Photoresist Coating Techniques

Revised: 2009-11-05
Source: www.microchemicals.eu/technical_information

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Criteria for the Resist Coating Technique

Each photoresist-related process requires a resist film with a certain thickness on a given substrate. This document aims for an understanding which coating technique is the best-suited coating method for a certain application.

Hereby, the following criteria have to be considered:

- Required resist film thickness and thickness homogeneity
- Tolerable resist film roughness
- Coating time (throughput)
- Size, geometry, and weight of the substrate
- Substrate texture and tolerable esge coverage on texures
- Resist yield (and -cost)

Spin Coating

During spincoating, the centrifugal force of the substrate spinning with several 1.000 rounds per minute (rpm) distributes few ml of resist over the substrate.

Advantages: The high resist film thickness homogeneity as well as the short coating times make spincoating the most-applied coating technique at least in microelectronics. The fact that the coated resist already lost a significant amount of its solvent after spin coating, no time-consuming delays have to be kept before further process steps (handling, softbake).

Limitations and disadvantages: In case of non-rotation-symmetric substrates, the resist forms a pronounced edge bead near the substrate edges due to the strong air turbulences. On textured substrate, the attained edge coverage of the textures is rather small, and parts of the topology might not be coated at all. With only few %, the resist yield is comparable low.

Suited photoresists: Almost all AZ® and TI resists from our product range are suited for spincoating. Generally, the last two digits of the resist name (e. g. AZ® 66<u>32</u>) indicate the film thickness attained by spin coating (without gyrset) at 4000 rpm in 100 nm units. The thickness approximately decreases with the (increasing) square-root of the spin speed (in rpm). The document Resists, Developers, and Removers gives an overview on our products and their main fields of application.

Further information on spin coating can be found in the document Spin Coating of Photoresists.

Spray Coating

Hereby the sufficiently solvent-rich resist is atomized into µm-sized droplets via a N_2-nozzle or ultrasonic atomisation. The atomized spray moves towards the substrate where millions of droplets form a growing resist film. In order to attain a homogeneous resist film thickness, nozzle and substrate usually laterally move against each other.

Advantages: The spray coating technique works with all arbitrary sized and shaped substrates. Even three-dimensional bodys (when suitably mounted) can be spray coated with resist. Substrates with pronounced topology are also easy to be spray-coated, and under optimized condictions, a good edge coverage can be attained. Theoretically, the resist gain is higher than for spincoating. However, in application only few % of the atomized resist reach the substrate and form the resist film.

Limitations and disadvantages: Since millions of droplets form the resist film, the film roughness is comparable high if the droplets loose too much solvnt during flight (however, this does not have to be a disadvantage for further processing). If the droplets are too solvent rich when they hit the substrate, the attained edge coverage will be poor. Since the resist needs to flow a little bit on the substrate before drying in order to convert from spheres to a flat film, hereby the resist tries to minimize its surface and withdraws from edges. One always has to make a compromise between resist film smoothness and edge coverage.

Suited spray resists: Our TI Spray and AZ® 4999 are optimized for spray-coating. We supply both resists also in 250, 500 and 1.000 ml sales volumes. Please contact us!

Further information on spray coating can be found in the document Spray Coating of Photoresists.

Dip Coating

Hereby, a substrate is pulled out of a resist-filled basin with a well-defined speed of typically 3-20 mm/s. The lower the speed, the thinner the resist film hereby formed: Immediately over the resist bath surface, the saturated solvent concentration thins the resist film just leaving the basin.

Advantages: Even large-scaled and arbitrary shaped substrates (e. g. stainless steel panels) can easily be dip-coated. The attained resist film is very smooth, whereas the resist film thickness may change over the dimension of the substrate. The resist yield of almost 100 % (or, respectively, 50 %, if the rear side of the substrate would not have to be coated) is very high.

Limitations and disadvantages: In order to start dip-coating, a rather big resist volume to fill the basin is required. The forced coating of the rear side of the substrate can be either an advantage or a disadvantage. Irregularities on the substrate such as vias or mounting

Suited spray resists: Generally, all resist from our product range are suited for dip-coating (some after a proper dilution). We supply all resists also in 250, 500 and 1.000 ml units as well the recommended thinners.

Further information on dip coating can be found in the document Dip Coating of Photoresists.

Roller Coating

During roller-coating, a polymeric roller transfers resist to the substrate.

Advantages: The resist gain is almost 100% making roller coating to a coating technique with very low resist consumption.

Limitations and disadvantages: For smooth resist films, roller coating requires resists with special *thixotropic* properties. However, if the requirements on the coating homogeneity are not too uncompromisingly, good results can be attained with almost every resist with adjusted viscosity.