

DEVICE FOR LACQUERING OR COATING OF PLATES OR DISKS

Background of the Invention

The present invention relates to a device for lacquering or coating of plates or disks with an open channel that is narrowed to a capillary, especially for coating glass plates for LCD production.

In the field of thin layer technology, especially for the production of LCD monitors, masks for semi-conductor manufacture, semi-conductor or ceramic substrates etc., the following problem is often encountered: Rectangular or round plates must be provided with a uniform layer color filters or special protective layers made of lacquer or other initially liquid media. From PCT/DE 93/00392 an improvement of such lacquering and coating processes is known. With this device the uniformness of the lacquer layer thickness, especially for rectangular plates is improved, while at the same time the required amount of lacquer is reduced. Furthermore, the plate must not be rotated during the application of the lacquer, and the required mechanical devices for

rotation are obsolete.

It is therefore an object of the present invention to improve on the device described in PCT/DE 93/00392 for lacquering and coating of plates with respect to the aforementioned criteria and also to simplify the construction design.

Description of Preferred Embodiments

This object, and other objects and advantages of the present invention, will appear more clearly from the following specification in conjunction with the accompanying drawings, in which:

Fig. 1 shows a side view of the inventive design of a lacquering and coating device; and

Fig. 2 shows a cross-section of the channel with capillary slot according to Fig. 1 at the beginning of a coating process.

Summary of the Invention

The device for coating a plate according to the present invention is primarily characterized by:

A capillary slot; and

Means for supplying the capillary slot with a liquid coating medium, wherein for a coating process a plate with a surface to be coated facing the capillary slot is advanced across the capillary slot such that a thin film of the liquid coating medium is deposited on the plate by a capillary effect and an adhesion effect.

The plate with the surface to be coated facing downwardly is guided across the channel that is designed such that it acts as a capillary and thus supplies the liquid coating medium or lacquer automatically and with an especially uniform velocity. The capillary effect is achieved by providing a narrow slot which is less than 0.5 mm wide. Due to the capillary effect the lacquer or liquid coating medium advances automatically upwardly with a constant velocity against the force of gravity in the slot and exits at the upper end of the capillary slot. Above the slot the stream of lacquer contacts as a narrow line the plate surface to be coated and is deposited thereon.

It is advantageous to generate the capillary by providing two vertically extending thin plates that are immersed in the open channel filled with

a liquid coating medium (lacquer), whereby the distance between them can be adjusted in an infinitely variable manner. Thus, between the two plates over the entire length of the channel a capillary slot with a width that corresponds most suitably for the desired capillary effect can be obtained. Accordingly, the capillary geometry can be adjusted to the various types of plates to be coated.

It is especially advantageous to guide the plate to be lacquered or coated with a uniform and low velocity at a very small distance, for example, less than 0.2 mm, over the upper end of the capillary slot. Accordingly, the lacquer, after exiting from the upper end of the capillary contacts directly the plate surface. Due to an adhesion effect, the lacquer is attached to the plate surface and is carried away from the upper end of the capillary slot with the plate. The result is that the following lacquer, in addition to its upward movement due to the capillary effect, is pulled from the capillary slot and, as a function of the velocity of the plate, is deposited in a defined layer thickness on the plate. Due to the adhesion effect of the lacquer

at the plate surface there is also no risk that the lacquer after exiting from the capillary slot could flow laterally resulting in a decrease of the uniformness of the coating layer.

It is expedient to open the capillary slot between the plates after each lacquering process to between 2 mm and 3 mm. This prevents the automatic (capillary) upward movement of the lacquer, which is undesirable between lacquering processes. It has been shown that during longer residence within the capillary slot the lacquer changes its properties. Such changes are disadvantageous for the lacquering process. However, when the capillary slot is widened to between 2 mm and 3 mm, the lacquer remains unchanged.

Expediently, the slot between the plates is narrowed directly before starting the lacquering process to reach the capillary width. Accordingly, the lacquer located between the plates is in a first step pressed mechanically upwardly until it exits from the upper end of the capillary slot and contacts the plate surface arranged above the capillary slot. Thus, the coating process is started. It is subsequently

commenced due to the capillary effect within the slot that is now of a capillary width, the movement of the plate, and the adhesion effect, as described above.

According to another expedient embodiment of the present invention, it is no longer necessary to guide the plates with a leading corner and at a small upward angle to the horizontal across the lacquering channel. Furthermore, it is no longer required that the liquid coating medium forms a meniscus above the channel (slot) so that supplying the lacquer via a compensation tank becomes obsolete.

Description of Preferred Embodiments

The present invention will now be described in detail with the aid of several specific embodiments utilizing Figs. 1 and 2.

Fig. 1 shows a first embodiment of the inventive coating device 10. To a frame 11 the channel 12 as well as the supports 13 and 14 of the linear transport device 15 are connected. The movable portion of the linear transport device 15 faces downwardly. Connected to it is a rotatable holder 16 for the plate (substrate) 17 to be coated. The plate 17 is, for example, a glass

plate to be coated with a lacquer in order to be used subsequently for the production of a mask or an LCD monitor. The plate 17 is, for example, supported by vacuum at the plate holder 16. For this purpose, the holder 16 is provided with respective vacuum bores, that are not represented in the drawing. Within the context of the invention it is conceivable to use other holding devices whose design and construction are known to a person skilled in the art.

The channel 12 is represented in cross-section in Fig. 1 and, in detail, in Fig. 2. The hollow interior (cavity) 18 of the channel 12 is partially filled with lacquer. Two thin parallel plates 19 and 20 are immersed in this lacquer. The plate 19 is fixedly connected at the location 33 to the upper edge of the channel 12. It is not displaceable. On the other hand, the plate 20 is connected with a suitable device to a linear displacement unit 22. Via this displacement unit 22, the plate 20 can be moved back and forth in the direction of the arrow 23. Accordingly, the width of the slot 24 between the parallel plates 19 and 20 can be adjusted in an infinitely variable manner.

For achieving optimal lacquering or coating results, the corresponding liquid coating medium (lacquer) must have a certain temperature and must be very clean. Accordingly, it is supplied from a supply tank 28 via a temperature control unit 29 and a filter 30 to the channel 12. The conveying of the liquid medium can be achieved by generating a pressure (gas cushion) within the supply tank or by providing a suitable arrangement of the supply tank so that the liquid is conveyed by the geodetical height difference to the channel. However, any other suitable device, known to a person skilled in the art, for transporting the liquid is conceivable.

For a fully automated version of the coating device, at the location indicated at 31 an automated loading device and at the location 32 an automated unloading device are provided. The loading device (31) removes the plate 17 to be coated from a magazine connected to the frame and conveys the plate to the plate holder 16. The unloading device (32) removes the plate 17 from the holder 16 and loads it into another magazine connected to the frame.

Mode of Operation of the Lacquering and Coating Device

In a first step, the plate 17 is automatically or manually connected to the holder 16. By rotating the holder 16 its position can be corrected. The plate holder 16 at this time is located at the location indicated at 31 in Fig. 1. After the plate has been correctly positioned at the holder 16, the linear transport device 15 is set in motion in the direction of arrow 26, i.e., in direction toward the channel 12.

Plate 17 is thus advanced from the side to the upper edge of the slot 24. As soon as the leading edge 25 of the plate 17 is positioned directly above the slot 24, the plate 20 within the channel 12 is advanced toward the plate 19 such that a suitable capillary width is provided between the plates i.e., the slot becomes a capillary slot. Due to the narrowing of the slot 24 a small amount of liquid is forced out of the capillary slot 24 against the leading edge of the plate 17 to be coated. Thus the coating process has begun. The plate 17 is now advanced further at a uniform velocity via the linear transport device 15 in the direction of arrow 26. Due to

the adhesion effect a thin liquid layer is deposited on the plate surface. The required stream of liquid is supplied by the capillary effect within the capillary slot 24.

The coating process is terminated as soon as the rear edge 27 of the plate 17 passes the capillary slot 24. The two plates 19 and 20 are now moved apart to a distance of 2 to 3 mm for the aforementioned reasons until the next coating process is to be performed. The plate 17 is advanced to the location indicated at 32 where it is automatically or manually removed from the holder 16.

The present invention is, of course, in no way restricted to the specific disclosure of the specification and drawings, but also encompasses any modifications within the scope of the appended claims.



WHAT WE CLAIM IS:

1. A device for coating a plate, said device comprising:

a capillary slot; and

means for supplying said capillary slot with a liquid coating medium, wherein for a coating process a plate with a surface to be coated facing said capillary slot is advanced across said capillary slot such that a thin film of the liquid coating medium is deposited on the plate by a capillary effect and an adhesion effect.

2. A device according to claim 1, wherein said means for supplying comprises a channel partially filled with the liquid coating medium and wherein said capillary slot is formed by two parallel plates immersed into the liquid coating medium contained in said channel.

3. A device according to claim 2, further comprising a means for adjusting a distance between said parallel plates in an infinitely variable manner.

4. A device according to claim 3, wherein after each coating process said distance between said parallel plates is enlarged to cancel the



capillary effect and preserve the liquid coating medium.

5. A device according to claim 3, wherein immediately before each coating process said distance between said parallel plates is decreased to zero for pressing a small amount of the liquid coating medium out of said capillary slot to thereby start the coating process.

6. A device according to claim 2, further comprising a holder and a means for moving said channel so that the coating process is performed with said holder being stationary and said channel being moved across the plate.

7. A device according to claim 1, further comprising a loading device and an unloading device for operating said device fully automatically.

8. A method for coating a plate 17, said method comprising the steps of:

supplying a capillary slot with a liquid coating medium; and

coating a plate by the following steps:

a) advancing a plate with a surface to be coated facing said capillary slot across said capillary slot; and



b) depositing a thin film of the liquid coating medium on the plate by a capillary effect and an adhesion effect.

9. A method according to claim 8, further comprising the steps of:

providing a channel and partially filling said channel with the liquid coating medium; and

arranging in said channel two parallel plates and immersing said two parallel plates in the liquid coating medium contained in said channel so that said two parallel plates define said capillary slot.

10. A method according to claim 9, further comprising the step of:

after each step of coating enlarging a distance between said parallel plates to cancel the capillary effect and preserve the liquid coating medium.

11. A method according to claim 9, further comprising the step of:

immediately before each step of coating decreasing a distance between said parallel plates to zero for pressing a small amount of the liquid coating medium out of said capillary slot to



thereby start the step of coating.

12. A method according to claim 9, further comprising the step of:

supporting the plate on a holder; and
moving said channel relative to said holder so that the step of coating is performed with said holder being stationary and said channel being moved across the plate.

13. A method according to claim 8, further comprising the steps of:

operating automatically the step of supplying and the step of coating by providing a loading device and an unloading device.