any one of claims 1 to 7, wherein laminating the carrier core to produce a laminated carrier core further includes:

5 subjecting the carrier core to a hot cycle, wherein subjecting the carrier core to a hot cycle includes subjecting the carrier core to high temperature of at least 80°C and applying pressure of at least 20×10^5 pascal (Pa) to the carrier core; and

10 subjecting the carrier core to a cold cycle, wherein subjecting the carrier core to a cold cycle includes subjecting the carrier core to low temperature of no more than 30°C and applying pressure of at least 20×10^5 pascal (Pa) to the carrier core.

9. The method of any one of claims 1 to 8 further comprising:

15 cutting the laminated carrier core into a plurality of individual sections.

10. The method of claim 9, wherein cutting the laminated carrier core into a plurality of individual sections further includes:

20 cutting each of the individual sections as ID-1 size according to ISO 7810, wherein each of the individual sections includes at most one of the at least one conductor pattern.

11. The method of claim 10, wherein the at least one contact pad is dimensioned according to ISO 7816.

25 12. The method of claim 11, wherein an embossing area is designated on each of the individual sections according to ISO 7811.

13. The method of any one of claims 1 to 12, wherein a thickness of the first substrate is greater than a thickness of the second substrate.

30 14. The method of any one of claims 1 to 13, wherein each of the conductor patterns further includes at least one antenna coil formed on the flexible film, and

wherein the at least one antenna coil is electrically coupled to the at least one flip chip.

15. A smart card device comprising:

5 a laminated carrier core comprising:

a first substrate;

a second substrate; and

a flexible film having a conductor pattern and interposed between the first and the second substrate, characterised in that the conductor pattern includes:

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at least one flip chip embedded into the first or the second substrate,

a contact pad arranged offset relative to the at least one flip chip,

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at least one conductor path electrically coupling the contact pad to the at least one flip chip, wherein the at least one conductor path and the contact pad are formed on the flexible film and wherein the contact pad is projected through a cavity in the second substrate to form a continuous even plane from an outer surface of the laminated carrier core to the contact pad such that a region between the contact pad and the outer surface of the laminated carrier core is devoid of gap.

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16. The smart card device of claim 15, wherein the laminated carrier core is dimensioned as ID-1 size according to ISO 7810.

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17. The smart card device of claim 16, wherein the contact pad is dimensioned according to ISO 7816.

18. The smart card device of claim 17, wherein the outer surface of the laminated core includes an embossing area which is designated on the laminated carrier core according to ISO 7811.

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19. The smart card device of claim 18, wherein the embossing area is configured to be embossed with information being at least one selected from the group consisting of identification number, name and address.

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20. The smart card device of any one of claims 15 to 19, wherein the at least one flip chip and the contact pad are arranged on opposite sides of the flexible film.

21. The smart card device of any one of claims 15 to 19, wherein the at least one
10 flip chip and the contact pad are arranged on same side of the flexible film.

22. The smart card device of any one of claims 15 to 21, wherein the conductor pattern further includes at least one antenna coil electrically coupled to the at least one flip chip, wherein the at least one antenna coil is formed on the flexible film.

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23. The smart card device of any one of claims 15 to 22, wherein the first or the second substrate provides an encapsulation to the at least one flip chip, the encapsulation having an area and a volume which are greater than the contact pad.