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DEVICE FOR COATING SUBSTRATES IN SEMICONDUCTOR
PRODUCTION ✓

The invention relates to a device for coating of semiconductor substrates in two steps. In the first step the coating medium or lacquer is applied with an open capillary slot that is filled with the lacquer and across which the substrate with the surface to be coated facing downwardly is guided. In the second step, the lacquer layer thickness is made more uniform and thinner in a spinning operation with the surface to be coated facing downwardly.

In the field of semiconductor production the object of coating rectangular or round substrates with a uniform layer of a lacquer or a coating medium that is initially liquid is encountered in order to produce color filters or special protective layers. For this purpose in conventional devices the substrates are connected to a turntable in a horizontal position whereby the surface to be coated faces upwardly. A certain amount of lacquer or coating medium is dripped onto the center of the plate from above via a jet. Subsequently, the turntable is rotated. Due to the centrifugal force the liquid is distributed over the substrate during the rotational movement. A great portion of the liquid is spun off the plate across its edge. The uniformness of the layer thickness that is achievable with this method depends on the magnitude of the rotational acceleration and the

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rotational velocity.

The disadvantage of the known method is that approximately up to 95% of the employed amount of lacquer is spun off the substrate. This spun off lacquer cannot be reused and is thus lost.

An improvement of this lacquering and coating method has been achieved by supplying the liquid via a very narrow open channel so that the liquid is applied to the surface to be coated which is facing downwardly by capillary and adhesion effects.

Such a device is, for example, especially well suitable for lacquering or coating of relatively large plates in the thin layer technology, for example, for LCD monitors etc. However, the uniformness of the lacquer thickness achievable with this method is not in all cases satisfactory for lacquering substrates for manufacturing highly integrated circuits.

It is therefore an object of the present invention to improve the known lacquering and coating processes with respect to the aforementioned criteria and to achieve for lacquering of semiconductor substrates the required high uniformness of the lacquer layer thickness.

According to the invention the solution to this object for a device of the aforementioned kind is comprised of the characterizing features of patent



claim 1. The lacquer is first applied to the substrate with a capillary slot. Subsequently, the substrate, with the lacquered surface facing downwardly, is spun with a suitable velocity. During this process the centrifugal force acts on the lacquer layer, i.e., an outwardly oriented displacement force. Naturally, within the lacquer layer an equilibrium between the displacement force and the adhesion force must be established. The areas of the lacquer layer in which the adhesion forces to the substrate surface, respectively, the underlying lacquer layers is too small, are displaced toward the edge of the substrate and a portion thereof is spun off across the edge. Accordingly, the lacquer layer thickness across the substrate surface is made more uniform and is reduced.

It has been proven to be especially advantageous to apply the lacquer onto the substrate surface (prelacquering). With this the optimal conditions for the effectiveness of the subsequent spinning process are provided.

It is furthermore especially advantageous, to fasten the substrates for the prelacquering step and the subsequent spinning step, with the surface to be lacquered facing downwardly, to the same holder, comprised of a turntable with drive shaft and corresponding drive motor.

Furthermore, one should preferably proceed such that this holder is connected to a horizontally



arranged linear transport device which provides for the transport of the substrates from the loading station to the unloading station and between the treatment stations as well as the uniform movement of the substrates across the capillary slot required during prelacquering.

It is advantageous to arrange a protective ring of a suitable shape about the rotating substrate. With it the lacquer, which is spun off across the edge of the substrate as described above, is caught and removed in a directed manner.

Another advantageous embodiment of the invention is characterized in that the protective ring can be lowered into a lower rest position when the spinning process is not performed. With this measure the substrate can be transported in the horizontal direction from the prelacquering station to the spinning position without any impediment. When the substrate reaches this position, the protective ring is raised to the level of the substrate in order to perform its function during the spinning process.

More advantageously, the inventive lacquering device is provided with a loading and unloading device so that the entire lacquering process can be automated. This is necessary in view of the manufacturing conditions in semiconductor production and allows for a uniform and reproducible lacquering result for large numbers of produced pieces.



Further details and advantageous embodiments of the invention will become apparent from the embodiments, described in the following and represented in the drawings, which embodiments are not to be understood as a limitation of the invention, and from the dependent claims. It is shown in:

- Fig. 1 a side view of the complete design of the inventive lacquering and coating device;
- Fig. 2 a view of the device for precoating that is part of the device represented in Fig. 1; and
- Fig. 3 a perspective view of the spinning device as part of the device according to Fig. 2.

Fig. 1 shows a first embodiment of an inventive lacquering device 10. On the frame 11 the channel 12 for the precoating step and the protective ring 22 of the spinning station 13 as well as the supports 14 and 15 for the linear transport device 16 are connected. At the movable part of the linear transport device 16 the rotating motor 17 and at its shaft 18 the turntable 19. The substrate 20 is connected to the plate holding device 19, for example, by vacuum. For this purpose, the holding device 19 is provided with respective vacuum bores, not represented in the drawing. In the context of the present invention,

other holding devices known to a person skilled in the art can be used.

The open channel 12 with the capillary slot 21 for the prelacquering step is represented in cross-section in Fig. 1 and is further represented in Fig. 2, also in section, in a perspective view.

Adjacent to the prelacquering device the protective ring 22 for the spinning process is arranged. It is connected to one or more stands 23 and 24 which can automatically adjust the height position of the protective ring 22. For example, they may be pneumatically adjustable units, but also other devices, known to a person skilled in the art. For the spinning process the protective ring 22 is vertically upwardly displaced with one or more stands 23 and 24, until the protective ring 22 surrounds the substrate in a suitable manner. In Fig. 2 the substrate to be lacquered is shown above the protective ring 22 connected to the turntable 19 and the motor shaft 18. This position is represented in Fig. 1 in a dash-dotted line and illustrates the situation before or after the spinning process in which the substrate is connected to the linear transport device 16 in a position predetermined for the spinning process the protective ring 22 however in this position has not yet been displaced upwardly or has already been lowered. This upward and downward movement of the protective ring 22 is necessary so that it does not obstruct the substrate during its horizontal transport with the



linear transport device 16.

Fig. 1 shows the protective ring 22 in cross-section. Its cross-section has a slanted U-shaped profile. This embodiment ensures that the lacquer or coating medium spun across the edge of the substrate is caught within the annular profile and is guided downwardly to the inner edge of the protective ring 22 from where it is removed completely from the inventive device with a lacquer removal 25.

For a fully automated version of the coating device automatic loading and unloading stations are provided in the areas indicated respectively at 26 and 27 in Fig. 1. The loading device removes the substrate 20 to be lacquered from a magazine connected to the coating device at an appropriate location and transfers it onto the plate holding device 19. The unloading device receives the substrate 20 from the holding device 19 and places it into a magazine provided at a suitable location.

Mode of operation of the lacquering device:

In a first step a substrate 20 is automatically or manually connected to the turntable 19. The turntable at this moment is in the area which is indicated by reference numeral 26 in Fig. 1. Subsequently, the linear transport device 16 is moved in the direction of arrow 28, i.e., in direction toward the channel 12.

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As soon as the leading point of the substrate 20 reaches the upper edge of the capillary slot 21, prelacquering begins. Of course, the substrate 20 is moved across the capillary slot 21 of the channel 12 during the step of prelacquering.

After completion of the precoating step the substrate 20 is moved together with the turntable 19, the motor 17, and the drive shaft 18 in the direction of arrow 28 until it is centered above the protective ring 22 which is at this moment in its lowered rest position. When the substrate 20 has reached this position, the protective ring 22 is moved upwardly until the substrate 20 is surrounded by it in a suitable manner. Then the spinning process starts with which the lacquer layer thickness on the substrate is made more uniform and thinner. The excess lacquer is spun off into the protective ring 22 and is removed via the lacquer removal 25.

After completion of the spinning process the protective ring 22 is again lowered. The substrate 20 is subsequently transported by the transport device 16 into the area shown at 27 in Fig. 1 where it is automatically or manually removed from the turntable 19.

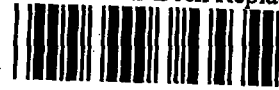
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Patent Claims

1. Device for lacquering (10) substrates (20) in two steps, characterized in that in the first step the substrate (20) is prelacquered via a capillary slot (21) and in a second step the thus applied lacquer layer thickness is made more uniform and thinner in a spinning process.
2. Device according to claim 1, characterized in that during the prelacquering as well as the spinning process the surface of the substrate (20) to be lacquered is facing downwardly.
3. Device according to at least one of the preceding claims, characterized in that the substrate (20) is connected, with the surface to be coated facing downwardly, during the entire lacquering process to a turntable (19) with motor and motor shaft (18).
4. Device according to at least one of the preceding claims, characterized in that the treatment stations for the prelacquering and the spinning process are arranged adjacent to one another and that the substrate (20) is transported between these stations with a linear transport device (16).
5. Device according to at least one of the preceding claims, characterized in that for the spinning process a protective ring (22)



with a slanted U-shaped cross-sectional profile is arranged about the rotating substrate (20) in order to catch the spun-off lacquer.

Device according to at least one of the preceding claims, characterized in that the protective ring (22) is lowered into a lower rest position below the substrate (20), when the spinning process is not performed.

Device according to at least one of the preceding claims, characterized in that the lacquering device (10) is provided with a respective loading (26) and a respective unloading station (27) and is thus operable in a fully automated manner.