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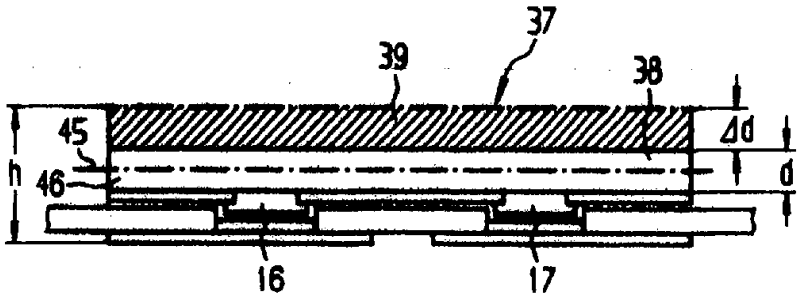

(57) Abstract

Disclosed is a chip module (37) with a substrate (12) and, mounted thereon, at least one chip (38) which (11) is contacted through its connecting surfaces with the connecting leads (14, 15) provided on the substrate (12) and presents, following an electrochemical removal of material from the back (39), a reduced thickness d as compared with its original thickness D.

(57) Zusammenfassung

Chip-Modul (37) mit einem Substrat (12) und mindestens einem auf dem Substrat angeordneten Chip (38), wobei der Chip (11) mit seinen Anschlußflächen auf Anschlußleitern (14, 15) des Substrats (12) kontaktiert ist und durch einen Materialabtrag auf seiner Rückseite (39) eine gegenüber seiner ursprünglichen Dicke D reduzierte Dicke d aufweist.

A CHIP MODULE AND PROCESS FOR THE PRODUCTION THEREOF

The present invention relates to a chip module comprising a substrate and at least one chip arranged on the substrate according to the preamble of Claim 1. The present invention further relates to a process for the production of a chip module according to the preamble of Claim 7.

Chip modules comprising a chip arranged on a substrate are basically used in all cases in which simplified electric contacting of the chip is to be facilitated by means of substrate connecting leads which are substantially larger than the chip terminal surfaces. Thus such chip modules are used, for example, in chip cards and via the exposed substrate connecting leads extending over the card surface permit "external contacting" of the chip accommodated inside the chip card by the arrangement on the rear side of the substrate. Such chip modules are also used to construct so-called contactless chip cards in the case of which the substrate connecting leads provide for simplified contacting with an antenna coil arranged inside the card body. Naturally such chip modules can also be used, for example, to construct a so-called "combi-card" in the case of which external contacting for contact access to the card chip as well as internal contacting for contactless access to the chip via the antenna coil are facilitated by means of the substrate.

The combination of a chip with the substrate to form the chip module results in a composite structure, the thickness of which is relatively great compared to the thickness of the chip and the thickness of the substrate and which must be accommodated in a card body with defined outer dimensions. To ensure that the accommodation of a chip module in a card body imposes the least possible restrictions upon the possibilities of further component installations in the card body, it thus proves essential for the chip module to be designed to be as thin as possible.

A disadvantage of the known, relatively thick chip modules is that simply by virtue of their relative thickness, they have greater bending resistance compared to the flexible card body and therefore when the card body is subjected to bending stress as frequently occurs in everyday use, in particular when the substrate is arranged in the card surface as in the case of a contact card, the connection between chip module and card body can be stressed to a high level, leading to the detachment of the chip module from the card body.

The object of the present invention is to propose a chip module which is characterised by an overall planar formation.

This object is achieved by means of a chip module having the features of Claim 1.

In the chip module according to the invention, by means of terminal surfaces arranged on its front side the chip is contacted onto contact surfaces of the substrate, and as a result of a removal of material on the surface of its rear side the chip has a thickness reduced compared to its original thickness.

The chip module according to the invention utilizes the fact that the electric circuit planes in the silicon body of the chip are adjacent to the front- or contact side of the chip provided with the terminal surfaces, and the region of the silicon body adjoining the surface of the rear side is free of electric circuit planes. It is thus possible, without impairing the function of the chip, to remove the surface of the chip from the rear side until a minimum thickness of the chip body ensuring satisfactory chip functioning is obtained, and in this way to make the chip substantially thinner.

EP-A-0 207 853 has disclosed a process wherein a plurality of chip modules are produced continuously using a film carrier.

Preferably, the present invention provides a chip module and a process for the production of a chip module facilitating the simplified establishment of a connection between a chip and a chip substrate and more effective processing of the chip to reduce the chip thickness.

In accordance with a first aspect of the present invention, there is provided a chip module comprising a substrate and at least one chip arranged on the substrate, wherein the chip is contacted via terminal surfaces arranged on its front side onto connecting leads of the substrate provided with a conductor path structure and the chip has a thickness which is reduced compared to its original thickness, characterised in that in order to obtain an interlocking contacting with bonding pads (16, 17) formed on the terminal surfaces, the chip (38) projects into recesses (19) of the substrate (12)whose base is formed by the connecting leads (14, 15) of the conductor path structure and the bonding pads (16, 17) of the chip (38) are embedded in a connecting material (22)which is arranged in the recesses (19) of the substrate (12), the connecting material serving both for the electrical contacting of the chip and for the mechanical connection of the chip to the substrate.

In accordance with a second aspect of the present invention, there is provided a process for the production of a chip module comprising a substrate and at least one chip arranged on the substrate, wherein a handling unit consisting of at least one chip and a substrate is formed by contacting the chip or chips onto the substrate provided with a conductor path structure in such manner that the chip or chips is/are contacted by its/their terminal surfaces onto connecting leads of the substrate, and wherein the processing of the chip or chips

is effected by a material removal process on its or their rear side, the substrate providing for the handling and stabilisation of the chip or chips during the processing, characterised in that for the formation of the handling unit (10), the chip or chips (11) is/are contacted onto the substrate (12, 27) such that bonding pads (16, 17) arranged on the terminal surfaces of the chip or chips (11) are inserted into a connecting material (22) arranged in recesses (19) of the substrate (12, 27).

Preferably, the chip module according to the invention utilizes the fact that the electric circuit planes in the silicon body of the chip are adjacent to the front- or contact side of the chip provided with the terminal surfaces, and the region of the silicon body adjoining the surface of the rear side is free of electric circuit planes. It is thus possible, without impairing the function of the chip, to remove the surface of the chip from the rear side until a minimum thickness of the chip body ensuring satisfactory chip functioning is obtained, and in this way to make the chip substantially thinner.

The reduction in thickness of the chip not only facilitates a corresponding reduction in the overall thickness of the chip module but also enables the bending behaviour of the chip module to be influenced. As a result of the reduction in the chip thickness, the bending behaviour of the chip is adapted to the bending behaviour of the substrate, thus leading to an overall more readily bending, more flexible chip module, the bending behaviour of which resembles that of the card body.

In the chip module according to the invention, in order to achieve an interlocking contacting with bonding pads formed

leads of the substrate, to provide the flattest possible overall arrangement of chip and substrate wherein the surface of the chip and the surface of the substrate can adjoin one another directly, thus without a gap. In the production of the chip module according to the invention it is thus also possible to omit the application of an underfiller known in the context of underfiller technology. The mechanically stabilising effect of the underfiller which improves the shearing strength of the chip module can also be dispensed with since a particularly stable, mechanical load-bearing connection is provided by the "embedding" of the bonding pads and the associated covering of the bonding pads with the connecting material on all sides, at least in partial regions of the contact metallizations.

The above described form of interlocking contacting between a chip and a substrate also has substantial advantages regardless of whether the contacted chip is a chip reduced in thickness by the removal of material or is a conventional chip, especially when a mechanically stable chip module is to be constructed.

To further increase the mechanical stability of the connection provided between chip and substrate in the chip module, at least one further projection which is electrically independent of the chip structure can be provided on the chip surface in addition to the bonding pads electrically conductively connected to the chip structure, said projection engaging into a fixing recess of the substrate. This projection, which can be designed and produced to be identical to the bonding pads forming electric terminals, provides a "contact dummy" which has merely a mechanically stabilizing function.

The bonding pads can be formed from any electrically conductive material, such as for example an electrically conductive adhesive or a contact metallization made of solder material or the like.

The above described form of interlocking contacting between a chip and a substrate also has substantial advantages regardless of whether the contacted chip is a chip reduced in thickness by the removal of material or is a conventional chip, especially when a mechanically stable chip module is to be constructed.

To further increase the mechanical stability of the connection provided between chip and substrate in the chip module, at least one further projection which is electrically independent of the chip structure can be provided on the chip surface in addition to the bonding pads electrically conductively connected to the chip structure, said projection engaging into a fixing recess of the substrate. This projection, which can be designed and produced to be identical to the bonding pads forming electric terminals, provides a "contact dummy" which has merely a mechanically stabilizing function.

If desired, further mechanical stabilisation or sealing can be provided by a peripheral or planar application of adhesive.

Preferably, a particularly advantageous use of the chip module is in a chip card.

In the process according to the invention as claimed in Claim 5, the contacting of the chip or chips on the substrate is performed in such manner that bonding pads

arranged on the terminal surfaces of the chip or chips are inserted into a connecting material arranged in recesses of the substrate. In this way a connection can be obtained

In accordance with an advantageous variant of the process according to the invention, the handling unit is formed in that a plurality of chips are contacted onto a continuously formed substrate strip and the substrate strip is separated to form individual chip modules following the processing of the individual chips. This enables the substrate strip to be continuously equipped with chips and facilitates the subsequent continuous processing of the individual chips to form the chip modules of reduced thickness, so that the chip modules of reduced thickness can also be produced in a particularly economical manner.

In the implementation of the above mentioned process variant, a plurality of chips can be processed simultaneously. The chips can be processed using a tool which permits the simultaneous processing of a plurality of chips or the chips can be processed simultaneously using different tools.

For the formation of the handling unit it has proved particularly advantageous to carry out the contacting of the chip or chips on the substrate in such manner that bonding pads arranged on the terminal surfaces of the chip or chips are inserted into a connecting material arranged in recesses of the substrate. In this way a connection can be obtained which withstands even the highest levels of shearing stress, such as occur for example during the grinding processing of the rear side of the chip, as the connection established by the embedding of the bonding pads into the connecting material is additionally secured by the engagement of the bonding pads into the recesses of the substrate.

The processing of the chip or chips can be performed using a grinding or lapping process. Another possible method of processing the chips to form a chip module of reduced

thickness consists of performing a chemical etching process on the rear side of the chip.

The connecting material required to form the connection can differ in type and form. Thus, for example, prior to the insertion of the bonding pads into the recesses, the connecting material can be introduced into the recesses by planar application to the surface of the insulating layer and subsequent stripping off of the surface.

It is also possible to introduce the connecting material into the recesses in a liquid state, before or after the insertion of the bonding pads into the recesses, in a dosing process.

Another possible method of applying the connecting material consists of introducing the connecting material into the recesses in lump form, for example lead/tin solder spheres, prior to the insertion of the bonding pads.

The substrate used to produce the chip module can also have been pre-prepared inasmuch as the bonding pads are inserted into recesses already provided with a coating of connecting material in the region of the connecting leads. It is thus possible for the process according to the invention for the production of a chip module also to be performed on the basis of substrates appropriately pre-prepared by the substrate manufacturer, thereby facilitating a particularly cost-effective implementation of the process.

If the connection between the connecting material and the bonding pads and between the connecting material and the connecting leads takes place under the influence of pressure and heat, a connection between chip and substrate is ensured in which the adjacent surfaces of chip and substrate bear against one another whereby, when an appropriate quantity of connecting material is provided, an

connecting material to take place via the connecting leads of the substrate. In this way the chip remains substantially free of thermal stress during the establishment of the connection.

It is also advantageous if a function test of the chip is performed following the processing of the chip. Here the connecting leads of the substrate form the test contacts. The implementation of this electric test, generally a continuity test, facilitates the detection of a chip module which has been functionally impaired, possibly due to the processing of the chip or due to the formation of the connection between chip and substrate.

In the following the chip module according to the invention will be explained in detail in the form of an exemplary embodiment and a process for its production, making reference to the drawings in which:

Figure 1 is a perspective view of a chip module comprising a chip and a substrate arranged thereon.

It is to be understood that, if any prior art publication is referred to herein, such reference does not constitute an admission that the publication forms a part of the common general knowledge in the art, in Australia or any other country.

For the purposes of this specification it is to be clearly understood that the word "comprising" means "including but not limited to", and that the word "comprises" has a corresponding meaning.

Claims

1. A chip module comprising a substrate and at least one chip arranged on the substrate, wherein the chip is contacted via terminal surfaces arranged on its front side onto connecting leads of the substrate provided with a conductor path structure and the chip has a thickness which is reduced compared to its original thickness, characterised in that in order to obtain an interlocking contacting with bonding pads formed on the terminal surfaces, the chip projects into recesses of the substrate whose base is formed by the connecting leads of the conductor path structure and the bonding pads of the chip are embedded in a connecting material which is arranged in the recesses of the substrate, the connecting material serving both for the electrical contacting of the chip and for the mechanical connection of the chip to the substrate.

2. A chip module according to Claim 1, characterised in that in addition to the bonding pads, which are electrically conductively connected to the conductor path structure and engage into the recesses, at least one further projection which is electrically independent of the conductor path structure is provided on the front side of the chip, said projection engaging into a fixing recess of the substrate.

3. A chip module according to Claim 1 or 2, characterised in that the chip is adhesively connected to the substrate in peripheral or planar manner.

4. A chip module according to one or more of the preceding claims, characterised by its use in a chip card.

5. A process for the production of a chip module comprising a substrate and at least one chip arranged on the substrate, wherein a handling unit consisting of at least one chip and a substrate is formed by contacting the chip or chips onto the substrate provided with a conductor path structure in such manner that the chip or chips is/are contacted by its/their terminal surfaces onto connecting leads of the substrate, and wherein the processing of the chip or chips is effected by a material removal process on its or their rear side, the substrate providing for the handling and stabilisation of the chip or chips during the processing, characterised in that for the formation of the handling unit, the chip or chips is/are contacted onto the substrate such that bonding pads arranged on the terminal surfaces of the chip or chips are inserted into a connecting material arranged in recesses of the substrate.

6. A process according to Claim 5, characterised in that the processing of the chip or chips is performed by means of a grinding or lapping process.

7. A process according to Claim 5, characterised in that the processing of the chip or chips is performed by means of an etching process.

8. A process according to one or more of Claims 5 to 7, characterised in that a function test of the chip is performed following the processing of the chip.

9. A chip module as substantially described herein with reference to the accompanying drawings.

10. A process as substantially described herein with reference to the accompanying drawings.

FIG 1

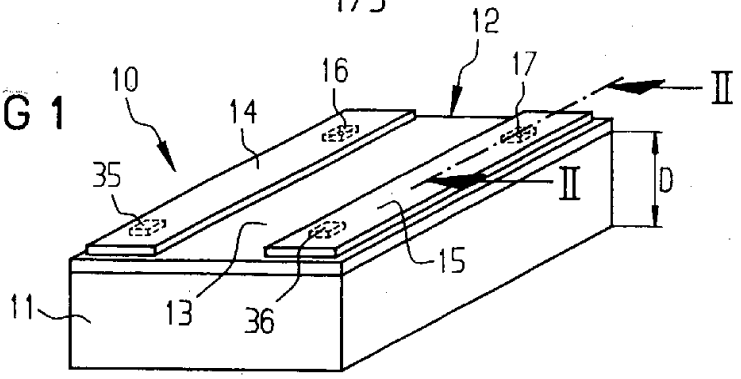

FIG 3

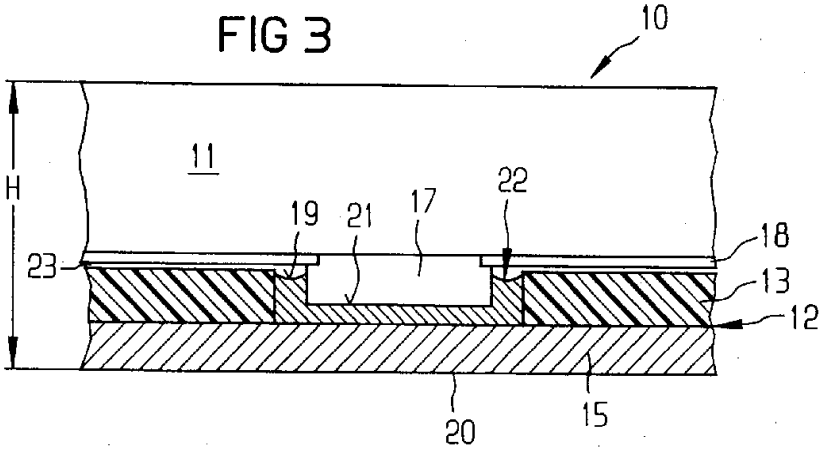

FIG 4

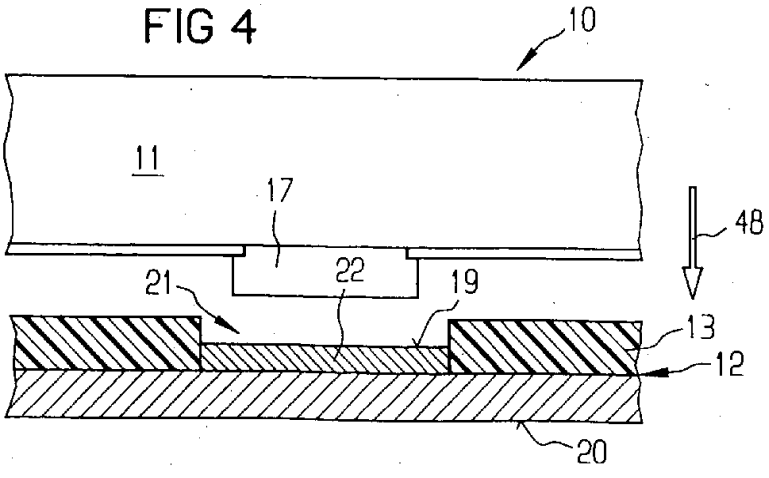

FIG 2

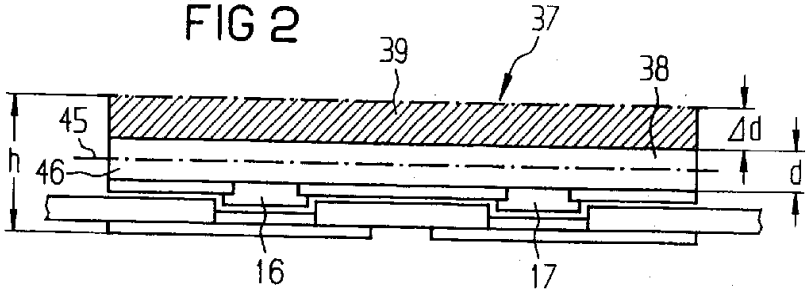

FIG 6

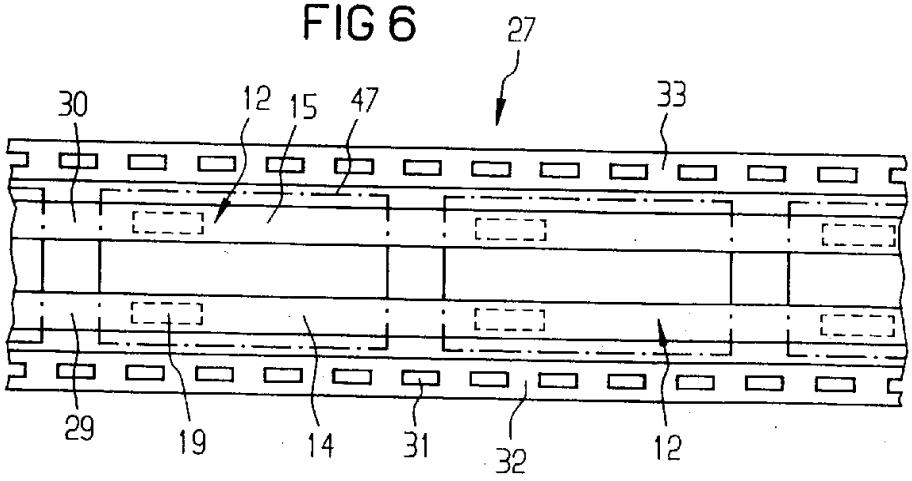

FIG 5