HiTech Photopolymere AG

# DiaEtch 101

**Aqueous processable, liquid, photo-imagable dip-coating etch resist**

## Processing Guidelines

## General Product Description

DiaEtch 101 is a photosensitive negative working, liquid etch resist specifically designed for dip-coating application. In thin layers it is sensitive to UV light, particularly to radiation of wavelengths from 300 to 350 nm. Depending on developing conditions the resist will resolve features down to the range of the applied film thickness. The dried material exhibits excellent adhesion to various metals and alloys and will withstand long etching cycles in acidic media. If the part design allows, the acrylate-based resist may be processed in horizontal, conveyorized develop-etch-strip equipment using standard wet chemistry (Taging).

## Material Properties (typical values)

| Property | Unit | Value | Method |
|---|---|---|---|
| Color (unexposed) | | Bluish | Visual |
| Color after exposure | | Faded blue | Visual |
| Viscosity 20°C | [s] | 90 | Zahn Cup No.1 |
| | [s] | 24 | DIN Cup No 4 |
| Density liquid | [g/cm³] | 0.89 (±1%) | Gravimetric |
| Density dry | [g/cm³] | 1.25 | Gravimetric |
| Solid content | [%] | 27.5 | Gravimetric |
| Solvent | | 1-Propanol | |
| Photosensitivity[1] | $\Delta_{OD}$= 0.15 | 4 – 5 (solid) | 250 mJ/cm² |
| Surface | | Suited for hard-contact exposure | |

[1] Heavily depending on applied developing conditions. Quoted step is received with general conditions outlined in this brochure (1% sodium carbonate, 35°C, 45 sec dwell time).

# Processing Parameters

The following processing conditions were established in a production environment and therefore may be optimized to match particular needs.

## Pre-cleaning

Depending on the material to be etched and the final finish of the goods to be produced various methods may be applied. Obviously a roughened surface will promote adhesion of the resist material and therefore is preferred whenever possible.

The holdtime before coating should be kept as short as possible in order to avoid the surface to become stained and contaminated, which may result in coating irregularities and subsequently affect the etch rate.

## Coating

The resist is supplied at ready-to-use viscosity (~90 sec Zahn Cup 1). Variation in coating quality due to immersion speed could not be observed. Resist thickness' of about 9 to 11 µm are obtained using a withdrawal speed in the range of 8 to 12 cm/min. Such coatings provide sufficient mechanical resistance and allow to take full advantage of the resolution capabilities.

Figure 1 below shows the resulting film thickness after drying in dependence of the applied withdrawal speed.

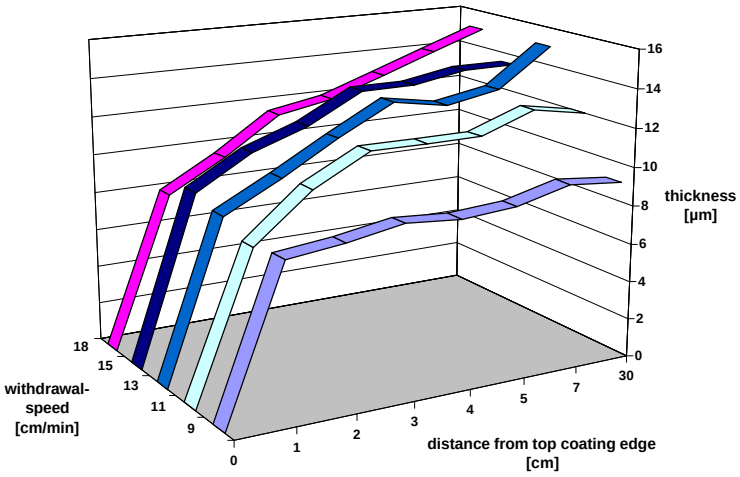


Figure 1

The data indicate a leveling out of the resulting thickness at higher withdrawal speeds. If the sample is withdrawn at more than 12 cm/min, the resist bead on the lower edge becomes difficult to dry and might cause sticking problems during exposure. At even higher coating speeds dripping occurs, whereas no drops can be observed at speeds below 12 cm/min.

Coating defects due to contamination can be avoided by introducing slow circulation of the resist from bottom to top of the coating tank, passing through a 5 to 10 µm filter unit. The overflow will carry away residual dust particles. During interruptions a lid should be placed on the tank to prevent a) excessive solvent evaporation into the clean-room air and b) unavoidable contamination from environment.

## Drying

A flash-off period of about 5 minutes in a slightly air-vented cabinet will result in a tackfree surface of the coating. Measures must be taken to prevent the wet surface from being contaminated by residual particles in the clean room environment. Sufficient mechanical properties for the subsequent processing are obtained only after a drying cycle at elevated temperature. This also will dry the bead formed at the lower edge. Good results are seen, if dried in a convection oven at 80°C for 10 minutes. Excessive drying at temperatures well above 100°C must be avoided. Such treatment may lead to changes of the metal surface quality (blooming).

There is no holdtime required after drying. However, the coated parts may be held in yellow light for 24 hours under cleanroom conditions.

Though the resist surface is tackfree, allowing hard contact exposure, it is not recommended to store coated sheets racked. The surfaces may fuse, leading to substantial yield losses due to severe coating defects.

## Exposure

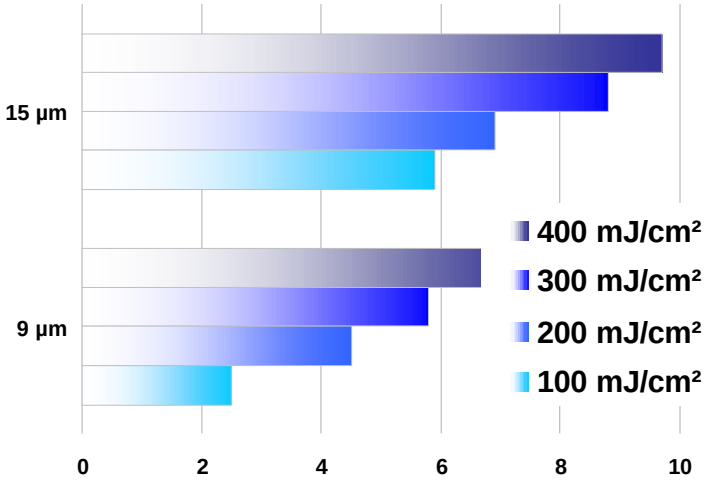


Figure 2

The resolution capabilities under hard contact exposure conditions exceeds 25 µm after developing. A non-collimated light source therefore is mandatory. As a consequence good cleanroom procedures should be observed. Dust particles and any other contamination in the range of 5 to 25 microns will cause imaging defects leading to pits.

DiaEtch 101 requires an exposure energy of about 200 to 300 mJ/cm². This will result in a step wedge reading of approximately 4 to 5 solid[2].

There is no particular exposure unit to be recommended. However, high power printers not only will reduce required exposure times, but also provide more constant temperature within the frame. Temperatures above 30°C should be avoided. At this point the uncured resist will tend to become tacky and herewith stick to the photomask.

Both silver halide and diazo film can be used as long as the optical density in the range of 300 to 400 nm does prevent the resist from being cured.

It is recommended to avoid exposing the resist bead at the lower edge of the sheet. Longer stripping times must be accepted, if the bead is exposed and cured. Most desirable are specifically designed artworks, which „half-tags“ the area of the bead to the remainder of the sheet (see Figure 3 and Figure 8 on page 6).

[2] As mentioned beforehand, the step wedge reading heavily depends on applied developing conditions (see also next paragraph)

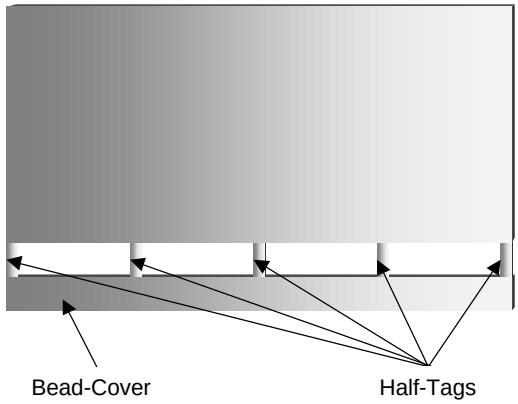


Figure 3

If only partially developed, the part will survive the etching process, but can easily be removed before stripping or thereafter. At the same time this practice will facilitate the registration of the coated sheet with the artwork, since the bottom edge of the artwork can be recognized as a black line.

## Developing

Unexposed areas of resist readily dissolve in aqueous sodium carbonate at elevated temperature. Most commonly used parameters for standard developing equipment are:

aq. $Na_2CO_3$ concentration ... 0.8 – 1.2 %
Temperature ..... 30 – 35°C
Spray pressure..... 1 – 2 bar
Dwell time..... 30 – 60 s

Applying above settings will result in a breakpoint of about 10 to 30% of the developing chamber length.

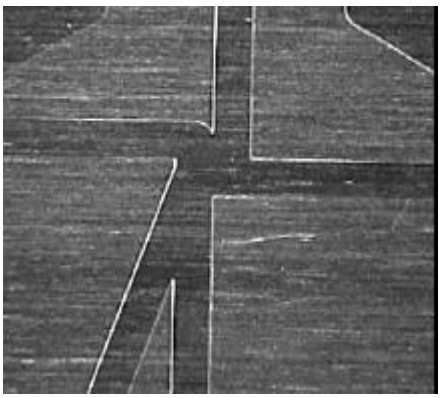

Figure 4; Cleanly developed resist pattern

Though the resist pattern exhibits good mechanical stability, it still is susceptible to damages caused by manual handling of parts. Therefore care should be taken, when moving parts from one place to another.

## Thermal Cure

Especially on stainless steel substrates it could be shown, that a thermal cure before etching helps improve the adhesion of the resist to these critical surfaces. This might be due to release of stress

induced during polymerization (shrinkage) and mobilization of residual reactive sites (acrylates and radicals) in the polymer network, which herewith get a chance to toughen the resist material.

Curing conditions might also have an influence on strippability lateron and therefore should not exceed **120°C for 10 minutes**. It is recommended to investigate on these parameters in order to achieve best results.

## Etching

The resist has performed well in commonly used etching environments such as acidic ferric- and cupric chloride. Limited experience has been obtained using alkaline etchants like ammonia. Exposed to caustic solutions, the resist will strip, due to its poly-acid functionality.

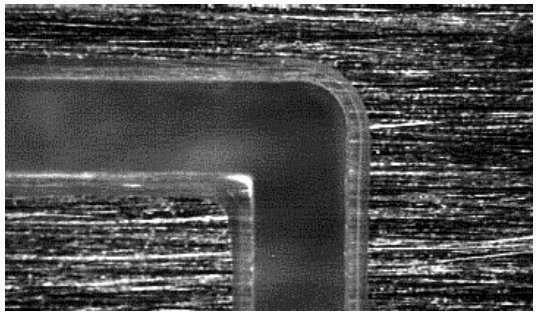

Figure 5; Overhang on copper

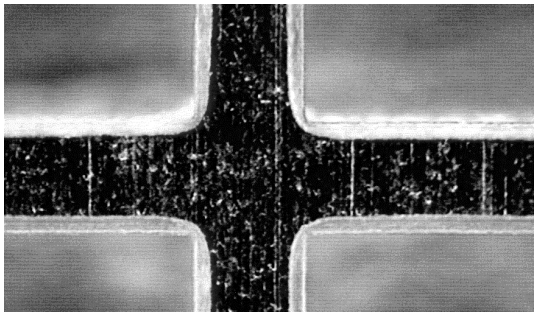

Figure 6; Overhang on brass

**Generally, proper etching conditions must be optimized for specific metal types, thickness' and pattern geometry.**

## Stripping

A typical stripping medium consists of 3 to 5% aqueous potassium hydroxide. When exposed to such a solution at elevated temperature (above 50°C) the resist will readily peel off in flakes. The flake size depends on temperature, KOH concentration and mechanical impingement of the solution on the resist layer aswell as additives added to the stripping solution (amines, organic solvents etc.).

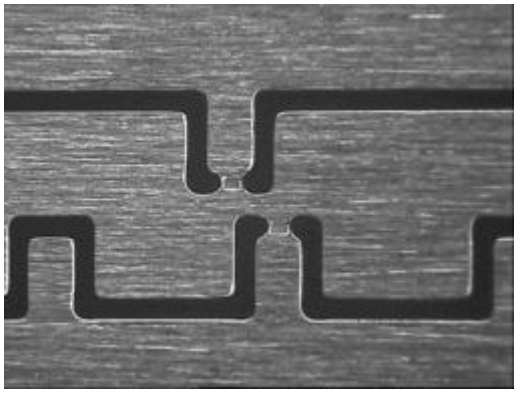

Figure 7; Resist is cleanly removed, also from critical areas

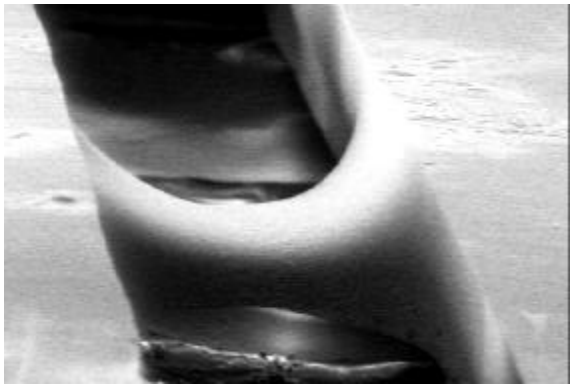

Figure 8; Half tag on final part

Conveyorized stripping is preferred whenever possible. However, untagged parts obviously will disconnect and must be collected on a sieve.

## Handling and storage conditions

In order to avoid evaporation of solvent and premature curing by UV light, keep containers closed and shelter from direct exposure to day light. Wear gloves and eye protection when pouring resist. Observe respective information outlined in the Material Safety Data Sheet (MSDS) provided with each resist delivery.

When stored at ambient temperature (between 15 and 25°C) in the original sealed containers the resist is expected to perform as described above for at least one year after manufacturing date. Once opened the containers should be used on a first-in–first-out basis.

## Technical Customer Service

For further information and advice please contact:

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