Electroplating with Photoresist Masks

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Electroplating - Basic Requirements on the Photoresist

Electroplating with photoresist masks requires a chemically stable resist with a superior adhesion to the substrate and often also steep sidewalls. Beside a resist optimized for electroplating, also its processing strongly impacts on the demand to avoid underplating as well as a resist attack by the electrolyte.

The following sections give recommendations on how to improve your plating process using photoresist masks.

Acidic and Alkaline Stability of the Resist

The cresol resin of all AZ® and TI photoresists makes the resist mask stable in common acidic electrolytes.

Aqueous alkaline solutions, however, attack a non-cross-linked positive resist mask when the pH-value significantly exceeds 10. Of course, the stability depends on the time in the electrolyte and its temperature. Moreover, one has to consider that the local pH-value near the metal deposition can be quite different from the value measured in the electrolyte.

The alkaline stability of the resist film can be improved via a hardbake applied at temperatures > 140°C where the resin starts to cross-link. However, such temperatures are beyond the softening point (typically: 110 ... 130°C) of positive and image reversal resists which will deteriorate the resist profile.

Cross-linking negative resists such as the AZ® nLOF 2000, the AZ® 15 nXT, or the AZ® 125 nXT reveal an elevated alkaline stability as compared to non-cross-linked positive resists.

Substrate Adhesion of the Resist

Resist swelling during electroplating in combination with a suboptimum resist adhesion often causes peeling of the resist with underplating as a consequence. The resist adhesion to the substrate can be improved via a suited resist, its processing, and the substrate pretreatment.

Compared with resists optimized for dry etching, the resist series AZ® 1500, 4500, 9200, and ECI 3000 show an improved adhesion to many substrate materials. Cross-linking resists such as the negative resists AZ® nLOF 2000, the AZ® 15 nXT, or the AZ® 125 nXT also show a very good adhesion.

Optimum softbake parameters (we recommend 100° C for one minute/µm resist film thickness on a hotplate, some minutes more when using an oven) also improve the resist adhesion. Especially in case of thick resist films, one should avoid an abrupt cooling down of the substrates in order to prevent the formation of cracks in the resist film. A hardbake after development can improve the resist adhesion, however, the required temperatures of 120-140°C are beyond the softening point of most positive resists which will deteriorate the resist profile.

In case of cross-linked negative resists, such a hardbake can be applied without the danger of resist softening. However, towards higher hardbake temperatures (= increasing degree of cross-linking), the wet-chemical removability of the resist after electroplating decreases.

The best adhesion promoter is a thin titanium film (chromium will also be very beneficial) on the seed layer. If required, this additional adhesion film can be removed after development of the resist where the structures are cleared. In this case, care has to be taken not to underetch the metallic adhesion layer under the resist film. Therefore, the etching step should not take much longer than required for removing the uncovered metal film.

Contamination by Residual Solvent

Typical softbake parameters keep the remaining solvent concentration in the resist film at approx. 2-4 %. If released to the electrolyte, the solvent may impact the metal deposition chemistry with a reduced deposition rate as a consequence. In this case, a longer softbake and/or elevated softbake temperatures are recommended.

Thick resist films will have a comparable high solvent concentration especially near the substrate even after a prolonged softbake. In this case, a baking step after development at temperatures of approx. 10°C below the resist softening point would be beneficial.

Cross-linked negative resists do not soften during a hardbake. However, towards higher baking temperatures, the degree of cross-linking increases making the resist film less removable after electroplating.

Resist Profile

If steep resist sidewalls are required, we recommend the positive AZ® ECI 3000 or AZ® 6600 series for film thicknesses < 5 µm, or the positive resists AZ® 4562 or AZ® 9260, or the negative resist AZ® 15 nXT, for 5-30 µm resist film thickness. If very thick resist films are required, the negative resist AZ® 125 nXT allows steep sidewalls in the range 30-150 µm resist film thickness.

If required, a positive profile of the deposited metal structures requires a negative resist profile. This can easily be obtained with the negative AZ® nLOF 2000 or AZ® 15 nXT resists for thicknesses of 5 ... 30 µm, or the AZ® 125 nXT for films up to 100 µm and even higher. These resists allow an adjustment of the undercut via the process parameters exposure dose and post exposure bake temperature.

Metal Adhesion

Some resists require special developers for residual-free development. If unsuitable developers are used, or the subsequent rinsing is not sufficiently applied, thin and almost invisible resist residuals may stay on the substrate (‚scumming') preventing a proper contact between the substrate and the deposited metal.

If such residuals occur despite a sufficiently long development and rinsing, the usage of (or a 20-30 second dip after development in) the developer AZ® 826 MIF which has a special scum remover added will be beneficial.

Incorrectly applied adhesion promoter such as HMDS applied from the liquid phase may also deteriorate the contact between seed layer and deposited metal.

Disclaimer of Warranty

All information, process guides, recipes etc. given in this brochure have been added to the best of our knowledge. However, we cannot issue any guarantee concerning the accuracy of the information.

Generally, and especially for the wet chemical etching recipes we do not guarantee the correctness of the specification of the composition, the mixing ratio, the mixing and application of the etches and solutions. The recommended sequence of the mixing of the components of each recipe does not generally correspond to the order of the components listed. Generally, it is recommended to i) add the acid to the dilutor, ii) add stronger acids to weaker acids, and iii) add the oxidizer last.

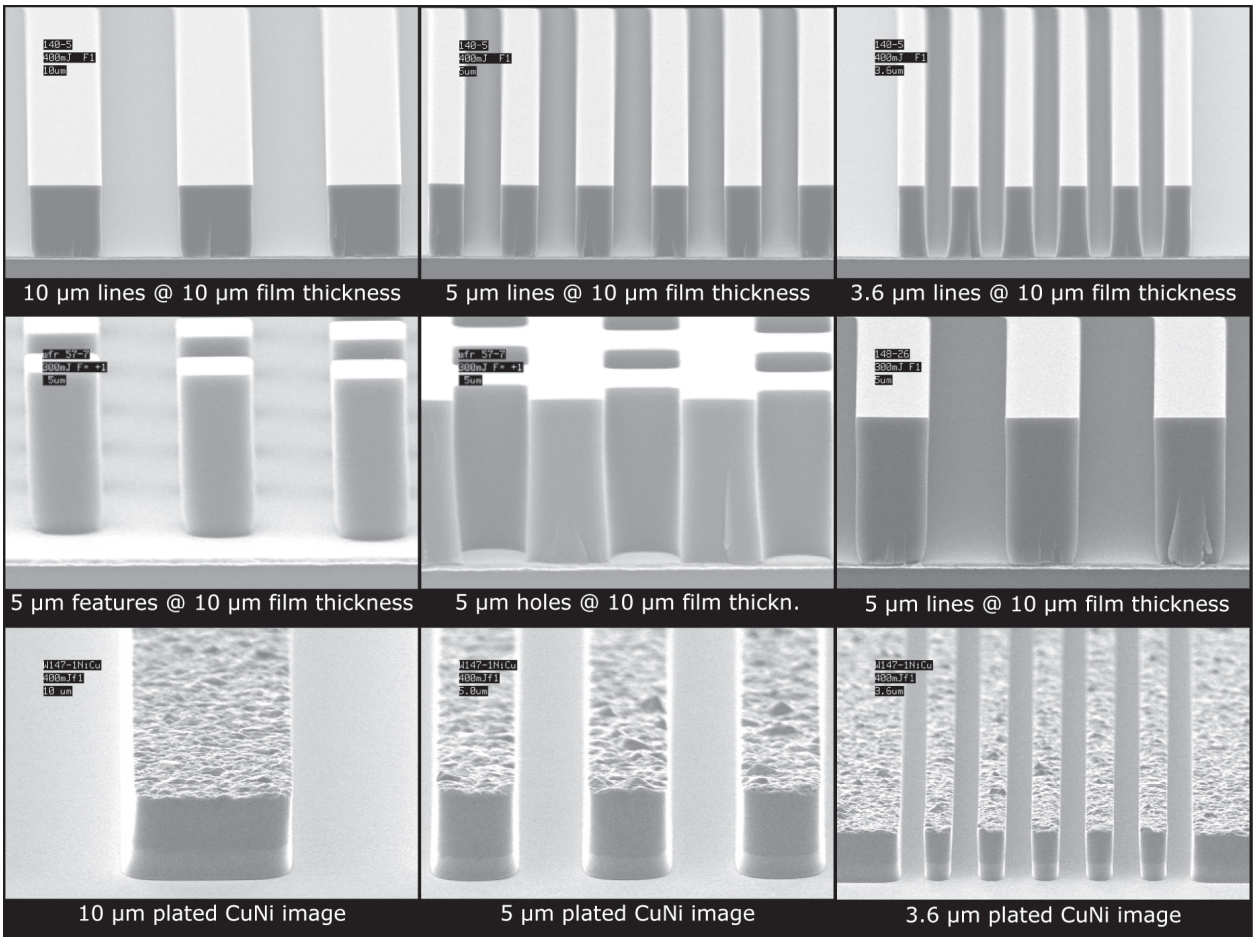
We assume no liability for any hazard for staff and equipment which might stem from the information given in this brochure.

Generally speaking, it is in the responsibility of every staff member to inform herself/himself about the processes to be performed in the appropriate (technical) literature, in order to minimize any risk to man or machine.

Photoresists for Electroplating

The following two sections introduce the two negative resists AZ® 15 nXT and AZ® 125 nXT. Please contact us for further information or a free sample!

Electroplating with the AZ® 15 nXT Negative Resist

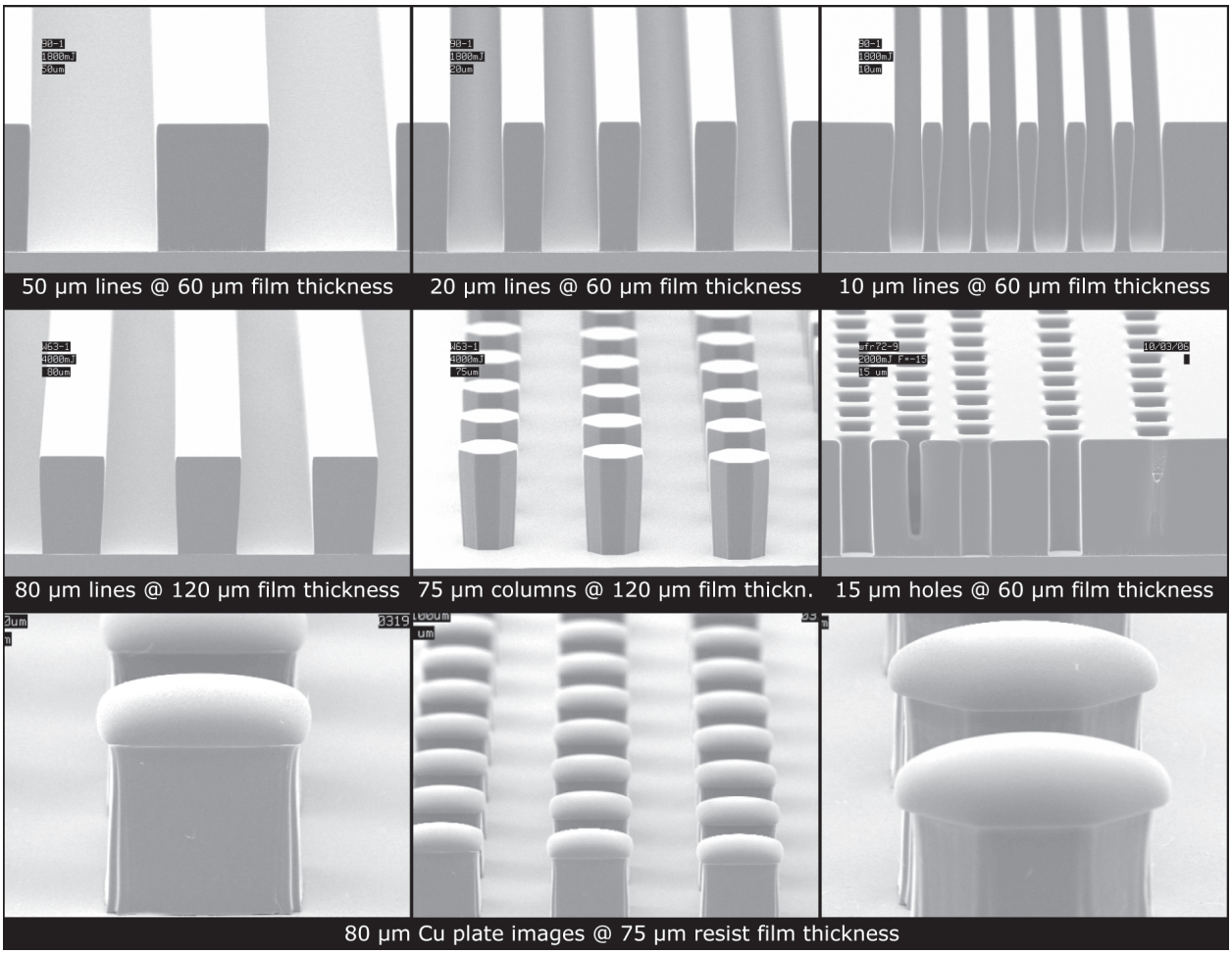


AZ® 15 nXT is a cross-linking negative resist for resist film thicknesses up to approx. 30 µm. The high stability and superior adhesion make the AZ® 15 nXT well suited for most electroplating applications. The resist sidewalls are very steep up to a film thickness of approx. 10 µm, towards higher resist film thicknesses the resist profiles becomes more and more negative allowing the electrodeposition of structures which narrow from bottom to top.

- 5 ... 20 µm via single-coating
- Aqueous alkaline developers (such as the TMAH-based AZ 326/726/827 MIF)
- Excellent adhesion, no underplating
- Wide substrate compatibility: Cu, Au, Ti, NiFe, …
- Wide plating compatibility: Cu, Ni, Au, …
- Standard wet stripping processes

Please contact us for further information, the technical data sheet, process recommendations, or a free sample!

Electroplating with the AZ® 125 nXT Negative Resist



AZ® 125 nXT is a cross-linking negative resist for resist film thicknesses up to 100 µm and even more with very steep sidewalls. The high stability and superior adhesion make the AZ® 125 nXT well suited for most electroplating applications where very thick films are required. This resist requires no post exposure bake or any delays between the process steps.

- 30 … 100 µm via single-coating
- Aqueous alkaline developers (such as the TMAH-based AZ 326/726/827 MIF)
- Excellent adhesion, no underplating
- No post exposure bake, no delays between process steps required
- Wide substrate compatibility: Cu, Au, Ti, NiFe, GaAs, …
- Wide plating compatibility: Cu, Ni, Au, solder …
- Standard wet stripping processes

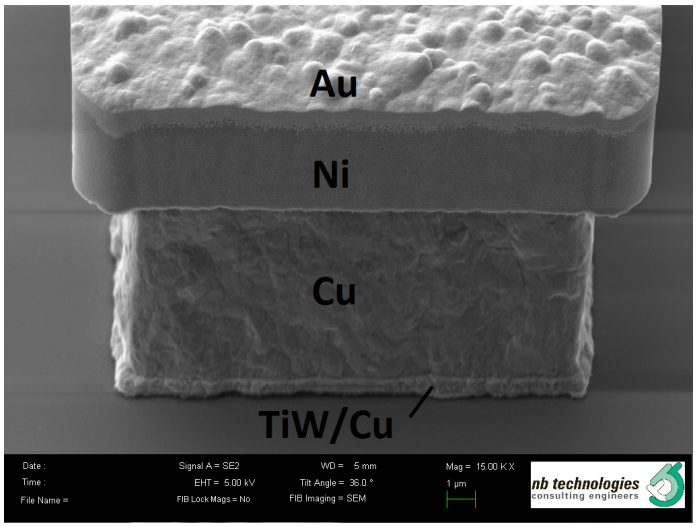
Please contact us for further information, the technical data sheet, process recommendations, or a free sample!

Our Electroplating Solutions

NB SEMIPLATE CU 100 (Copper Electroplating Process)

The NB SEMIPLATE CU 100 process is an acid copper plating formulation engineered for wafer plating applications including copper bump plating, interconnects for VLSI/ULSI or MEMS.

The NB SEMIPLATE CU 100 process provides excellent throwing power, improved levelling characteristics, ductile low stress deposits and offers unique flexibility in its operation.



NB SEMIPLATE AU 100 (Gold Electroplating Process)

NB SEMIPLATE AU 100 is an alkaline, non-cyanide electroplating formulation which produces a bright, ductile deposit.

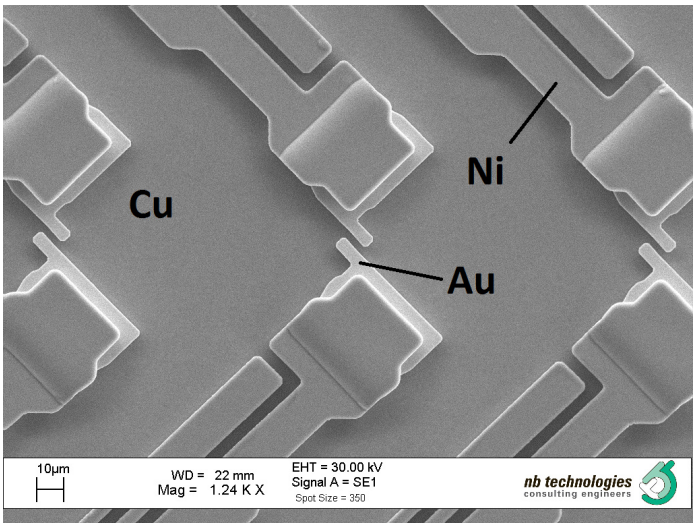
In comparison with other gold plating processes, the NB SEMIPLATE AU 100 electrolyte demonstrates exceptional throwing power that results in good coverage of recesses, holes and hollows of parts of complex geometry.

Deposits from the NB SEMIPLATE AU 100 process also exhibit the unique ability to build brightness with increasing thickness. Specific gravity measurements of the deposit consistently show values of 19.1 which indicate freedom of codeposited polymers generally found in deposits from other systems of similar purity. NB SEMIPLATE AU 100 deposits have main applications in MEMS processing.

Physical Properties of the Deposit

- Purity 99.9%
- Hardness 130 to 190 $mHV_{0,020}$
- Contact Resistance 0.3 mΩ (measured by cross-wire method with 200 gram load)
- Deposit weight for 2.5 microns 31.6 mg/in^2 (4.9 mg/cm^2) (100 micro inches)

NB SEMIPLATE NI 100 (Nickelsulfamate Electroplating Process)



NB SEMIPLATE NI 100 is a nickelsulfamate electroplating process that produces a pure, ductile, finegrained,semi-bright low stress nickel deposit required to meet the needs of the semiconductor industry for quality assured chemistry.

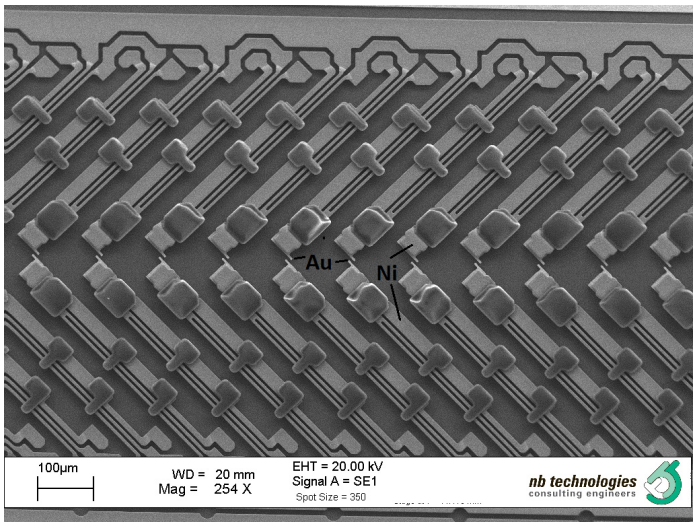
NB SEMIPLATE NI 100 is manufactured to meet the requirements associated with the electroforming of microstructured wafers (Micro System Technology).

The NB SEMIPLATE NI 100 process contains an anode activating agent in controlled amounts to enhance anode corrosion and prevent anode passivation.

Deposit properties are easy to control and maintain.

Feature / Benefits

- Pure nickel depositions
- High ductile plating
- Fine grained, satin dull deposition
- Controllable inner stress of the deposition up to 7000 µm
- No anode passivation
- High hardness, controllable
- Good throwing power



NB SEMIPLATE SN 100 (Pure Tin Plating Process)

NB SEMIPLATE SN 100 is a high-purity electroplating process which produces fine-grained, matte, pure tin deposits. It is especially formulated for use in the fabrication of circuit patterns and bumps on semiconductor wafers.

The process contains no fluoborates or formaldehyde and can be used with either soluble or insoluble anodes.

Data Sheets and Further Technical Information on Electroplating

We collected comprehensive theoretical and application-orientated information on electroplating and our plating solutions here:

http://www.microchemicals.com/products/electroplating/plating_electrochemistry_theory.html

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