A method and device for processing components arranged on a substrate, in particular semiconductor chips

The invention relates to a method for processing components arranged on a substrate, in particular semiconductor chips, according to the preamble of claim 1. Such methods are for example applied with the application of certain semiconductor elements, with which the finished chip provided with connection locations is only negligably smaller than the raw silicon chip (chip scale package or in short CSP).

With this, between the substrate and the component there is arranged a buffer mass, for example of an elastomer or a foil, which compensates the differing coefficients of thermal expansion of the materials. In order to ensure an adequate adhesion and to cure the elastomer mass, the components with the simultaneous heating must be pressed against the substrate.

A disadvantage of the known method lies however in the fact that the exact placing of the components on the substrate and the final connection under a high pressure and at a high temperature is effected in one step. The pressing procedure with this lasts considerably longer that the placing procedure which leads to great capacity reductions in the production line. On the other hand however the application of high temperatures in the region of the placing of the components is disturbing. At the placing station, specifically highly precise manipulators and measuring apparatus operate, which react sensitively to temperature effects. It is therefore the object of the invention to provide a method of the previously mentioned type with which, with simple means, the production capacity within the same line may be increased. Furthermore the method is to permit a separation of the

placing-on procedure from the actual processing procedure for the definitive connection.

This object, according to the invention, is achieved with a method which comprises the features in claim 1. The pressing in groups and/or heating of the components is with this effected separately with respect to time from the placing-on procedure so that according to the tool size a relatively large number of components may be simultaneously treated.

With this, the placing of the components onto the substrate and the impinging with the tool at working stations arranged at a distance to one another are effected particularly advantageously. Specifically it has been shown that the exact placing and the processing do not necessarily have to be effected at the same working station. With the application of suitable substrates and adhesives these also at room temperature have an adequate adhesive force for the further transport after the placing. With this the substrates may be transported away from the sensitive placing region to a processing station at which without negative influence to the placing procedure, pressure and/or heat may be applied.

Several groups of components after one another may with this in a cycled manner be impinged, wherein the impingement of a group in the ideal case lasts maximally for as long as the placing-on of a preceding group. With the placing-on procedure with this in a rapid succession the components may be arranged to a group, wherein at the processing station during the whole time duration from the placing of the first component up to the placing of the last component one presses. Considerable advantages with the processing of the components may further be achieved when each component is impinged with a separate plunger and when with the

impinging for achieving a uniform bearing force on all components each plunger is adapted to the individiual height of the component. With this measure it is ensured that also with the unavoidable height tolerances of the component a uniform processing of the whole group with pressure and temperature is effected. A component with a maximum height which is only just allowable will thus be subjected to the same pressing force and to the same temperature as a component with an allowable minimum height.

For the heat treatment before or during the impingement of the components the plunger and/or a substrate rest serving as a counter bearing are heated. It would however also be conceivable to carry out the whole pressing proedure in a closed oven or to effect the heating in another manner, e.g. by way of a convection oven or by microwaves. The substrate is furthermore during the impingement of the components advantageously held on the substrate rest by way of a vacuum. Since with the substrate it is usually the case of a film-like or gel-like material, with this also a flat lying on the substrate rest is ensured without air pockets.

The invention also relates to a device for processing components arranged on a substrate, in particular semiconductor chips, according to the preamble of claim 5. This device is particularly suitable for carrying out the method according to the invention, but may also be applied in other manners. The device in particular is to ensure that inspite of the processing of the components in groups, their individual nature is taken account of as with an individual processing. This is achieved by a device which comprises the features in the characterising part of claim 5.

The individual and displaceably mounted plungers in the tool permit each individual component of a group to be processed individually. Conceivable therefore would be the exertion of an individual pressing force and/or an individual temperature. The individual plungers may be shaped diferently so that within a group various sizes and shapes of components may be impinged.

With the above mentioned manufacture of semiconductor elements however as a rule only the differing heights of the raw silicon chips need be taken into account. This is preferably effected in that the plungers are in active connection with a compensation means. This compensation means may function according to differing technical principles. Thus for example a purely mechanical solution would be conceivable, with which in a neutral home position of the tool the displaceable plungers are applied loosely onto the components. Via a central locking then all plungers are locked in their sliding bearing whereupon via the tool the pressing force is exerted via the individually adjusted plungers. It would however also be conceivable to allocate to each individual plunger a pressure means cylinder whose allowable inner pressure may be individually controlled.

In a particularly simple manner the compensation means however is formed by a fluid chamber for the hydrostatic distribution of the impingement force onto the individual plungers. The fluid chamber functions according to the known principle, according to which in a practically non-compressible still fluid, the pressure forces propagate indepenent of direction. With this each of the plungers could with an equal impingement surface submerse into the fluid chamber whose walls are otherwise rigid.

A technically considerably more simple solution lies in arranging the fluid chamber on the rear side, of the plunger, which is

distant to the substrate rest and for it to comprise a flexible membrane, wherein the rear sides of the plunger bear on the membrane. The volume in the chamber always remains the same size, independently of how the plungers are positioned. With this the elasticity of the membrane within a certain tolerance region permits a displacement of the plungers. The pressure in the fluid and thus the pressure on the individual plungers with this however remain constantly equal.

For monitoring and control or where appropriate also for protocolling the pressing force acting on the plungers the fluid chamber may be in active connection with a pressure sensor. It is also with tools without fluid chambers generally advantageous to control the pressing pressure of the tools via a pressure sensor, in order to approximate the pressing force during the whole pressing duration to a nominal value. In particular pressure sensors, but also other sensors, e.g. force sensors may be applied.

The plungers could be mounted in a plunger guide which for heating the plunger is provided with a heating device. The plungers may with this, indirectly via at least one heating device, be heated to process temperatures of up to 300°C. Preferably the plunger guide and the plunger consist of the same metallic material so that no jamming occurs with the thermic expansion. The plungers specifically must be guided in the plunger guide with a very small play so that exclusively vertical forces and no transverse forces act on the working surface of the plungers. For the same reason the plunger guides in relation to the diameter of the plungers are formed relatively long.

In order to prevent the irradiation of heat or to protect the operating personnel, the tool at least partly may be surrounded

by a heat-insulating layer. The same also applies to the substrate rest in the case that this is likewise heated by way of a heating device. So that also the operating temperature may be monitored and protocolled in the tool as well as in the substrate rest there is arranged at least one temperature sensor.

For safety reasons the plungers in the idle condition of the tool are biased into a neutral home position in which they are preferably completely retracted into the tool. In this manner the plungers may not be damaged when the tool for example for re-equipping work is removed from the tool mounting. Furthermore it is thus ensured that the plunger rear sides in the home position bear uniformly on the membrane of the fluid chamber. Finally with the spring biasing it is also ensured that the plungers for the optimal heat accommodation after each operating stroke again completely submerge into the plunger guide.

The substrate rest rests preferably on an adjustable three-legged stand. By way of this the substrate rest in a particularly simple manner may be aligned plane-parallel onto the working plane of the plungers. Also this measure serves the prevention of transverse forces acting on the components.

The device may in particular be used for re-pressing the chips in a line for manufacturing chip scale packages (CSP), in particular ball grid arrays (BGA) or flex BGA's. With the same devices however also other processings in semiconductor manufacture may be carried out. Thus for example in the field of flip chips, wherein the chips are adhesed with bumps, are eutectically fastened or are soldered. The device is however also suitable for LOC processes (lead on chip) with which the connection between the chips and a metallic lead frame is manufactured under pressure and temperature. Finally it would however also be

conceivable to apply the device according to the invention also outside semiconductor technology, for example in the field of electro-technology or opto-technology.
Further advantages and individual features of the invention result from the subsequent description of one embodiment example and from the drawings. There are shown:

Figure 1 a heavily simplified perspective representation of a treatment method,

Figure 2 a schematic representation of a treatment device,

Figure 3 a cross section through a group of components with a differing constructional size, and

Figure 4 a schematic whole representation of the device according to Figre 2 in a press.

Figure 1 shows a cutout of a manufacturing line for the manufacture of semiconductor elements. With this there is represented a placing-on station 5 and an re-pressing station 6, which however both may be a part of the same installation. On a substrate advance 18 by way of suitable advance means, not shown in more detail here, a substrate 2 is displaced forwards in the arrow direction a. With the substrate it may with this be the case of a polyimide film which at a previous working station is coated over a large surface with an adhesive material.

At the placing-on station, with means known per se, for example with a conventional die bonder, silicon chips 1 are deposited onto the substrate 2. The chips with the help of a receiving arm 20 are removed from a wafer 19 and placed. The receiving arm with this swings to and fro in the arrow direction b and it may

furthermore be moved in the three various spacial axes x, y, z. With this also a turning of the relative position of the chip and the wafer and the substrate is possible (flip chip).

As soon as at the placing-on station 5 a group 4 of chips 1, which is previously defined with respect to position, is deposited, the substrate is transported further to the re-pressing station 6. These chips with this may not displace with respect to position, although there does not yet exist an intensive connection to the substrate. A permanent connection is only achieved by the re-pressing and the heating with the help of a tool 3. With this processing the substrate 2 lies on a plane substrate rest 8. The tool 3 may in the arrow direction c be pressed plane-parallel against this substrate rest. To each individual chip 1 on the substrate 2 in the tool 3 there is allocated an individual plunger 7 which likewise is displaceably mounted in the arrow direction c. The substrate rest 8 stands on a three-legged stand 29 whose relative position may be set with adjusting screws 30. This adjusting possibility permits a plane-parallel adaptation to the working surface of the plunger. The adjusting procedure may also be automised with the help of means known per se.

The tool 3 is during a certain pressing time pressed against the substrate rest 8, wherein via the plunger 7 or via the substrate rest simultaneously the adhesive is cured by heating. During this pressing time at the placing-on station 5 in turn a new group of chips is deposited onto a new substrate.

Further details of the re-pressing station 6 are viewable from Figure 2. The substrate rest 8 rests on a machine frame 21. For fixing the substrate 2 in an exactly defined pressing position there are provided suction openings 16 which via a suction con-

duit 23 are connectable to a non shown vacuum source. The substrate rest may be heated by way of an incorporated heating cartridge 14'. For the temperature control there serves a temperature sensor 17'. In order to prevent heat losses the substrate rest is shielded with respect to the machine frame by a heat insulation 15.

The tool 3 by way of a tool mounting 22 may be tensioned into the extension arm 28 of a conventional press 27 (Figure 4). The tool has a plunger guide 13 in which the individual plungers 7 are displaceably mounted in an axis-parallel manner. Beyond all plunger rear sides there extends a fluid chamber 9 which is sealed with respect to the plungers by a flexible membrane 11. The plunger rear sides are pressed against the membrane under the biasing of compression springs 25 with the help of a driver plate 26. In this home position the plunger end-face sides 24 are furthermore retracted into the tool 3 or they run roughly in the same plane as the underside of the plunger guide 13.

The fluid chamber 9 is in active connection with a pressure sensor 12. Furthermore temperature sensors 17 are also arranged on the plunger guide 13. The heating of the plunger guide and thus of the plungers 7 mounted therein is effected likewise via at least one heating cartridge 14. Likewise the tool is covered as closed as possible with a heat-insulating layer 15.

The acting manner of the fluid chamber 9 is represented by way of Figure 3. On the substrate next to one another there are arranged three chips 1a, 1b, and 1c. The chip 1a has with this the predetermined nominal construction height H1 whilst the chip 1b the minimum constructional height H2 and the chip 1c the maximal constructional height H3. If these three chips are pressed with the same pressing plate plane-parallel to the substrate rest 18

then the pressing plate would evidently load chip 1c the most and possibly damage it, whereas the chip 1b possibly would not be loaded at all. According to the invention however each plunger as a result of its displaceability may adapt to the constructional height of the chip, whilst by way of the bearing on the flexible membrane 11 a uniform pressing force distribution is ensured. According to the press, per plunger a pressing force of up to 9 bar may be exerted.

Patent claims

1. A method for processing components (1) arranged on a substrate (2), in particular semiconductor chips, with which the components are placed onto the substrate and for the permanent connection to the substrate where appropriate using an adhesive are impinged by a tool (3) and are subjected to a pressing pressure and/or to a heat treatment, characterised in that on the substrate there are placed several components after one another or with one another to a group (4) and that subsequently the whole group is simultaneously subjected to the pressing pressure and/or to the heat treatment.

2. A method according to claim 1, characterised in that the placing of the components (1) onto the substrate (2) and the impingment with the tool (3) is effected at working stations (5, 6) arranged at a distance from one another.

3. A method according to one of the claims 1 or 2, characterised in that each component (1) of the group (4) is impinged with a separate plunger (7) and that with the impingment, for achieving a uniform contact force on all components, each plunger is adapted to the individual heights of the component.

4. A method according to claim 3, characterised in that before and/or during the impingment of the components the plungers and/or a substrate rest (8) serving as a counter bearing are heated.

5. A device for processing components (1) arranged on a substrate (2), in particular semiconductor chips, with a sub-

strate rest (8) and with a tool (3) which is movable against the substrate rest, for impinging the components by way of pressure and/or heat, characterised in that the tool (3) for the simultaneous impingement of a group (4) of components comprises several plungers (7) which are individually displaceably mounted in the movement direction of the tool (3).

6. A device according to claim 5, characterised in that the plungers (7) are in active connection with a compensation means for compensating differing heights of the components (1) during the impingement.

7. A device according to claim 6, characterised in that the compensation means is a fluid chamber (9) for the hydrostatic distribution of the impingement force onto the individual plungers (7).

8. A device according to claim 7, characterised in that the fluid chamber (9) is arranged on the rear sides (10), of the plungers (7), which are distant to the substrate rest, and comprises a flexible membrane (11) and that the rear sides of the plungers bear on the membrane.

9. A device according to one of the claims 5 to 8, characterised in that the plungers (7) are mounted in a plunger guide (13) which is provided with a heating device (14) for heating the plungers.

10. A device according to claim 9, characterised in that the plungers (7) and the plunger guide (13) consist of the same metallic material and that the heating device (14) is at least one electrical heating cartridge.

11. A device according to claim 9 or 10, characterised in that the tool (3) is at least partly surrounded by a heat-insulating layer (15).

12. A device according to one of claims 5 to 11, characterised in that in the tool as well as also in the substrate rest there are arranged temperature sensors for monitoring the treatment temperature.

13. A device according to one of the claims 5 to 12, characterised in that the plungers (7) in the idle condition of the tool (3) under spring bias are biased into a neutral home position in which they are preferably completely retracted into the tool.

14. A device according to one of the claims 5 to 13, characterised in that the substrate rest (8) rests on a three-legged stand which is adjustable for the plane-parallel alignment of the substrate rest onto the plane of the plungers.

15. A device according to one of the claims 5 to 14, characterised in that the pressing pressure of the tool (3) is controllable via a sensor (12) mounted on the tool, in particular a pressure sensor.

16. A device according to one of the claims 7 or 8 in combination with claim 15, characterised in that pressure sensor (12) is in active connection with the fluid chamber (9).

17. The use of a device according to one of the claims 5 to 16, for the re-pressing of the chips in a line for manufacturing chip scale packages (CSP's), in particular ball grid arrays (BGA's).