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(54) IMPROVEMENTS IN SUPPORTS FOR SEMICONDUCTOR CRYSTALS

(71) We, PHILIPS ELECTRONIC AND ASSOCIATED INDUSTRIES LIMITED, of Abacus House, 33 Gutter Lane, London, E.C.2., a British Company, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention relates to supports for semiconductor bodies and to semiconductor devices comprising such supports.

Such a support, such as a base part of a semiconductor device envelope which usually consists of iron or an iron alloy, but alternatively may consist of copper, nickel or alloys of these metals, usually has a plurality of insulated electrical lead-through wires for which glass is the commonly used insulation material, and furthermore the semiconductor body is mounted on this base part. There is also a construction wherein the support and semiconductor body mounted thereon is embedded in a synthetic resin, the support being formed as part of a metal contact comb or contact strip. The mounting of the semiconductor body on the support is frequently effected with the aid of soldering, for example, by means of tin, an alloy of tin and indium or a eutectic alloy of gold and silicon. Since iron and iron alloys are poorly wetted by these soldering metals, a thin layer of gold is provided on the support which is wetted satisfactorily.

A fairly high temperature, approximately 1100°C, is necessary for making an adherent glass-to-metal seal when sealing lead-through wires in a support. During this thermal treatment growth of the crystals takes place in the iron or the iron alloy, so that a fairly coarse crystalline structure is created. The gold layer which is precipitated thereon likewise obtains a coarse crystalline structure and the result thereof is that the wetting properties of the gold become too good, namely to such an extent that the solder has already flown away over the gold surface before wetting of, and adherence to, the semiconductor body have been able to take place. As a result a poor soldered joint having many cavities is produced.

The experiments which led to the present invention showed that the phenomenon of the said gold layer obtaining a coarse structure when the layer underneath has also coarse crystallites probably must be ascribed to the fact that both gold and iron, copper, nickel and the usual alloys on the basis or iron, copper or nickel crystallize according to a cubic lattice. In fact, it was found that only when it is ensured that the gold layer is provided on a metal layer whose atoms or molecules are not present in a cubic packing in the lattice, this layer is deposited in a fine crystalline form.

According to the invention a support for a semiconductor body comprises a metal member selected from the group consisting of iron, an iron alloy, copper, nickel, and an alloy on the basis of copper or nickel, an outer layer of gold providing a surface for securing a semiconductor body to the support, and an intermediate layer consisting of a metal which crystallizes in a hexagonal close packing situated between the metal member and the gold layer.

The said intermediate layer functions as a growth barrier. The gold layer, which is applied, for example, by way of electroplating or by chemical reduction from a solution of a gold salt on the intermediate layer then does not adapt to the naturally coarse crystalline structure of the metal member but is precipitated in a fine crystalline form. This fine crystalline gold has the properties required for the desired wetting by a solder material. As a result a good soldered joint is obtained between the support and the semiconductor body.

Cobalt crystallizes in an alternately

hexagonal and cubic packing. For the relevant purpose cobalt has the additional advantage that it does not substantially dissolve in gold so that substantially no gold diffuses into the layer underneath during soldering of a semiconductor body to the support. The use of a cobalt intermediate layer may permit a thinner gold layer to be used.

Ruthenium, osmium, rhenium, titanium or zirconium are also suitable as materials for the intermediate layer.

An embodiment of the invention will now be described in detail by way of the following Example.

Supports in the form of base parts of envelopes for semiconductor devices, which base parts consist of round plates of an iron alloy of the composition in % by weight Fe 54, Ni 28 and Co 18 and having current conductors led through *via* glass beads were electrolytically coated with a cobalt layer of from 0·2μ to 2μ thickness by means of an aqueous solution having a pH of 3—4 which contained per litre:

$CoSO_4 . 6H_2O$	200 g.
NaCl	20 g.

and boric acid until saturation. This bath was used at a temperature of 50°C and a current density of 1—3 A/sq.dm. A gold layer of from 1μ to 2μ thickness was provided on said layer by electroplating by means of an aqueous electrolyte containing per litre:

15—25 g $KAu(CN)_2$ and
50 g of citric acid

which was brought by addition of KOH to a pH of 6. This bath was used at a temperature of 60°C and a current density of 250 mA/sq.dm.

A silicon crystal was secured thereto by means of soldering with the aid of solder having the eutectic composition of Au—Si with 6% by weight of Si at a melting point of 378°C. An adherent joint was obtained.

WHAT WE CLAIM IS:—

1. A support for a semiconductor body comprising a metal member selected from the group consisting of iron, an iron alloy, copper, nickel, and an alloy on the basis of copper or nickel, and outer layer of gold providing a surface for securing a semiconductor body to the support, and an intermediate layer consisting of a metal which crystallizes in a hexagonal close packing situated between the metal member and the gold layer.

2. A support as claimed in Claim 1, wherein the intermediate layer consists of cobalt.

3. A support for a semiconductor body substantially as herein described in the Example.

4. A semiconductor device comprising a support as claimed in any of the preceding Claims having a semiconductor body secured thereto by soldering.

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