

[54] **METHOD FOR SCRUBBING THIN, FRAGILE SLICES OF MATERIAL**

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[56]

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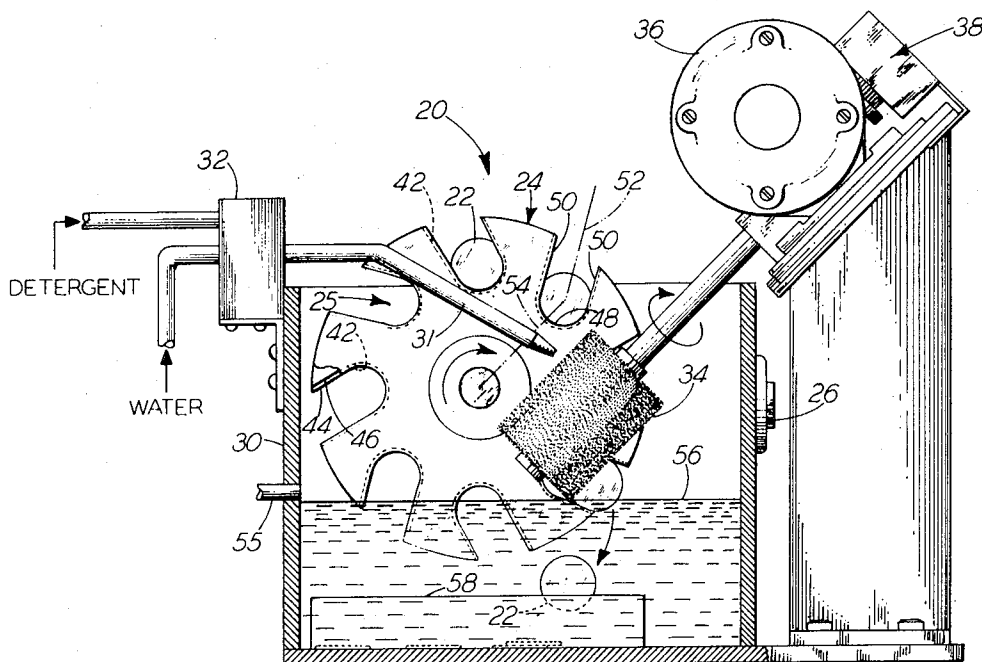
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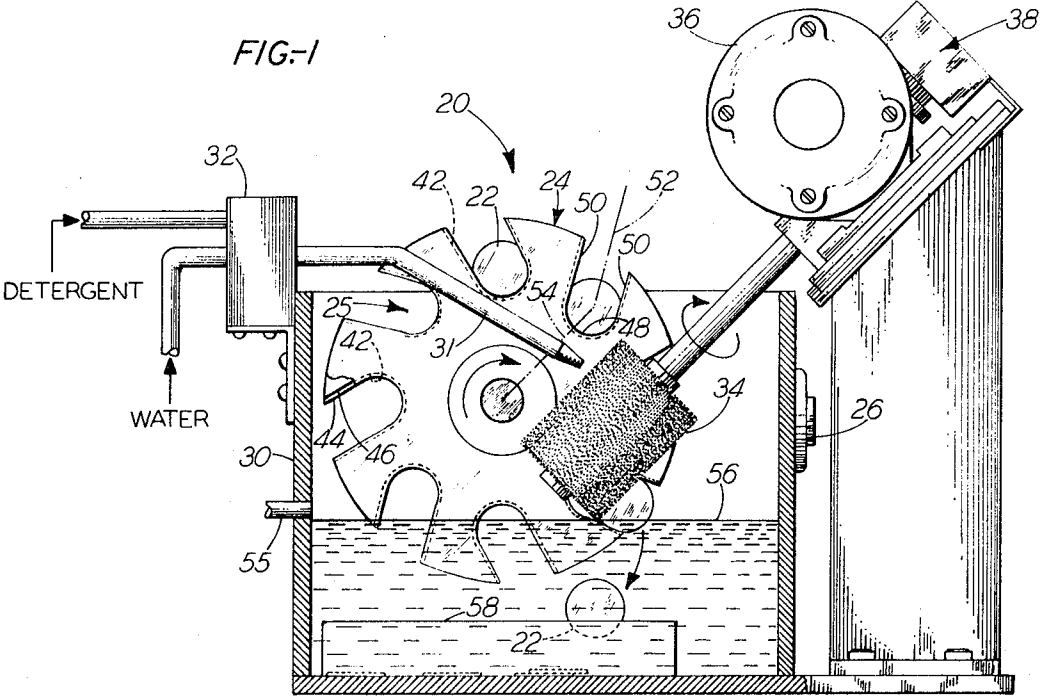
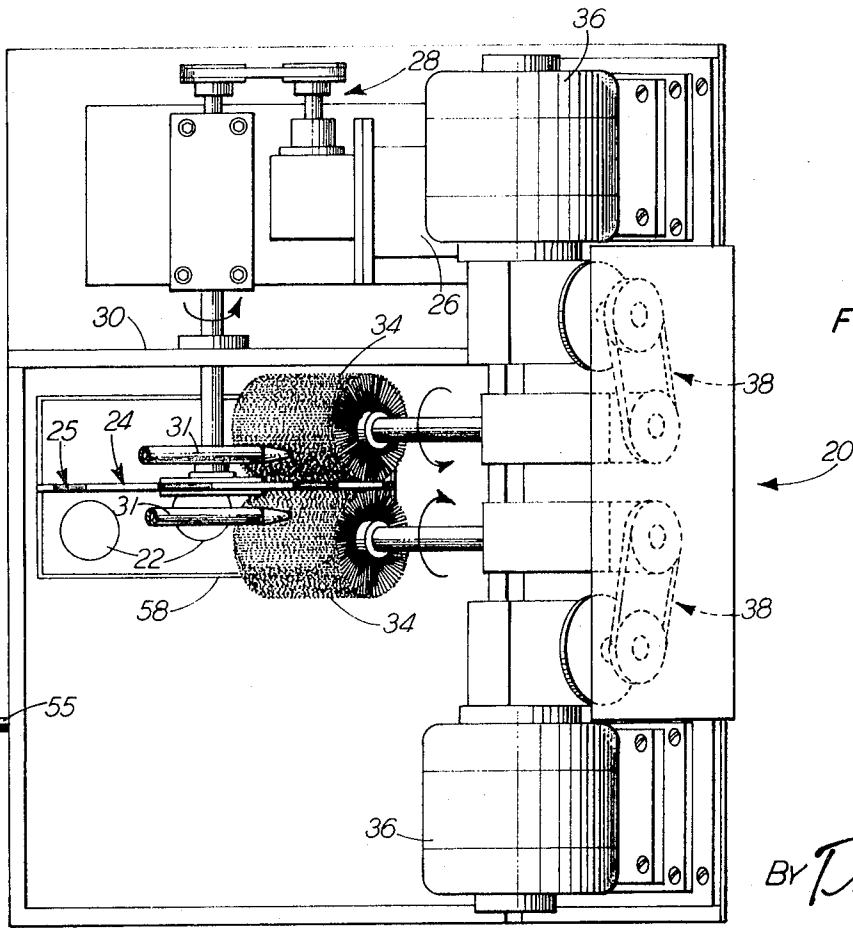
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ABSTRACT

Simultaneously, both sides of a thin, fragile slice of brittle material, such as single-crystal silicon, are scrubbed. The slices are loaded, one at a time, into a rotatable disc having pockets formed in the periphery thereof. The disc conveys the slices between two opposed counter-rotatable brushes within a detergent spray. After passing the rotatable brushes, the slices drop from the disc and float through the detergent bath to a container positioned below the disc.

5 Claims, 2 Drawing Figures





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METHOD FOR SCRUBBING THIN, FRAGILE SLICES OF MATERIAL

BACKGROUND OF THE INVENTION

1. Field of the Invention

This invention relates to methods and apparatus for scrubbing thin, fragile slices of material. More particularly, the invention relates to methods and apparatus wherein both sides of the thin slices are scrubbed simultaneously and wherein handling of the slices is minimized.

2. Description of the Prior Art

In the field of semiconductor manufacturing, a long standing problem has been elimination of manual processing steps and introduction of automatic machinery for performing these steps. One area which consumes a significant amount of processing time is cleaning of semiconductor material.

Semiconductor manufacturing typically starts with growing single crystal ingots and then cutting the ingots into thin slices of single crystal material. Some typical materials are silicon and germanium. Current semiconductor technology demands that the slices be quite thin, in the order of magnitude of 10 to 20 thousandths of an inch.

The thin slices, having been cut from a rod of bulk material must have residual particulate matter and cutting lubricants removed from their surfaces. Scrubbing is usually necessary. This scrubbing has been performed manually by placing each individual slice on a scrubbing pad and then brushing each side of the slices manually with a detergent solution. The operation has been performed manually because of the extremely fragile nature of the thin silicon or germanium slices.

Some mechanized apparatus has been available for scrubbing semiconductor slices but it can only scrub one side of a slice at a time. The slices must be initially loaded into such apparatus then unloaded, turned over and reloaded in order that both sides of a slice can be scrubbed. Such multiple handling has left a situation in which it is still more desirable to manually scrub devices than to use mechanized apparatus in the existing form.

SUMMARY OF THE INVENTION

It is therefore an object of the invention to provide a system for scrubbing thin, fragile slices of material wherein both sides of a slice are scrubbed simultaneously.

It is a further object of the invention to provide a system of scrubbing slices in which the handling of such slices is minimized.

These and other objects are realized by loading slices into pockets of a slice-conveying disc and rotating the disc between two oppositely rotating brushes which scrub the slices as they pass therebetween.

BRIEF DESCRIPTION OF THE DRAWINGS

Other objects and features of the present invention will be more readily understood from the following detailed description of specific embodiments thereof when read in conjunction with the appended drawings in which:

FIG. 1 is an elevational view of an inventive scrubbing machine with portions thereof removed for purposes of clarity; and

FIG. 2 is a plan view of the machine of FIG. 1.

DETAILED DESCRIPTION

Illustratively, the invention will be described in connection with scrubbing slices of single crystal silicon material having a thickness of 10 to 20 thousandths of an inch and having a diameter of 2 inches. However, it is to be understood that the method and apparatus will function quite successfully in the scrubbing of various types of thin, fragile slices of material having a range of dimensions quite diverse from those set forth in the example.

FIGS. 1 and 2 show a general arrangement of a scrubbing machine, designated generally by the numeral 20, in which the

inventive scrubbing method may be performed. Thin, fragile slices 22 of single crystal silicon material are deposited into a rotatable slice-conveying disc, designated generally by the numeral 24. The slices are loaded into slice holding pockets, designated generally by the numeral 25, one at a time, as the disc 24 continuously rotates. Rotation of the disc 24 is accomplished by a motor 26 and drive train, designated generally by the numeral 28.

The disc 24 rotates with a fluid-tight container 30. Both sides of the disc 24 are continuously sprayed with a water detergent solution comprised for example of 1 percent Igepal available from General Aniline and Film Corp., Grasselli, New Jersey. The solution emerges from jets 31 which are fed by a conventional metering unit 32 and a source of water.

Two rotatable brushes 34 are engaged with opposite sides of a portion of the disc 24 adjacent the spray impingement area. The brushes are driven by motors 36 and drive trains, designated generally by the numeral 38. The brushes can be, for example, 5 mil nylon, full-brush bristled type 2024—T4 aluminum core and shank, brush No. 38454 available from M. W. Jenkins Sons, Inc. Cedar Grove, New Jersey.

In an alternate arrangement, not shown, the container 30 can be operated as a holding tank with the water-detergent solution completely covering the brushes 34.

The slices 22 are held within the disc 24 in slice holding pockets 25. The slice holding pockets 25 are advantageously formed in the disc, fabricating the disc from three sheets of metal, an inner sheet 42 having a configuration generally as shown by the dotted line in FIG. 1 and two outer sheets 44 having configurations generally as shown by the solid lines in FIG. 1. The inner sheet 42 is made thicker than the slice 22 so that when the outer sheets 44 are spot welded to the inner sheet, a groove 46 is formed into which the outer periphery of one of the slices 22 can easily slide. For example, to accommodate a slice 0.015 inch thick the inner sheet should be approximately 0.030 inch thick.

Each of the pockets 25 has a composite shape made up of a semicircular portion 48 and a parallel-sided slot portion 50 connecting the semicircular portion with the outer periphery of the disc 24. A central axis 52 of the slot portion 50 is oriented at an angle of 30° with respect to a radial line 54 connecting the center of the disc 24 with the center of the semicircular portion 48.

The angular arrangement of the slot portion 50 has utility during discharge of the slice 22 from the disc 24. Because the slices 22 are loosely held within their respective pockets 25, they fall from their pockets when the axis of the slot portion 50 becomes oriented downwardly during rotation of the disc 24. As each of the pockets 40 is oriented downwardly and emerges beyond the brushes 34, the slice 22 within the pocket 24 begins to roll out.

The container 30 is provided with an overflow valve 55 positioned to maintain a cushioning bath 56 of the water-detergent solution a level just above the point where the slice 22 begins to roll from their respective pockets 24. The slices 22 are thus carried into the bath 56 before they emerge from their pockets 24. If the level of the bath 56 were lower, the slices 22 would fall through air prior to reaching the surface of the bath. This might result in some of the slices 22 striking the surface of the bath 56 with their diametrical surfaces, and such a situation would result in the slices floating on the surface of the bath due to surface tension. Floating of a slice 22 would permit drying of one side of the slice resulting in undesirable marking of the exposing surface.

When each of the slices 22 emerges in the bath 56, there is a cushioning effect exerted by the bath and each slice is gently dropped into a slice container 58 positioned below the disc 24. The orientation of the slot axis 52 with respect to the radial lines 54 contributes to a gentle rolling action of each of the slices 22 as they are discharged from the disc 24. This is very desirable because of the extremely fragile nature of the slices 22. As the slices 22 gently roll from their respective pockets 25 and float down to the container 58 under the cushioning effect of the bath 56, there is very little probability of breakage.

In order to take advantage of the novel technique of handling the slices 22 within the loosely fitting pockets 25, it is necessary to drive the brushes 34 in such a way that they tend to force the slices inwardly of the disc 24. This is accomplished by rotating each brush in opposite directions as shown by the arrows on FIG. 2.

The brushes 34 are arranged so that both sides of one of the slices 22 are contacted simultaneously. Thus, each side of the slice 22 is subjected to substantially the same lateral force by each of the brushes 34 and, as a result, substantially no tendency to bend or break the slice develops. In other words, the slices 22 are subjected to substantially pure compressive force components and virtually no bending force components enter into the scrubbing activity. Thin silicon slices are, of course, highly intolerant of bending and use of an arrangement other than opposed brushes would require full support across the surface of the slice. It is only the opposed brush arrangement which permits simultaneous scrubbing of both sides of the slices 22 and the very desirable reduction in occasions that each individual slice must be handled.

The motors 28 and 36 are provided with controls by which their rotatable speed may be varied. It is desirable to be able to vary the speed of rotation of the disc 24 in order to be able to synchronize the loading of the machine 20 with the disc rotation. Also, the rate of rotation of the disc 24 determines the length of time that one of the slices 22 will be subjected to the scrubbing action of the brushes 34. It is, of course, desirable to have the flexibility of being able to adjust the scrubbing time in order to compensate for such variations as different compositions of cutting lubricants and particulate contaminants which are to be removed from the surface of the slice.

It has been found that optimum scrubbing conditions are achieved with the brushes 34 of the type set out in the preceding example when they are rotated at a speed of 110-150 rpm.

During scrubbing of silicon slices which are 0.013 inch thick it has been found that a brush speed of 110 to 150 rpm provides optimum scrubbing where brushes of the type mentioned in the preceding example are used and where the center-to-center spacing of the brushes would provide for approximately ¼-inch overlap of the bristles.

Although certain embodiments of the invention have been shown in the drawings and described in the specification, it is to be understood that the invention is not limited thereto, is capable of modification and can be arranged without departing from the spirit and scope of the invention.

What is claimed is:

1. A method of scrubbing thin slices of fragile material, which comprises the steps of:
 - loading slices into loosely fitting pockets of a substantially planar, vertically-oriented, rotatable slice-conveying disc;
 - rotating the disc between two opposed rotating brushes engaged with opposite sides of the rotating disc to scrub the slices passing between said brushes; and
 - removing the slices from the disc which have been scrubbed by permitting the slices to fall through a fluid bath whereby the fragile slices are cushioned after their removal to reduce breakage.
2. A method of scrubbing thin slices of fragile material, which comprises the steps of:
 - loading slices into loosely fitting pockets of a substantially planar, vertically-oriented, rotating slice-conveying disc;
 - rotating a pair of opposed brushes in opposite directions in engagement with opposite sides of the rotating disc to scrub the slices passing between said brushes;
 - maintaining a fluid bath around a lower portion of said disc; and
 - removing the slices from the disc which have been scrubbed and which are at least partially submerged in the fluid bath by permitting the slices to fall through the fluid whereby the fragile slices are cushioned after their removal to reduce breakage.
3. The method of scrubbing of claim 2 wherein the brushes are rotated in a direction which causes the engaged slices to be urged inwardly of the disc.
4. The method of claim 2 wherein the slices are cleaned by spraying a detergent solution onto the slices during the scrubbing thereof.
5. The method of claim 3 wherein the brushes are rotated at a speed of between 110 and 150 rpm.

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