United States Patent

Glass

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[54] SEMI-CONDUCTOR DEVICES AND THE MANUFACTURE THEREOF

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Related U.S. Application Data

[63] Continuation of Ser. No. 688,395, Dec. 6, 1967, abandoned.

[30] **Foreign Application Priority Data**

Jan. 30, 1967 Great Britain 4,382/67

[52] **U.S. Cl.** **29/578,** 29/580, 29/589, 156/17

[51] **Int. Cl.** **B01j 17/00,** H01l 5/00

[58] **Field of Search** 29/578, 590, 591, 580, 576, 29/589; 156/17

[56] **References Cited**

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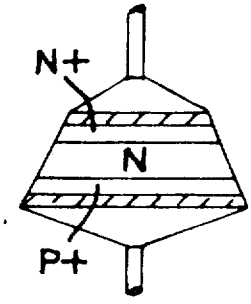
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[57] **ABSTRACT**

Unequal diameter pinheads, soldered to silicon chip, so that etch produces chamfered diode.

6 Claims, 2 Drawing Figures



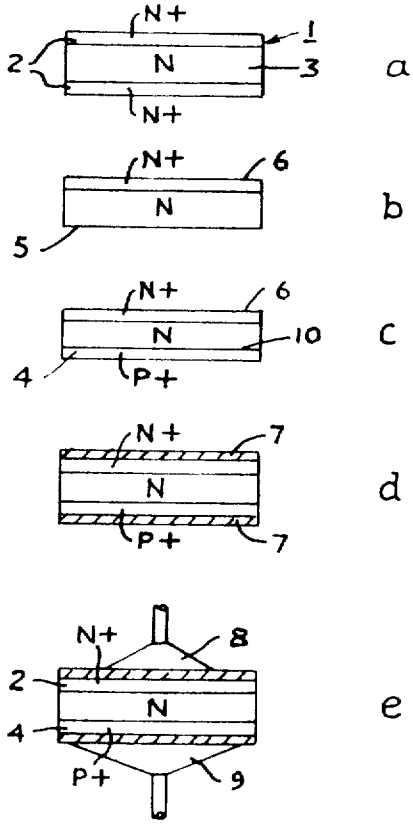


Fig. 1.

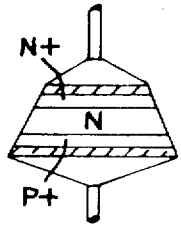


Fig. 2.

SEMI-CONDUCTOR DEVICES AND THE MANUFACTURE THEREOF

This is a continuation of U.S. Pat. Ser. No. 688,395, filed Dec. 6, 1967.

This invention relates to semi-conductor devices and the method of manufacture thereof.

The present invention provides a method of manufacturing a semi-conductor device, which method includes the steps of mounting one on each of two opposed faces of a semi-conductor element having therein a P-N junction, a pair of terminal members or contacts each of which has a face adjacent the respective one of the two opposed faces of the element, said face of one of the contacts being of lesser area than said face of the other of the contacts and said faces of the two contacts both being of no greater dimension in any direction than the dimension in the corresponding direction of the face of the element adjacent which it is, and thereafter etching away material from the semi-conductor element from areas thereof not covered by the contacts to provide the semi-conductor element with a peripheral face which extends between the two contacts and slopes inwardly of the element from the contact having said face of larger area to the contact having said face of smaller area, the periphery of the P-N junction then lying on said peripheral face.

The said faces of the pair of terminal members or contacts may each be circular, the diameter of the face of lesser area being less than the diameter of the face of greater area and the faces being arranged co-axially, and after the etching away of the material, the peripheral face is frustro-conical.

The zone of the element of that side of the P-N junction adjacent the contact having the face of lesser area may have a relatively high resistivity to that of the zone of the element on that side of the the P-N junction adjacent the other of the contacts.

The angle between the peripheral face and said face of larger area of the two contacts may be less than 60°.

The contacts may be of silver.

The element may have deposited thereon an alloy which includes nichol and gold, the contacts subsequently being soldered to the alloy.

The present invention further provides a semi-conductor device manufactured in accordance with the above designed methods.

One embodiment of the present invention will now be described, by way of example only, with reference to the accompanying drawing of which:

FIGS. 1*a* to 1*e* illustrate various steps in the method of manufacture of a semi-conductor device, and

FIG. 2 shows a cross sectional view of a device manufactured in accordance with the method illustrated in FIG. 1.

It will be appreciated that in normal manufacturing techniques the steps illustrated in FIGS. 1*a* to 1*d* inclusive are normally carried out on a large crystal of semiconductor material which is subsequently divided into the "chips" or "pellets" such as is shown, but for the sake of clarity only a single pellet is shown.

There is shown in FIG.1*a* a pellet 1 of intrinsically N type silicon into which phosphorus is diffused in a furnace to form the N+ type layers 2 with a layer 3 of intrinsic N type material remaining unchanged in the center of the pellet 1 as illustrated. On one surface 5 the N+ type material is subsequently lapped off as shown in FIG.1*b*.

A P+ type layer 4 as shown in FIG.1*c* is then formed in the pellet 1 by diffusing Boron into the surface 5 of the N type layer 3 to form a PN junction 10. The Boron will not penetrate the N+ type layer 2 since when this layer is formed a layer of phosphosilicate glass is deposited n the surface 6 of the layer 2 through which the Boron cannot penetrate.

The surfaces 5, 6 of the pellet 1 are then cleaned to remove any deposits such as the phosphosilicate glass before a layer 7 of an alloy containing nickel and gold is deposited thereon by a known technique such as plating, as shown in FIG.1*d*. Terminal members 8 and 9, which in the present embodiment are of silver, are then soldered in a furnace to the layer 7 of nickel/gold alloy (FIG.1*e*).

The device thus formed is subjected to an etching process which removes the silicon from the portion of the pellet 1 which is not covered by the terminal members 8, 9, to produce the device illustrated in FIG. 2.

In such devices it is desirable to have a chamfered peripheral face in the region of the PN junction to increase the surface breakdown voltage of the device. In order to obtain the desired characteristics it is necessary that the resistivity of the material on the side of the PN junction nearer to the larger surface is lower than the resistivity on the side of the PN junction nearer to the smaller surface.

In the specific embodiment, therefore, the P+ layer 4 is of relatively low resistivity, the N type layer 3 is of relatively high resistivity and the angle between the terminal member 9 on the peripheral face of the element is less than 60°.

It is, therefore, necessary before the terminal members 8, 9 are secured to the pellet 1 that a polarity check be made to ensure that the smaller terminal member 8 is secured to the pellet on the side of the N+ type layer 2, and the larger terminal member 9 on the side of the P+ type layer 4.

The device is finally completed with a coating of a protective material such as varnish, resin or rubber.

I claim:

1. A method of manufacturing semi-conductor device, which method includes the steps of forming a discrete semiconductor pellet from a crystal of semi-conductor material by dividing said crystal of material into a plurality of said discrete pellets, said pellet having therein a P-N junction lying between two opposed faces thereof, subsequently mounting, one on each of two opposed faces of said semi-conductor pellet, a pair of electrical terminal members and associated leads, each said terminal member having a face adjacent the respective one of the two opposed faces of the pellet, said face of one of the terminal members being of lesser area than said face of the other of the terminal members and said faces of the two terminal members both being of no greater dimension in any direction than the dimension in the corresponding direction of the adjacent face of the pellet is, and thereafter etching away material from the semi-conductor pellet from areas thereof not covered by the terminal members to provide the semi-conductor pellet with a peripheral face which extends between the two terminal members and slopes inwardly of the element from the terminal member having said face of larger area to the terminal member having said face of smaller area, the periphery of the P-N junction then lying on said peripheral face.

2. A method as claimed in claim 1, wherein the said faces of the pair of electrical terminal members are each circular, the diameter of the face of lesser area being less than the diameter of the face of greater area, said faces being arranged co-axially and, after the etching away of the material, said peripheral face of said element being frustro-conical.

3. A method as claimed in claim 1 wherein the zone of the element on that side of the P-N junction adjacent the terminal member having the face of lesser area has a relatively high resistivity as compared with the zone of the element on that side of the P-N junction adjacent the other of the terminal members.

4. A method as claimed in claim 1, wherein after the etching away of material, the angle between peripheral face and the face of larger area of the two terminal members is less than 60°.

5. A method as claimed in claim 1 wherein the terminal members are constructed of silver.

6. A method as claimed in claim 1 wherein the element has deposited thereon an alloy which includes nickel and gold, the terminal members subsequently being soldered to the alloy.

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