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APPARATUS FOR EDGE ETCHING OF SEMICONDUCTOR WAFERS

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16. Abstract

Device for use in the production of semiconductors, characterized in that the semiconductor wafer is etched in a rapidly rotating etching bath. The fast rotation causes the surface of the etching bath to assume the form of an paraboloid of revolution, so that the semiconductor wafer adjusted at a given height above the resting bath surface is only attacked by etchant at the edges.

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APPARATUS FOR EDGE ETCHING OF SEMICONDUCTOR WAFERS

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[Summary]

The device is used in the production process for semiconductor components on circular semiconductor wafers. It serves to etch away distortions on the wafer edges and to round the edges. This eliminates all sources of mechanical stress on the wafer edge, which in the thermal processes to produce semiconductor elements might act as sources of glide systems or displacements. Thus the wafer is kept from being rendered useless by such defects of crystal structure. The device is characterized in that the semiconductor wafer is etched in a rapidly rotating etching bath. The fast rotation causes the surface of the etching bath to assume the form of a paraboloid of revolution, so that the semiconductor wafer adjusted at a given height above the resting etching bath is only attacked by the etchant at the edges. The area of application of the invention is semiconductor technology.

Title of the Invention /1

Apparatus for edge etching of semiconductor wafers.

Area of Application

The invention concerns a process in the field of edge etching in semiconductor technology, preferably for the edges of circular semiconductor wafers.

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*Numbers in the margin indicate pagination in the foreign text.

Characteristics of Prior Technical Solutions

A single process is known -- Patent 26.43 750 -- that can be used for the round etching of circular semiconductor wafers, although the method was developed from a different viewpoint, namely to etch an n-conductive zone in solar cells. A drawback of this process is that the etchant gets onto the whole wafer and does not remain exclusively on the areas near the edge. This means that the entire surface of the wafer is more or less attacked, i.e. damaged. The wafer can be rendered completely useless in the cited process, particularly if the wafer has already undergone several process steps before etching. In the process, the circular wafer sits vertically on two horizontal rollers which in turn are wetted by the acid bath. By rotation, the rollers are covered with a thin film of acid which attacks the lateral surface of the semiconductor wafer standing on the rollers. The rotation of the rollers also causes the semiconductor wafer to rotate, so that the entire edge is etched over time by the acid bath. Now it is impossible to wet only the lateral surface part of the wafer, so that the acid film /2
picked up by the lateral surface finally runs over the entire wafer and damages it. The thickness of the acid film on the roller depends on the surface tension of the liquid and cannot be influenced.

Goal of the Invention

The goal of the invention is to eliminate wastage of semiconductor wafers due to mechanical edge distortions in semiconductor component production. It is estimated that internationally 75% of the waste of mechanical origin is caused by edge distortions. During the production process the edges and rims of the wafers are damaged, distorted. Such wafer defects can only be avoided by a fully automatic contact-free apparatus to transport the wafers to individual process steps.

Morphologically speaking, distortions are areas of high plastic deformation, i.e., of high mechanical stress, which arise by gliding and destruction of the ideally periodically structured lattice during the distortion process.

In all temperature processes necessary for component production, these distortions act as sources of displacements which under suitable thermal conditions can migrate through the entire crystal slice, increase rapidly in number by multiplication and reaction processes, and finally make the entire wafer useless for component production. One solution is to etch the wafer edges before the critical thermal processes, to remove the plastically deformed areas.

A simple protective lacquer coating of the wafer and subsequent dipping pickling process yield the following problems:

1. The acid preferably attacks at the lacquer/wafer boundary, generating a groove there that acts as a source of thermal stresses in the subsequent thermal process.

2. In general, the lacquer adheres variably to the wafer, so that the wafer is under-etched.

3. In concentrated etching baths, the lacquer is not entirely acid-resistant, so that thin points of the lacquer can be etched through. /3

4. Finally, these methods necessitate further steps in the already extensive and complicated process of semiconductor element production -- namely two-sided application of the protective lacquer, drying of the lacquer, cleaning the wafers after the etching process.

Under the invention, the goal is accomplished by etching the semiconductor wafer in a rapidly rotating acid bath. The specimen is housed in a vessel mounted centered on an axis of rotation with little play.

In its simplest configuration the vessel contains a mounting for the semiconductor wafer to be etched, with a precise height adjustment, as well as the acid bath, such that the acid and the wafer are not in contact. The axis of rotation is driven by an adjustable d.c. motor via a belt drive.

When the axis and thus the vessel are set in rotation, the liquid assumes the form of a paraboloid of revolution whose shape depends on the speed of rotation, the level of the acid in the vessel and the internal radius of the latter.

By correctly selecting these three parameters and the height of the wafer to be etched above the resting surface of the liquid, at a certain rotational frequency one achieves the correct wetting of the wafer edge by the etching solution and thus the wafer edge is etched off without grooving.

The wafer, together with its mounting, is fixed to the device and rotates at the same speed as the bath. If this were not so, the forces of friction would generate severe turbulence at the wafer/bath interface, which would counteract the development of a steady state.

The rotation of the wafer and the centrifugal forces thus transmitted by the wafer to the liquid keeps the liquid paraboloid stable while it attacks the wafer edge. The liquid is always pressed outward, so that it cannot encroach beyond the edge of the wafer. The wafer is attached by a teflon suction cup to the bar-shaped mounting, and is centered precisely with wedges. During edge etching, the acid near the edge is consumed by the etching process and fresh etchant must be supplied, since otherwise the etching process is slowed.

Under the invention this problem can be solved by pivot-mounting the semiconductor wafer. /4

If the vessel is slowly started in rotation, the wafer is entrained by the liquid friction and despite its mounting finally rotates at the same speed as the liquid.

If a friction brake is applied to the wafer axis, the wafer rotates slower than the liquid. A weak turbulence develops which does not significantly disturb the paraboloid of revolution and guarantees circulation of the liquid.

Another possibility would be to control the motor so that several times during the etching process it is automatically shut off, or its speed is so reduced that the paraboloid collapses. When it is switched on again the paraboloid re-forms, likewise circulating the fluid.

Practical Examples

The first practical example concerns an apparatus to etch a single wafer. Fig. 1 shows the simple vessel for edge etching of the semiconductor wafer. The top is screwed hermetically to the bottom. The top contains the guide and clamps for the wafer mounting. The wafer mounting consists of a teflon bar with a teflon suction cup to hold the semiconductor wafer. The exact height of the wafer above the etching bath is adjusted with a gauge ring on the bar. Fig. 2 shows the paraboloid of revolution as a function of rotation frequency in r.p.s.

Fig. 3 shows the adjusted height of the semiconductor wafer above the etching bath for various internal diameters of the etching vessel, to etch the wafer edge.

The second practical example refers to a device for the simultaneous etching of several wafers. The wafers are attached together using two-sided teflon suction cups. Because of the shape of the paraboloid the lower wafers are etched considerably more broadly than the upper ones. The maximum number of wafers will be very small, since they cannot stand at just any height above the acid bath if the rotating paraboloid, which expands upward, is to reach the wafer edge. Under the invention the problem is solved by giving the vessel wall the shape of an /5 inverse paraboloid. The shape of the paraboloid is determined solely by the acting gravitation and centrifugal force.

By forming the vessel wall as an inverse paraboloid, the resulting liquid wall at a given rotating frequency will be approximately perpendicular to the wafers over wide areas.

In contrast to the simple device for edge etching of a single wafer, the etchant is introduced into the vessel during rotation via a nozzle, and is immediately pressed against the wall by centrifugal force, so that the wafers do not dip into the acid bath before the vessel is set in rotation. Fig. 4 shows the etching vessel for edge etching several semiconductor wafers. The axis of rotation of the vessel here is above the vessel. The bottom is open to introduce the acid.

Claims /6

1. Apparatus for edge etching of semiconductor wafers, characterized in that the semiconductor wafers are etched in an etching bath in the shape of a paraboloid of revolution.

2. Apparatus under Claim 1, characterized in that the

specific shape of the etching bath is caused by a rapid rotation of the etching vessel.

3. Apparatus under Claim 1, characterized in that the wafers are applied to the adjusting mounting using teflon suction cups and that two-sided teflon suction cups are used for simultaneous etching of several wafers.

4. Apparatus under Claims 1 to 3, characterized in that the centering of the wafer in the top of the vessel is performed using adjusting wedges.

5. Apparatus under Claims 1 to 4, characterized in that the height setting of the wafer over the etching bath is adjusted by a gauge ring applied to the adjusting wedge outside the vessel.

6. Apparatus under Claims 1 to 5, characterized in that the wafer is rigidly connected to the vessel and rotates with it.

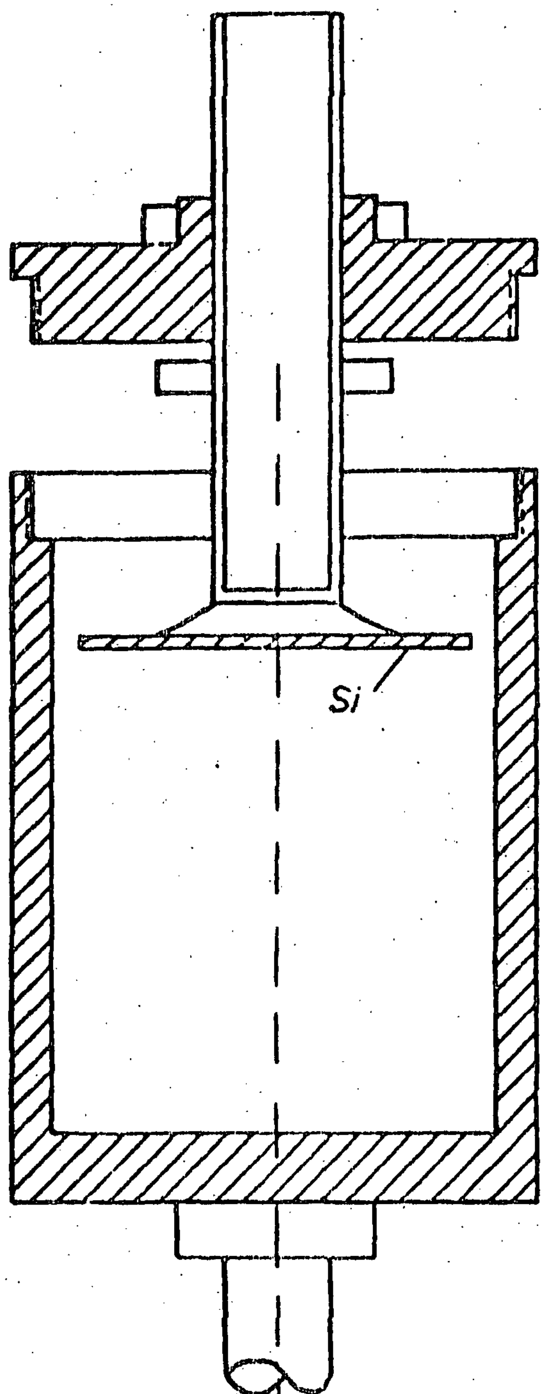
7. Apparatus under Claims 1 to 6, characterized in that the semiconductor wafer is pivot-mounted to circulate the fluid.

8. Apparatus under Claims 1 to 7, characterized in that the speed of the motor is periodically varied to circulate the fluid.

9. Apparatus under Claims 1 to 8, characterized in that to etch several wafers, the bottom of the vessel is open and the etching fluid is introduced into the vessel via a nozzle.

10. Apparatus under Claims 1 to 9, characterized in that when etching several wafers the inner wall of the etching vessel has the shape of an inverse paraboloid of revolution.

Plus 4 pages of drawings.



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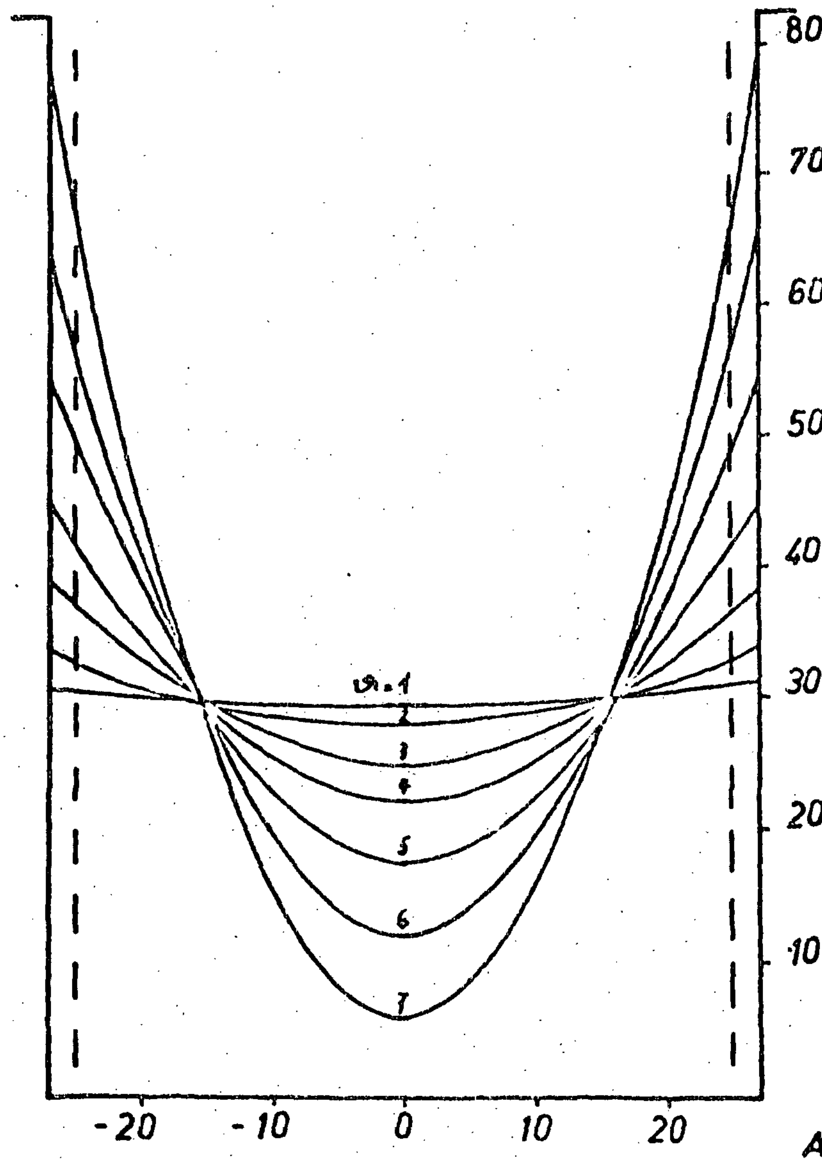

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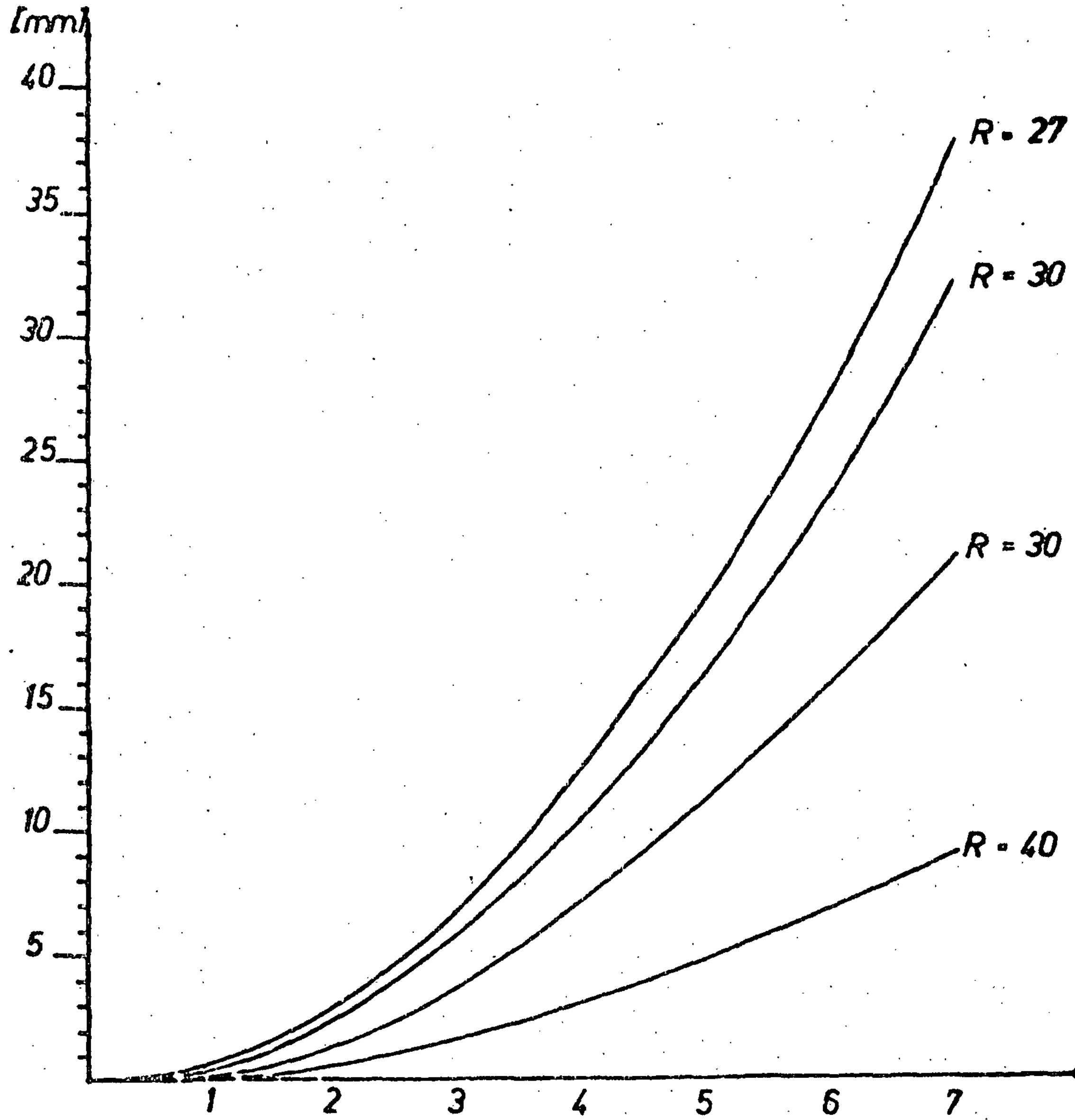

Abb.3

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R = 27

R = 30

R = 30

R = 40

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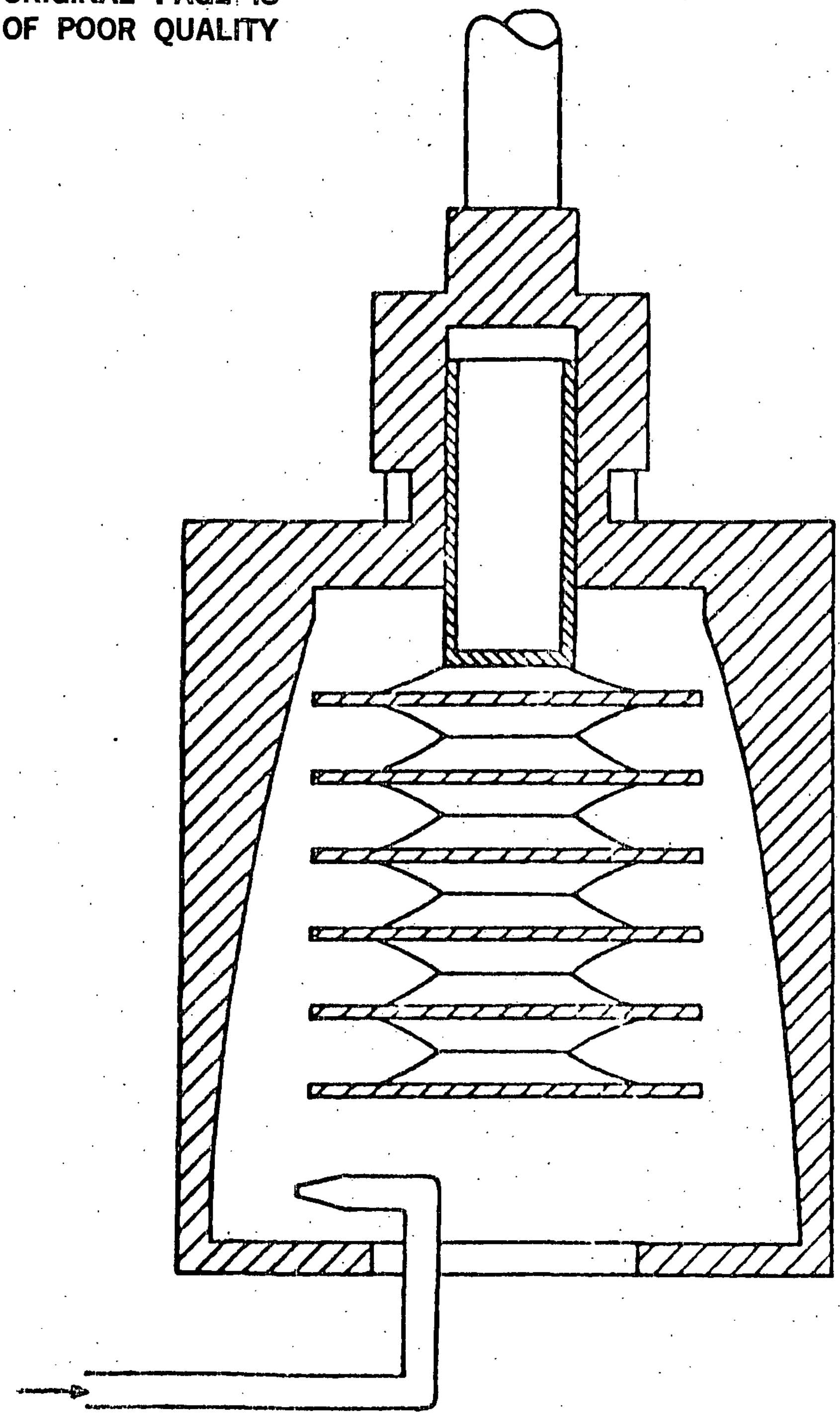

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