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PRODUCTION OF WAFERS OF SEMI-CONDUCTOR MATERIAL

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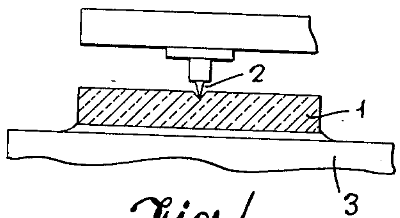

Fig.1.

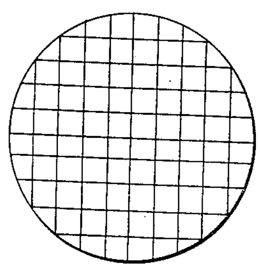

Fig.2.

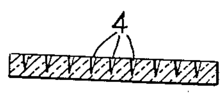

Fig.3.

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PRODUCTION OF WAFERS OF SEMI-CONDUCTOR MATERIAL

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2 Claims. (Cl. 156—17)

This invention relates to the production of wafers of semi-conductor material, e.g. germanium, from slices of monocrystalline material, the wafers being required for use in producing rectifiers and transistors.

In producing wafers of semi-conductor material it is the usual practice to cut a slice from a monocrystalline ingot of the material and then divide the slice into sections, usually of rectangular shape, for incorporation into semi-conductor devices, the separation into sections of the slice being effected by an abrading device, e.g. a diamond wheel, or by the reciprocatory action of a thin wire loaded with abrasive over the slice. The sections, or wafers, so produced possess rough edges possibly in a state of strain and this may lead to the subsequent fracture of the wafer, or to a readiness to fracture when subjected to stress.

The object of the present invention is to provide an improved process for producing the wafers from the slice in which this disadvantage is avoided.

The method of separating into sections a slice of mono-crystalline semi-conductor material, according to the invention, consists in cutting the slice along a plane substantially parallel to a principal plane of the crystal, scribing on the slice a pattern representing the lines of separation between the sections, and then etching the scribed slice by a reagent which preferentially attacks the strained regions of the semi-conductor in the vicinity of the scribed lines.

In this way wafers with smooth edges are formed and it is believed that during the etching treatment any strains present in the edges of the wafers are released.

The invention will be better understood from the following description of the accompanying drawings, in which:

FIG. 1 illustrates in elevation the scribing of the slice of semi-conducting material,

FIG. 2 shows in plan view a slice of semi-conducting material after scribing, and

FIG. 3 illustrates in cross-section a slice after etching.

Referring to the drawings, a slice 1 of mono-crystal semi-conducting material, e.g. mono-crystalline germanium, is cut from an ingot of mono-crystalline germanium obtained perferably by crystal pulling from a mass of molten germanium; the method of obtaining such an ingot is now well known in the art. The ingot is cut transversely to its longitudinal axis by any suitable means, e.g. an abrasive wheel, to obtain the slice 1. The slice may be of about 0.020″ thick and is preferably cut from the ingot in a manner such that the face of the slice is parallel to a principal plane, preferably a 1.1.1. plane, of the crystal. The slice is then lapped to a thickness of about 0.006″ to obtain the slice 1 indicated in the drawing. If the slice can be successfully cut to the required smaller thickness, the lapping step

is rendered unnecessary. The slice is then placed in an etching bath for a measured time period after which it is removed and its thickness measured so that the etching rate of the bath can be calculated.

The slice 1 is scribed suitably by drawing a sharp instrument 2 across the face of the slice. A suitable instrument is in the form of a diamond probe. During scribing the slice 1 may be secured to a supporting plate 3 by means, for example, paraffin wax or a suitable adhesive. The scribing is effected in a pattern representing the lines of separation between the wafers to be obtained from the slice. A suitable pattern is that indicated in FIG. 2 where the scribed lines form a rectangular lattice. Since a number of parallel scribed lines are made in producing this lattice a corresponding number of sharp probes may be employed simultaneously. A plurality of slices may be supported on the plate 3 so as to be scribed in succession. This requires that the slice, or slices, are arranged to pass under the scriber in two separate passes in directions normal to one another.

As mentioned above the thickness of the slices should be about 0.006″ before scribing. If the slice is cut from the mono-crystalline ingot in a direction parallel to the (1.0.0.) plane of the crystal the thickness of the slices may be increased to 0.012″.

After scribing the slice is removed from the plate 3 and the scribed slice is then replaced in the etching bath for a time sufficient to reduce its thickness to a value of 0.002″. The time required for the etching step may be estimated from the etching rate of the bath as determined by the reduction in thickness of the slice initially obtained when the slice was introduced into the bath for a measured time period.

When the scribed slice is introduced into the etching bath the scribed lines are preferentially attacked by the etching reagent by reason of the irregularities produced in the crystal by the scribing. As a result of this preferential attack on the slice at the scribed lines deep cavities or chasms 4, as indicated in FIG. 3, are produced in the slice with the result that the slice breaks into the desired wafers. Further etching of the waters produced in this way reduces only the thickness of the wafers and the process is allowed to continue until the desired thickness is reached.

A reagent suitable for forming the etching bath employed for treatment of the germanium is as follows:

15 ccs. hydrogen peroxide (100 vols.)
15 ccs. potassium hydroxide soln. (20%)

The temperature of the bath should be maintained between 70° C. and 80° C., and agitation of the reagent, during etching, is preferable. It is found that the etching rate varies from 0.0002″ to 0.0003″ per minute, but that for a given bath-slice combination within the above temperature range the etching rate is constant. Temperatures below 70° C. and above 80° C. reduce and increase, respectively, the etching rate. If etching to chemical exhaustion of the reagent is adopted, temperature and time could be eliminated as control elements in the reaction.

It has been found that the slice having an initial thickness of 0.006″ introduced into the etching bath above mentioned has its thickness reduced to 0.002″ in a time of about 20 minutes when the bath is maintained at a temperature of between 70° and 80° C. The breaking of the slice into the desired wafers is also effected during this period.

What we claim is:

1. The process of separating into sections a slice of mono-crystalline germanium which consists in cutting a slice from an ingot of mono-crystalline germanium, said slice being cut along a plane substantially parallel to a 1.1.1. plane of said crystal, scribing on said slice a rectangular pattern representing the lines of separation between desired sections, so as to introduce strain into the scribed regions of the crystal, etching said slice by an etching bath which preferentially attacks the strained regions of said semi-conductor material in the vicinity of the scribed lines until said slice breaks into sections determined by said pattern and continuing the etching until the sections have attained a prescribed thickness.

2. The process according to claim 1, in which said etching bath comprises substantially equal proportions of hydrogen peroxide and potassium hydroxide, said bath being maintained at a temperature of between 70° and 80° C. during etching.

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