

Packaging for Microelectronic Components

This invention relates to packaging for microelectronic and/or micromechanical components which have been applied to a structure substrate as claimed in Claim 1 and corresponding methods as claimed in Claims 8, 9 and 10 and a structure substrate as claimed in Claim 11.

In the prior art a plurality of methods for packaging of microelectronic components is known. Technical problems consist mainly in that the number of packaging steps for encapsulation of microelectronic and/or micromechanical components is large. In part there are complex intermediate steps so that packaging is tedious and costly.

The object of this invention is therefore to devise packaging and a corresponding method with which a rapid, efficient, inexpensive and simple packaging of microelectronic and/or micromechanical components is enabled.

This object is achieved with the features of Claims 1, 8, 9, and 10. Advantageous developments of the invention are given in the dependent claims. All combinations of at least two of the features given in the specification, the claims and/or the figures also fall within the scope of the invention. At the given value ranges, values within the indicated limits will also be considered to be disclosed as boundary values and will be claimed in any combination.

The invention is based on the idea of packaging microelectronic and/or micromechanical components using a carrier wafer with an antiadhesion layer which has been applied at least partially, preferably at least predominantly to the packaging receiving surface of the carrier substrate with a structure material which has been applied temporarily to the carrier substrate with

chamber openings for accepting microelectronic and/or micromechanical components.

Especially after removing the carrier substrate, which is facilitated by the antiadhesion layer as claimed in the invention, the packaged microelectronic and/or micromechanical components which have been applied to the carrier substrate, are packaged, preferably encapsulated, even more preferably hermetically encapsulated only by the structure material, especially individually in chambers. The advantage of using a carrier substrate with an antiadhesion layer consists in the greatly simplified handling in packaging with few packaging steps and moreover especially very favorable materials can be used, starting with the carrier substrate, in which a comparatively simple substrate can be used and no single-crystal wafer is required. Another advantage of this invention is that the packaging is extremely space-saving. Another technical advantage of this invention is that at the same time a plurality of microelectronic and/or micromechanical components can be packaged.

Accordingly the described packaging consisting of the carrier substrate, the antiadhesion layer and the structure material with chamber openings can be regarded as an independent invention, especially in combination with the method disclosed as an independent invention for producing the packaging by applying the structure material to the antiadhesion layer of the carrier substrate and providing chamber openings in the structure material.

As a further independent invention, the aforementioned inventions yield a method for packaging of microelectronic and/or micromechanical components which have been applied to a carrier substrate by aligning the aforementioned packaging relative to a structure substrate which has the microelectronic and/or micromechanical components and by joining the packaging to the structure substrate and especially to a subsequent detachment of the carrier substrate.

As a method product this yields, as another independent invention, microelectronic and/or micromechanical components which are packaged especially exclusively from the structure material (especially without the carrier substrate) and the structure substrate, especially each encapsulated separately.

According to one advantageous embodiment of this invention it is provided that the chamber openings are bordered by structure elements, especially chamber walls. Thus an especially sealing, preferably hermetic encapsulation of the microelectronic and/or micromechanical components is possible, especially chambers provided separately for each microelectronic and/or micromechanical component.

Here it is especially advantageous if face sides of the structure elements are made flush, especially parallel to the carrier substrate. In this way the packaging (especially without a further processing step such as straightening) can be connected to the structure substrate with the microelectronic and/or micromechanical components applied thereto.

In a development of the invention it is advantageous if the structure elements can be joined to a structure substrate which accommodates the microelectronic components, especially via an adhesive layer which has been applied to the structure elements, preferably their face sides. The type of joining depends especially on the material used for the structure material, which is suitable especially for sealing connection to the chamber openings to the structure substrate, preferably hermetically sealing. In this way it is especially conceivable as claimed in the invention to deliver a vacuum and/or protective gas into the packaging during the packaging, especially into the chambers which are bordered by the structure material and the structure substrate.

According to one advantageous embodiment of the invention the structure material is

chosen from one or more of the following materials: plastic, photoresist, polymer, ceramic, metal, glass. In particular the use of polymers and/or photoresist, especially solely polymer, is preferred since in this way thermal and/or electrical insulation and protection against impacts are ensured. The structure material is accordingly chosen preferably such that it is made thermally and/or electrically insulating.

Advantageously the structure material is made in one piece, from which durable packaging which can be produced with effort as small as possible results.

According to another advantageous embodiment of the invention it is provided that the antiadhesion layer has an edge zone with higher, especially at least twice as high, adhesive force as an antiadhesion zone of the antiadhesion layer which is at least predominantly, preferably completely surrounded by the edge zone. In this way, on the one hand during the packaging process reliable adhesion of the carrier substrate on the structure material is ensued and on the other hand the detachment of the carrier substrate as claimed in the invention after packaging of the microelectronic and/or micromechanical components is easily enabled. In particular it is not necessary as claimed in the invention to act on the antiadhesion zone of the antiadhesion layer so that in any case, if present, the adhesive force can be reduced to the edge zone, therefore especially from the periphery of the carrier substrate, with correspondingly less effort.

If present and/or packaging features are disclosed in the following description of the figures, they are all to be considered disclosed also as method features and vice versa.

Other advantages, features and details of the invention will become apparent from the following description of preferred exemplary embodiments and using the drawings.

Figure 1 shows a schematic cross sectional view of a first production step as claimed in the

invention for producing packaging as claimed in the invention,

Figure 2a shows a schematic cross sectional view of a second production step as claimed in the invention according to a first version as claimed in the invention for producing packaging as claimed in the invention,

Figure 2b shows a schematic cross sectional view of a second production step as claimed in the invention according to a second version as claimed in the invention for producing packaging as claimed in the invention,

Figure 3 shows a schematic cross sectional view of a third production step as claimed in the invention for producing packaging as claimed in the invention,

Figure 4 shows a schematic cross sectional view of a fourth production step as claimed in the invention for producing packaging as claimed in the invention,

Figure 5 shows a schematic cross sectional view of a first packaging step as claimed in the invention,

Figure 6 shows a schematic cross sectional view of a second packaging step as claimed in the invention and

Figure 7 shows a schematic cross sectional view of an assembled structure wafer which has been packaged as claimed in the invention.

In the figures, advantages and features of the invention are labeled with the reference numbers which identify them according to embodiments of the invention, components or features with the same function or function with the same effect being labeled with identical reference numbers.

Figure 1 shows a carrier substrate 1 with a packaging receiving area 1v. The carrier

substrate 1 is made especially as a rigid carrier substrate 1 in order to perform a support function. Preferably the carrier substrate 1 is a wafer. The thickness D_1 of the carrier substrate 1 is especially between 100 μm and 2000 μm , more preferably between 500 μm and 2000 μm , even more preferably between 1000 μm and 2000 μm . In any case it is known to one skilled in the art in the field that wafers with correspondingly standardized diameters are also standardized with respect to their thicknesses. If the substrates which are used as the carrier wafers are stiff enough to carry out the method as claimed in the invention, preferably standardized wafer thicknesses should be preferred. The diameter of the carrier substrate 1 is especially 1, 2, 3, 4, 5, 6, 8, 12, 18 inches. Generally the carrier substrate 1 can have any diameter.

According to Figure 2a an antiadhesion layer 2 is applied in a blanket manner to the packaging receiving area 1v in the illustrated exemplary embodiment; in turn according to Figure 3 a structure material 3, in the illustrated exemplary embodiment a photoresist, is applied to the layer. The photoresist is applied by known methods.

According to one second embodiment as claimed in the invention as shown in Figure 2b, an antiadhesion layer 2 is not applied in a blanket manner to the packaging receiving area 1v in the illustrated exemplary embodiment, but only in a central region, while a circular segment which lies concentrically with thickness R remains free of the antiadhesion layer. The advantage of this second embodiment lies in the higher adhesive strength which prevails on the edge between the material 3 or 3' and the packaging receiving area 1v of the carrier substrate 1. It is a modification of the ZonebondTM method which is known in industry. In the embodiment as claimed in the invention in any case instead of the cement a correspondingly structurable material 3 is used.

The adhesive force (relative to the unit area) between the antiadhesion layer 2 and the

structure material 3 is especially less than 1 N/mm^2 , preferably less than 0.1 N/mm^2 , more preferably less than 0.01 N/mm^2 , still more preferably less than 0.001 N/mm^2 , most preferably less than 0.0001 N/mm^2 , most preferably of all less than 0.00001 N/mm^2 .

The structure material 3 is applied in an especially uniform thickness D_2 , especially greater than the thickness D_1 of the carrier substrate 1. In particular the thickness D_2 of the structure material 3 is between $1000 \text{ }\mu\text{m}$ and $1 \text{ }\mu\text{m}$, preferably between $100 \text{ }\mu\text{m}$ and $10 \text{ }\mu\text{m}$.

In the method step which is shown in Figure 4, from the side of the structure material 3 facing away from the carrier substrate 1 chamber openings 4 are made in order to form an receiving space 8 for accepting microelectronic and/or micromechanical components 7 (see Figure 5).

In the illustrated embodiment for each microelectronic and/or micromechanical component 7 a separate receiving space 8 with a height H is formed. The receiving spaces are identical at least in the height H.

The height H of the receiving space is smaller than the thickness D_2 of the structure material 3 so that the receiving spaces 8 do not extend as far as the carrier substrate 1 or the antiadhesion layer 2 which is detached later (See Figure 7).

The receiving spaces 8 are bordered by chamber walls 9 of the structure material 3' which has been worked accordingly. Face sides 10 of the chamber walls (structure elements) 9 border the receiving spaces 8 laterally (therefore parallel) to the packaging receiving area 1v. The face surfaces 10 are made flush with one another, especially parallel to the packaging receiving surface 1v.

Preferably the structure material 3 is a resist which can be especially permanently cured and which is structured by known methods, especially exposure and corresponding known subsequent steps (shown in Figure 4).

In this way packaging 5 which has been produced as claimed in the invention for the microelectronic and/or micromechanical components 7 which have been applied to a structure substrate 6 is provided.

The packaging 5 is aligned according to Figure 5 opposite the microelectronic and/or micromechanical components 7 which have been applied to the structure substrate 6, a corresponding microelectronic and/or micromechanical component 7 which is to be accommodated in the receiving space 8 being located opposite each receiving space 8 or each chamber opening 4.

In the method step shown in Figure 6 the packaging 5 and the structure substrate 6 are brought into contact by moving them toward one another.

The face sides 10 lie directly on one receiving side 60 of the structure substrate 6 which accommodates the microelectronic and/or micromechanical components 7, specifically in the intermediate spaces 11 between the microelectronic and/or micromechanical components 7 which are applied spaced apart from one another to the structure substrate 6.

After a connection of the face sides 10 to the structure substrate 6, which connection seals especially the receiving spaces 8 on the chamber openings 4, preferably hermetically seals them, the microelectronic and/or micromechanical components are encapsulated in their respective receiving spaces 8. The contact-making and connecting of the method steps according to Figures 5 and 6 take place preferably under a vacuum and/or protective gas atmosphere.

In the method step shown in Figure 7 the carrier substrate 1 on the antiadhesion layer 2 is detached from the especially cured structure material 3'; this can take place extremely easily, especially by simply pulling off, as a result of the antiadhesion layer 2.

Reference number list

1	carrier substrate
1v	packaging receiving area
2	antiadhesion layer
3, 3'	structure material
4	chamber openings
5	packaging
6	structure substrate
6o	receiving side
7	microelectronic components
8	receiving space
9	structure elements
10	face sides
11	intermediate spaces
D ₁	thickness
D ₂	thickness
H	height
R	thickness of circular ring

Claims

1. Packaging for microelectronic components (7) applied to a structure substrate (6) with the following:

- a carrier substrate (1) with a packaging receiving area (1v), at least predominantly an antiadhesion layer (2) being applied to the packaging receiving area (1v),
- a structure material (3') applied to the antiadhesion layer (2) with chamber openings (4) for accommodating the microelectronic components (7).

2. The packaging as claimed in Claim 1, wherein the chamber openings (4) are bordered by structure elements (9), especially chamber walls.

3. The packaging as claimed in Claim 2, wherein face sides (10) of the structure elements (9) are made flush, especially parallel to the carrier substrate (1).

4. The packaging as claimed in Claim 2 or 3, wherein the structure elements (9) can be joined to a structure substrate (6) which holds the microelectronic components (7), especially via an adhesive layer which has been applied to the structure elements (9), preferably their face sides.

5. The packaging as claimed in one of the preceding claims, wherein the structure material (3, 3') is chosen from one or more of the following especially insulating materials: plastic, photoresist, polymer, ceramic, metal, glass.

6. The packaging as claimed in one of the preceding claims, wherein the structure material (3, 3') is made materially in one piece.

7. The packaging as claimed in one of the preceding claims, wherein the antiadhesion layer (2) has an edge zone with higher, especially at least twice as high, adhesive force as an antiadhesion

zone of the antiadhesion layer (2) which is at least predominantly, preferably completely surrounded by the edge zone.

8. A method for production of packaging for microelectronic components (7) which have been applied to a carrier substrate (1) with the following steps, especially the following sequence:

- applying a structure material (3) to an antiadhesion layer (2) which is located on one packaging receiving area (1v) of the carrier substrate (1),
- providing chamber openings (4) on one side of the structure material (3) facing away from the carrier substrate (1).

9. A method for production of packaging for microelectronic components (7) which have been applied to a carrier substrate (1) with the following steps, especially the following sequence:

- aligning packaging as claimed in Claim 1 relative to a structure substrate (6) which has the microelectronic components (7) such that the chamber openings (4) which correspond to the microelectronic components (7) are aligned flush with one another,
- joining the packaging to the structure substrate (6).

10. A method for detaching a carrier substrate (1) from packaging which has been packaged according to a method as claimed in Claim 9 and which has been produced especially according to a method as claimed in Claim 8, in which the carrier substrate (1) on the antiadhesion layer (2) is detached from the structure material (3').

11. A structure substrate (6) with microelectronic and/or micromechanical components (7) which have been applied to a structure substrate (6), the microelectronic and/or micromechanical components (7) being packaged by a structure material (3') with chamber openings (4) for accommodating the microelectronic and/or micromechanical components (7).