

- 1 -

Description



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Self-adhering chip

- 5 The invention relates to an integrated circuit (chip) according to the precharacterizing clause of patent claim 1.

10 Chips are usually securely soldered on printed circuit boards or attached on a carrier in some other way. For various reasons, however, it is desired to mount the chip on the carrier reversibly, i.e. such that it can be detached without being destroyed. Such technology is of advantage, for example, for carrying out chip tests and also makes it much easier to exchange defective chips.

20 Checking the functionality of chips generally takes place by means of special testers. In a conventional chip test for packaged chips, such as for example TSOP chips (TSOP: Thin Small Outline Package) or BGA chips (BGA: Ball Grid Array), the chips are inserted into test sockets which have complicated mechanical constructions and must perform mechanical compensating movements to connect the chip contacts, usually formed as soldered contacts, to the test board. The mechanical complexity of test sockets of this type is therefore relatively great and the type of connection is complicated. With increasing integration and pattern spacings becoming ever smaller, such mechanical contacting is becoming more and more difficult. This applies in particular to more recent generations of unpackaged chips, such as for example CSP chips (CSP: Chip Size Package).

35 The exchange of defective chips of multichip modules (MCM) has until now been performed by unsoldering the defective part, and cleaning and soldering in a good part. This known exchanging process is not only costly



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and time-consuming, it also cannot be automated very well.

In the case of packaged chips with legs (Lead Frame Based Packages), the exchange of the chips can also be performed with the aid of a socket which is
5 soldered onto the carrier. However, the contacts of chips of more recent generation are differently designed (as small balls), making this solution obsolete.

It is therefore the object of the present invention to provide a technology for
10 mounting chips on printed circuit boards or other carriers with which the chip can be attached on the carrier in such a way that it can be exchanged without being damaged.

This object is achieved by the features specified in patent claim 1. Further
15 refinements of the invention are the subject matter of subclaims.

The basic idea of the invention is to provide the chip and carrier with means of attachment which engage releasably in one another. In this case, the means of attachment of the chip are arranged directly on the "bare", i.e. unpackaged,
20 chip. It goes without saying that a package may be provided on the regions of the chip outside the means of attachment. An electrical connection of the chip and carrier is achieved by contact means, including a contact element which is put under mechanical compressive stress when the chip is attached to the carrier, whereby a reliable contact is achieved.

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The term "carrier" is to be understood in this description as meaning any type of means, such as for example printed circuit boards, sockets, other chips etc., on which the chip can be detachably attached.

30 The means of attachment of the chip and also those of the carrier are preferably produced from a layer, in particular a polymer layer, arranged on the chip or carrier.

- 3 -

The releasable connection is preferably formed on the basis of the lock-and-key principle, the oppositely lying means of attachment of the chip and carrier engaging in one another, with a slight pressure being exerted, locking in one another and consequently holding one securely in place on the other. If, in the reverse direction, a corresponding pull is exerted, the two mating parts can be separated from one another without being destroyed. This can also be performed repeatedly.

Preferably, at least the means of attachment of the chip or of the carrier are elastically formed.

The chip according to the invention can consequently be inserted into a corresponding test board to carry out a chip test. After the successful test, the chip can be placed on the module board. After the corresponding module test, chips specified as defective can in turn be exchanged.

According to a preferred embodiment of the invention, the opposing means of attachment of the chip and carrier are formed as a snap fastener.

According to one embodiment, the means of attachment of the chip comprise, for example, a number of extensions and depressions. Those of the carrier comprise corresponding mating pieces.

According to one embodiment of the invention, certain portions, in particular edges, of the chip itself may also serve as means of attachment, which interact with corresponding means of attachment of the carrier.

The means of attachment of the chip or carrier may also have, for example, hook-like elements.

- 4 -

The means of attachment preferably serve exclusively for the mechanical connection of the chip and carrier and are, in particular, not electrically conducting.

- 5 According to a special embodiment of the invention, the contact elements are elastic, and preferably protrude outward beyond the means of attachment.

When viewed perpendicularly in relation to the surface of the chip or carrier, the contact means should generally be longer than the distance between the
10 surface of the chip and surface of the carrier in the assembled state.

The contact elements are preferably arranged on a contact pad.

The invention is explained in more detail below by way of example on the basis
15 of the accompanying drawings, in which:

figure 1 a-h shows a number of method steps in the production of a self-adhering chip arrangement, comprising a chip and carrier;

20 figure 2 a-f shows a number of method steps in the production of a self-adhering chip arrangement according to a second embodiment of the invention;

figure 3 a, b shows method steps in the production of means of attachment
25 using a metal structure;

- 5 -

figure 4 a, b shows method steps in the production of a self-adhering chip arrangement using a plastically deformable fluid;

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figure 5 a-g shows various method steps in the production of a self-adhering chip arrangement according to a third embodiment of the invention;

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figure 6 a-e shows various method steps in the production of a self-adhering chip arrangement according to a fourth embodiment of the invention; and

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figures [sic] 7 a-e show various method steps in the production of a self-adhering chip arrangement according to a fifth embodiment of the invention.

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Figure 1a shows a chip 1, which is represented in a simplified way and essentially comprises a substrate 3 and an insulating layer 2, for example of polyimide, lying over the latter. Arranged on the chip 1 or the insulating layer 2 is a contact pad 4, which is in electrical contact with the substrate 3.

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As shown in figure 1b, in a following process step, a layer 5, in particular a polymer layer, is applied to the arrangement and structured in the way represented. The application and structuring of the polymer layer 5 takes place for example by spin coating with subsequent lithography and application of a suitable printing technique.

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Figure 1c shows the application of a number of relatively etching-resistant structure elements 18 to the polymer layer 5. The structure elements 18

- 6 -

consist, for example, of filled polymer which has a lower selective etching rate than the polymer layer 5.

The state after etching is represented in figure 1d.

5 The etching step can be carried out both as a dry process and as a wet process. The relief structure of the means of attachment 6 produced after the etching comprises a number of extensions 7 and depressions 8.

10 The application of a contact element 9 to the contact pad 4 is represented in figure 1e. The contact element 9 consists, for example, of a conductive polymer which has been produced by means of a suitable printing technique. The contact element 9 is arranged or
15 designed in such a way that it protrudes outward beyond the means of attachment 6.

Figure 1f shows an associated carrier 20 with corresponding "negative" means of attachment 16. The
20 carrier 20 essentially comprises a printed circuit board 10 with an insulating layer 2 located on it. On the carrier 20 there are means of attachment 16 which correspond to the means of attachment 6 of the chip 1 and are formed in such a way that the chip 1 and
25 carrier 20 can be releasably connected to one another. These negative means of attachment 16 likewise comprise extensions 7 and depressions 8.

Figure 1g shows the positioning and joining together of
30 the chip 1 and the carrier 20. The joining together of the chip 1 and carrier 20 is performed with slight pressure being exerted, whereby the means of attachment 6, 16 engage in one another and lock in the position shown in figure 1h. At least one of the means of
35 attachment 6, 16 is elastically formed.

As can be seen in figure 1h, in the assembled state of the chip 1 and carrier 20, the contact element is elastically deformed and is, in particular, under

compressive stress. As a result, a good electrical contact is ensured.

Figure 2a shows a first method step in the production of another embodiment of a self-adhering chip. The chip 1 in turn comprises a substrate 3 and an insulating layer 2 located on it. The chip 1 is also provided with a polymer layer 5, on which a contact pad 4 is arranged. In this embodiment, the contact pad 4 is consequently located on the polymer layer 5.

In a following method step, the polymer layer 5 is masked by a number of structure elements 18, for example in the form of islands or lines, which consist in particular of filled polymer. These polymers have a higher etching resistance than the polymer layer 5 lying under them.

The relief structure remaining after the etching is represented in figure 2c. The means of attachment 6 are in turn formed here as a row of extensions 7 and recesses 8.

Figure 2d shows a contact element 9, that [sic] consists for example of a conductive polymer, applied to the contact pad 4.

The placement of the chip 1 onto the printed circuit board 20 is represented in figure 2e. When the chip 1 and printed circuit board 20 are joined together, the chip is pressed onto the printed circuit board 20 in the direction of the arrow. As shown, the printed circuit board 20 has corresponding means of attachment 16, which engage with the means of attachment 6 of the chip 1.

The assembled state of the chip 1 and printed circuit board 20 is represented in figure 2f. In this case, the contact element 9 is pressed together and, in this

- 8 -

way, ensures a reliable electrical contact with the opposite contact pad 4 of the printed circuit board 20. Optionally, a conductive adhesive may be used in place of the elastic polymer as the contact element 9.

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Figures 3a and 3b show the production of a relief-like structure as means of attachment, using a metal masking. For this purpose, firstly a metal layer is applied to the polymer layer 5 and correspondingly structured. The remaining metal structure elements 11 have a relatively high etching resistance, so that, after carrying out an etching process, the structure shown in figure 3b can be created.

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Another possibility for producing corresponding means of attachment 6, 16 is shown in figures 4 a, b. In this case, a specific means of attachment is formed only on one of the mating parts, the chip 1 or the printed circuit board 20. On the other of the mating parts, on the other hand, there is provided a plastically deformable compound, such as for example a not yet cured polymer or a corresponding adhesive. The structure already formed on one of the mating parts is passed onto the other of the mating parts by a kind of transfer process, to be specific by pressing the chip 1 onto the printed circuit board 20. In the example represented, the relief surface of the chip 1 is pressed into the uncured surface of the polymer layer 17 of the printed circuit board 10.

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The electrical contact is in this case established by an elastically deformed, conducting contact element 9 or else, for example, by a conductive adhesive.

35 A further possible way of producing a self-adhering chip arrangement is represented in figures 5 a-g. Figure 5a shows a chip with contact pads 4, on which bump-like contact elements 9 are arranged. The contact

- 9 -

elements 9 may be produced, for example, by means of known printing techniques.

5 In a further method step, which is shown in figure 5b, auxiliary forms 12, which serve for producing corresponding means of attachment, are created on the chip 1 and on the carrier 20. The auxiliary forms 12 may, for example, consist of a polymer and be produced by means of dispensing.

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As can be seen in figure 5c, in a further method step, hook-shaped attaching elements 13, 14 are applied to the chip 1 and carrier 20. In this case, the respectively interacting attaching elements 13, 14 are
15 easily arranged offset with respect to one another, so that their hook-shaped portions 21, 22 can engage in one another.

20 After the removal of the auxiliary form 12 on the chip 1 and carrier 20, the arrangement shown in figure 5d is obtained. In this case, the contact elements 9 protrude outward beyond the attaching elements 13.

25 Finally, as shown in figure 5e, the chip 1 is pressed onto the carrier 20. In this case, the part 13 of the fastener located on the chip 1 at the same time forms a means of stopping compression when pressure is applied to the elastic contact elements 9.

30 The assembled state of the chip 1 and carrier 20 is shown in figure 5f. In this case, the contacts 9 have been elastically deformed and are under compressive stress, thereby ensuring a good contact junction.

35 The hook-like portions 21, 22 of the attaching elements 13, 14 are hooked with one another and lock the chip 1 on the carrier 20. The attaching elements 13, 14 form a snap fastener, which is releasable on account of the

- 10 -

elasticity of the elements 13, 14, so that the chip 1 is easily removed from the carrier 20.

Figure 5g shows a three-dimensional view of a self-adhering chip 1 and of the associated carrier 20. The means of attachment 13 of the chip 1 are in this case formed as continuous, elongate attaching elements 13, which can engage in similar attaching elements 14 of the carrier 20.

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The means of attachment 13, 14 are preferably arranged on two opposite sides of a chip. A chip preferably comprises two oppositely lying means of attachment, but it is also optionally possible for a number of attaching elements to be provided.

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The means of attachment 13 are located on two opposite longitudinal sides of the chip 1. In this case, their hook-like portions 21 point outward. The electrical contact elements 9 are located on the chip 1 within the confines of the contact elements 13. In addition, further attaching elements 13 (of which only one is shown) are provided on the end faces of the chip 1.

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A further embodiment of a self-adhering chip is represented in figures 6a to 6e. For producing the corresponding attaching elements, in figure 6a firstly an auxiliary form 12 is created, with which the attaching elements 13 shown in figure 6b are produced. The "keys" 13 are produced, for example, by means of dispensing or a suitable printing technique.

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Figure 6c shows the state of the arrangement after removal of the auxiliary forms 12, which is preferably carried out in a wet-etching process.

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For locking the attaching elements 13, corresponding recesses 15 are provided in the carrier 20 (figure 6d). The attaching elements 12 and recesses 15 are in this

- 11 -

case arranged such that they lie precisely opposite one another.

5 In the present case, the contact elements 9 do not extend outward beyond the attaching elements 13 but are located within the extent of the attaching elements 13. However, the thickness of the contact elements 9, viewed perpendicularly in relation to the surface of the chip, is greater than the distance between the
10 surfaces of the chip 1 and carrier 20 in the assembled state. This ensures a good electrical contact, since the contact element is deformed when the chip and carrier are joined together.

15 Figure 6e shows the assembled state of the chip 1 and carrier 20. In this case, the attaching elements 13 protrude into corresponding recesses 15 of the carrier and lock the chip 1 in this position.

20 The production of a further embodiment of a self-adhering chip is represented in figures 7a-e. Figure 7a firstly shows the production of an auxiliary form 12, for example from a specific polymer compound, which partially covers the contact areas 4.

25 In a further method step, as shown in figure 7b, hook-like attaching elements 15 are created between two oppositely lying auxiliary forms 12. The production of the hook structures takes place, for example, by means
30 of dispensing and a suitable printing technique.

Figure 7c shows the state of the carrier 20 after the removal of the auxiliary forms 12 by wet etching.

35 In figure 7d, the chip 1 has been positioned over the carrier, the chip 1 having on its lower outer edges protector elements 23, which on the one hand make it easier for the chip to be pressed onto the carrier (they provide a certain guidance) and on the other hand

- 12 -

protect the means of attachment 15 from the sharp-edged sides of the chip 1. The elements 23 may likewise be produced from polymer.

5 Figure 7e shows the chip 1 in the placed-on state. In this case, it can be seen that the chip has no separate means of attachment in the region between the chip 1 and the carrier 20. Rather, the upper edges 19 of the chip 1 itself serve for locking with the hook portions
10 22 of the attaching elements 15. In this embodiment of the self-adhering chip, there is in particular no need for method steps for producing separate holding elements.

Patent claims

1. Integrated circuit (chip) comprising:
means (6, 13, 16) for attaching the chip (1) on a carrier (20), the means
5 of attachment (6, 13) of the chip (1) being designed in such a way that
they can enter into a releasable connection with corresponding means of
attachment (14, 15, 16) formed on the carrier (20); and
separate contact means (4,9) for electrically connecting the chip and
carrier, the contact means including an electrically conducting contact
10 element (9), the contact element (9) being arranged to be under
compressive stress when the chip (1) and carrier (20) are in the
assembled state.
2. Integrated circuit according to claim 1, in which the means of attachment
15 (6, 13, 14, 15, 16) are arranged on an insulating layer (2) of the chip (1).
3. Integrated circuit according to claim 1 or 2, in which the means of
attachment (6, 13, 14, 15, 16) are produced from a polymer layer (5).
- 20 4. Integrated circuit according to one of the preceding claims, in which the
means of attachment (6, 13, 16) have a number of depressions (8)
and/or extensions (7, 13).
5. Integrated circuit according to any one of the preceding claims, in which

the means of attachment have hook-like elements (14, 15).

6. Integrated circuit according to one of the preceding claims, in which the means of attachment (6, 13, 14, 15, 16) serve only for the mechanical connection of the chip (1) and carrier (20), and in particular not for the electrical connection.
7. Integrated circuit according to any one of the preceding claims, in which the contact element (9) is arranged on a contact pad (4).
8. Integrated circuit according to claim 7, in which the contact element (9) protrudes outward beyond the means of attachment (6, 13, 14, 15, 16).
9. Integrated circuit according to one of claims 7 or 8, in which the contact element (9) is elastic.
10. Chip module, comprising one or more integrated circuits (1), according to one of the preceding claims, and a carrier (20), the carrier (20) having means of attachment (14, 15, 16) which interact with the means of attachment (6, 13) of the chip (1) and permit a releasable connection of the chip (1) and carrier (20).
11. Chip module according to claim 10, in which the means of attachment (8, 14, 15) of the carrier (20) have a number of depressions (15) and/or

projections (14).

12. Chip module according to claim 10 or claim 11, in which at least one of the means of attachment (6, 13, 14, 15, 16) is elastic.

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13. A method of attaching a chip (1) to a carrier (20), the chip (1) comprising before it is attached to the carrier (20) attachment means (6, 13, 16) for attaching the chip (1) on the carrier (20) and separate contact means (4, 9) for electrically connecting the chip (1) and carrier (2), the contact means (4, 9) including an electrically conducting contact element (9);
10 the method including forming a releasable connection between the attachment means (6, 13, 16) and corresponding means of attachment (14, 15, 16) on the carrier (20),
wherein the step of forming the releasable connection puts the contact
15 element (9) under compressive stress.