2104723

(18)

METHOD OF MANUFACTURING SEMICONDUCTOR SUBSTRATE AND SUBSTRATE SO MANUFACTURED

This invention relates to method of manufacturing semiconductor substrate and substrates so manufactured.

In a conventional method of manufacturing a semiconductor substrate having a monocrystalline semiconductor layer on an insulating film, a silicon semiconductor layer is formed by an expitaxial growth technique on a monocrystalline sapphire base member. This is the so-called SOS (Silicon-on-Sapphire) technique. However, in this conventional method there is no crystal surface where the lattice constant of the sapphire base member is in accord with the lattice constant of the monocrystalline semiconductor layer grown thereon. The difference of lattice constant is, at best, only within several percent so that many crystal defects can be found in the mono-crystalline semiconductor layer.

Furthermore, as the sapphire base member is expensive, practical use of it is not as great as would be expected from the large demand for high-speed semiconductor devices on monocrystalline semiconductor layers on such base members.

According to the present invention there is provided a method of manufacturing a semiconductor substrate, comprising providing along the edge of a base member a seed for growing a monocrystalline layer of a given material, forming a polycrystalline or amorphous layer of said material in contact with the seed, maintaining the temperature of the base member lower than the melting point of said material, melting the polycrystalline or amorphous layer by applying radiation thereto in the region of the seed, and progressively moving the region of irradiation to grow a mono-crystalline layer of said material from the polycrystalline or amorphous layer.

The method may include forming an insulating layer on the base member, removing a portion of the insulating layer to expose an edge portion of the base member to act as the seed, and forming the poly-crystalline or amorphous layer on the insulating layer and the said exposed portion of the base member. Alternatively, the method may include locating the seed along the edge of the base member, forming

the polycrystalline or amorphous layer overlying the base member and the seed, and forming an insulating layer over the polycrystalline or amorphous layer.

According to another aspect of the invention, a method of manufacturing a semiconductor substrate comprises providing a seed for growing mono-crystal on an edge portion of a first solid layer, forming a second solid layer of polycrystalline or amorphous state which is at least in contact with the seed and covers the first solid layer, maintaining the temperature of the first solid layer lower than the melting point of the second solid layer, applying radiation in the form of an energy beam to the second solid layer, scanning the energy beam from a contact point of the seed with the second solid layer across the second solid layer to melt the second solid layer, and cooling the second solid layer to grow a mono-crystalline layer therefrom.

The invention is illustrated, merely by way of example, in the accompanying drawings, in which:-

Figure 1 illustrates a method of manufacturing a semiconductor substrate, according to the present invention; and

Figure 2 illustrates a modification of the semiconductor substrate of Figure 1.

An electrical carbon heater 21 is held at between 1200°C to 1300°C. A silicon base member 22 is placed on the carbon heater and the greater part thereof is covered with an insulating layer 23 which may be a single layer of silicon oxide (SiO_2) or silicon nitride (Si_3N_4) or a two-layered structure consisting of a silicon oxide (SiO_2) layer and a silicon nitride (Si_3N_4) layer. A part of the insulating layer 23 is removed by etching to expose an edge portion of the base member 22. The exposed part of the base member 22 constitutes a seed 24 for growing monocrystalline silicon since the base member itself is made of monocrystalline silicon. A polycrystalline silicon layer 25 is formed overlying the insulating layer 23 and the seed 24 by chemical vapour deposition technique. Radiation 26 such as an electron beam or laser beam extending in the X direction is applied to the seed 24 and moved in the Y direction

thus progressively melting the polycrystalline silicon layer 25 at about 1400°C, so that, on cooling, a monocrystalline silicon layer 27 grows continuously in the Y direction. Eventually all the polycrystalline silicon layer 25 becomes a monocrystalline silicon layer.

The semiconductor substrate of Figure 1 can be modified as shown in Figure 2 where a monocrystalline silicon seed 32 for growing a monocrystalline silicon layer is arranged on or in the edge of the surface of an insulating base member 31, for example, of quartz glass or ceramic material. The seed 32 is fixed to the base member by using a coating glass, or by trapping it under a polycrystalline silicon layer 33 which is formed by a chemical vapour deposition technique. A silicon dioxide insulating layer 34 covers the polycrystalline silicon layer 33 and is formed by a chemical vapour deposition technique. The polycrystalline silicon layer 33 is converted into a monocrystalline silicon layer as described in relation to Figure 1.

The semiconductor substrates are advantageous because there are no crystal defects since there is complete crystal integrity between the seed and the monocrystalline silicon layer formed from the polycrystalline silicon layer. Moreover, the substrate is relatively inexpensive to manufacture compared to sapphire substrates and is suitable for the manufacture of high-speed semiconductor devices.

* C L M S *

CLAIMS

1. A method of manufacturing a semiconductor substrate, comprising providing along the edge of a base member a seed for growing a mono-crystalline layer of a given material, forming a polycrystalline or amorphous layer of said material in contact with the seed, maintaining the temperature of the base member lower than the melting point of said material, melting the polycrystalline or amorphous layer by applying radiation thereto in the region of the seed, and progressively moving the region of irradiation to grow a mono-crystalline layer of said material from the polycrystalline or amorphous layer.

2. A method as claimed in claim 1, including forming an insulating layer on the base member, removing a portion of the insulating layer to expose an edge portion of the base member to act as the seed, and forming the polycrystalline or amorphous layer on the insulating layer and the said exposed portion of the base member.

3. A method as claimed in claim 1, including locating the seed along the edge of the base member, forming the polycrystalline or amorphous layer overlying the base member and the seed, and forming an insulating layer over the polycrystalline or amorphous layer.

4. A method of manufacturing a semiconductor substrate, substantially as herein described with reference to Figure 1 of the accompanying drawings.

5. A method of manufacturing a semiconductor substrate, substantially as herein described with reference to Figure 1, and as modified in Figure 2, of the accompanying drawings.

6. A method of manufacturing a semiconductor substrate, comprising providing a seed for growing mono-crystal on an edge portion of a first solid layer, forming a second solid layer of polycrystalline or amorphous state which is at least in contact with the seed and covers the first solid layer, maintaining the temperature of the first solid layer lower than the metling point of the second solid layer, applying radiation

in the form of an energy beam to the second solid layer, scanning the energy beam from a contact point of the seed with the second solid layer across the second solid layer to melt the second solid layer, and cooling the second solid layer to grow a monocrystalline layer therefrom.

7. A semiconductor substrate manufactured by a method according to any preceding claim.