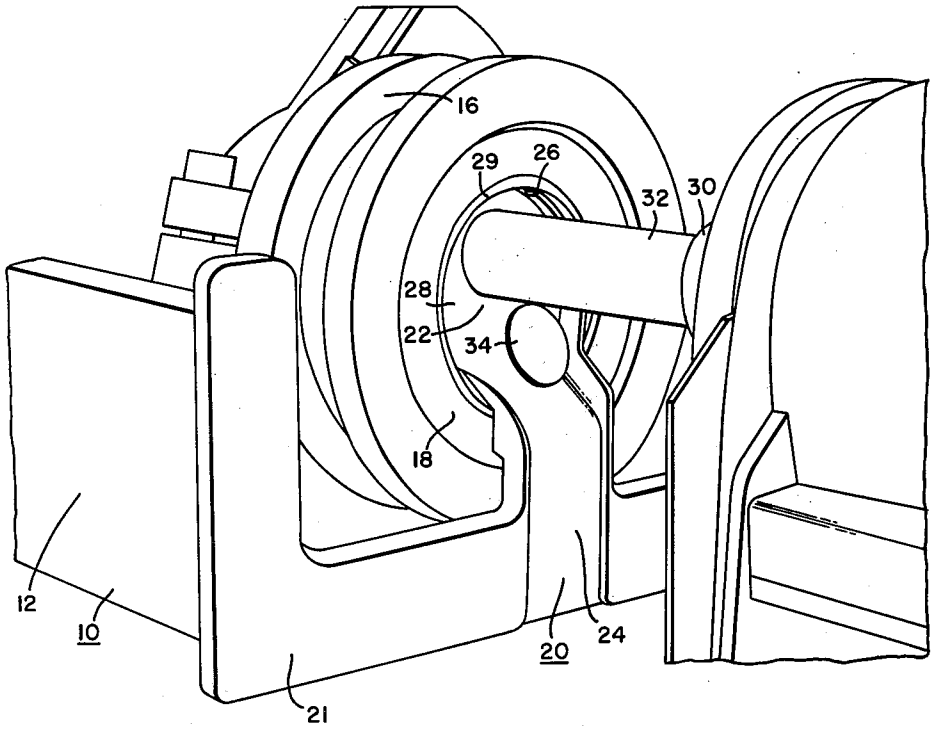
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SEMICONDUCTOR CRYSTAL SLICING DEVICE

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WITNESSES

John E. Hessler, Jr.

Raymond H. Majeska

INVENTORS
Alfred Meyerhoff &
Tibor Csakvari
BY

Frederick Hopper
ATTORNEY

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SEMICONDUCTOR CRYSTAL SLICING DEVICE

Alfred Meyerhoff and Tibor Csakvari, Greensburg, Pa., assignors to Westinghouse Electric Corporation, East Pittsburgh, Pa., a corporation of Pennsylvania

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The present invention relates to a semiconductor crystal slicing device.

Heretofore in the prior art, semiconductor manufacturers employed externally cutting diamond impregnated or bonded wheels for cutting silicon or other semiconductor material crystals. The wheels were usually relatively thin with diamond abrasive bound to the outer edge of a thin metal disk. One of the major problems arising with the use of such wheels is that they tend to buckle as they become thinner and thinner. To alleviate this problem, an annulus of steel was produced with diamonds bound to the inner edge or hole. Such cutting device is generally called an internally cutting diamond wheel. In this case the crystal ingot was mounted to a support and after slicing, the crystal slices remained attached to the support until the complete ingot was sliced, since various methods employed to receive the crystal slices after severance have proved unsatisfactory owing to the delicate fragility of the crystal slices especially if they are very thin.

In this procedure various problems were encountered. A cup-shaped frame was necessary to hold the cutting wheel on its outer edge or periphery. Therefore, the depth of the cup must be equal to the crystal length one wished to cut. The greater the length the greater the mass which must be revolved, and the sooner will be critical speed be reached at which the entire system will vibrate at its natural frequency. Therefore it is desirable to limit the depth of the cup in the supporting frame. For instance, if a crystal ingot of 10 inches in length is to be sliced and the cup is only 2 inches in depth, then the crystal bar must be severed initially into 2 inch sections. This step causes a loss in semiconductor material and entails extra operations. Next, before the first good slice can be obtained, a true-up cut must be taken, because severing the crystal into 2 inch sections cannot be readily performed with sufficient precision. Normally one millimeter of waste is allowed for this purpose. The same holds true for the end cut. A further source of trouble occurs when one of the wafers is not properly mounted in that it may separate from the crystal holder and be thrown against the wall of the cup imparted by the centrifugal force of the diamond wheel during rotation and it is easily crushed. Furthermore, a loose slice is likely to dislodge the remaining slices, resulting in even greater loss.

All of these problems are substantially eliminated if a suitable slice retriever as set forth herein is employed that will receive the individual crystal slices immediately after severance. In this case, the crystal need not be mounted on any type of bar for support and the length of the crystal ingot is not limited in any manner.

The object of the present invention is to provide a semiconductor crystal slice retriever suitable for use in cooperation with a semiconductor internally cutting crystal slicing device which permits the removal of the crystal slice away from the wheel after the completion of each cut, the retriever being spoon-shaped with a dished segment and a curved chute-shaped handle, a flange extending around one side of the outer periphery of the dished segment whereby the retriever may be disposed closely adjacent the internal cutting edge of a crystal slicing wheel to receive the slices immediately after severance.

Other objects of the invention will in part, be obvious and will in part, appear hereinafter.

In order to more fully understand the nature and scope of the invention, reference should be had to the following detailed description and drawing, the single figure of which is a perspective view of a semiconductor crystal slicing device employing, in combination, the crystal slice retriever.

In accordance with the present invention and in attainment of the foregoing objects, there is provided a semiconductor crystal slicing device in combination with an individual slice retriever. The device comprises a thin slicing wheel having an internal cutting edge. The wheel may be composed of a metal such as, stainless steel, with an abrasive coating on the wheel, such as, diamond or silicon carbide, the wheel having a thickness of about 6 mils or less. A wheel rim mount is attached to the outer periphery of the wheel to support the same and keep it rigidly aligned. The wheel rim mount may be composed of a metal such as aluminum when the wheel is composed of steel. The selection of the wheel and wheel rim mount materials is governed by their relative moduli of elasticity. The modulus of elasticity of the wheel rim mount preferably shall be less than that of the wheel so that the wheel mount or rim will expand to a greater extent than the wheel when both are subjected to centrifugal forces during rotation in the cutting process. The relatively greater expansion of the wheel rim mount causes the wheel to be exposed to tensile forces which cause the wheel to be rigid. If the slicing wheel is not under tension during the cutting process, buckling or flutter is liable to occur. A drive shaft is attached to the wheel mount or rim to rotate the slicing wheel and wheel mount. A suitably rigid housing frame is employed to support the slicing wheel, wheel rim mount and drive shaft so that each may be properly positioned with respect to each other.

A slice retriever is attached to the housing frame and is disposed in close proximity to the internal cutting edge of the slicing wheel and cooperates therewith to receive without damage the crystal slices immediately after they are severed and to guide them into a suitable receptacle. The slice retriever may be comprised of any material, such as stainless steel that is inherently nonreactive with semiconductor materials. A crystal bar holder is employed in a position relative to the frame housing to hold rigidly the crystal bar for successive incremental movement and for lateral feeding into the slicing wheel to cut the bar into slices.

Referring to the figure, there is shown a crystal slicing device with a slice retriever illustrative of the present invention. The device **10** comprises a housing support frame **12**. A drive shaft (not shown) projects through the housing support frame **12**. The drive shaft is attached to a housing (not shown) whose vertical position is adjustable. To the drive shaft in turn, is attached to a cup-shaped wheel rim mount **16** of aluminum, for example, to rotate the wheel mount at a high velocity. At the open end of the cup-shaped wheel mount and within the cup is secured an internally cutting slicing wheel **18** composed of steel, for example. A slice retriever **20** is secured to the housing frame **12** by means of brackets **21**. The retriever **20** is generally a spoon shape with a dished segment **22** and a curved chute shaped handle **24**. A flange extends on the left hand side of the chute shaped handle up to the segment **22**. A flanged portion **26** of the outer periphery of the dished segment **22** extends on the right hand side of the retriever almost but not fully up to the upper end of the segment **22**. The bowl **28** of the segment **22** is disposed closely adjacent to but within the internal cutting edge **29** of the slicing wheel **18**, a space of 0.02 to 0.03 inch is suitable.

A crystal bar holder **30** is employed to position a semiconductor crystal bar **32** in a desired position with respect to the plane of the cutting wheel **18** and capable of moving it from right to left into the cutting edge to cut off a slice, whereby immediately after severance of a slice **34** of the semiconductor crystal bar **32**, the slice is caught by the slice retriever **20** without any damage whatsoever to the slice. The slice is then allowed to slide gently into a receptacle (not shown) located beneath the chute handle outside of the slicing wheel **24**.

A silicon semiconductor bar of 6 inches in length was sliced in this manner employing a steel cutting wheel coated with a diamond material. Fifty perfect slices, each 13 mils thick, per inch of bar were readily obtained with a 6 mil wheel.

It should be understood that the foregoing description and drawing is only illustrative and not in limitation of the invention.

We claim as our invention:

1. A semiconductor crystal slicing device comprising, in combination, a slicing wheel having an internal cutting edge; a wheel rim mount attached to the outer periphery of the wheel; driving means to rotate the wheel and wheel mount; housing means supporting the wheel, wheel mount and driving means; a slice retriever associated with the housing means and having a portion disposed within and closely adjacent to the internal cutting edge of the slicing wheel and cooperating therewith to receive the crystal slices after they are severed and another portion to convey them outside the wheel; and a crystal bar holder to position the bar in a desired position to the cutting wheel for slicing.

2. A semiconductor crystal slicing device comprising, in combination, a slicing wheel having an internal cutting edge being comprised of a metal with an abrasive edge

and being of a thickness of not more than about 6 mils; a wheel rim mount attached to the outer periphery of the wheel, the modulus of elasticity of the rim mount being less than that of the slicing wheel; a drive shaft attached to the wheel rim mount whereby to rotate the slicing wheel; a housing frame supporting the wheel, wheel rim mount and drive shaft; a slice retriever attached to the housing frame of spoon-shape with a dished segment and a curved handle chute segment; a flange extending about one side of the outer periphery of the dished segment, the retriever being disposable through the slicing wheel so that it may be disposed within and closely adjacent to the internal cutting edge of the slicing wheel to receive crystal slices immediately after they are severed; and a crystal bar holder to position the bar in a desired proximity to the cutting wheel for slicing and means for traversing the holder and bar so that the wheel will cut a slice off the bar and the slice will be caught by the retriever and will slide down the chute handle to a position outside of the cutting wheel.

3. A semiconductor crystal slice retriever suitable for use in cooperation with a semiconductor internally cutting crystal slicing device, the retriever comprising a spoon-shaped member with a dished segment and a curved chute shaped handle, a flange extending around one side of the outer periphery of the dished segment whereby the retriever may be disposed closely adjacent the internal cutting edge of a crystal slicing wheel to receive the slices immediately after severance.

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