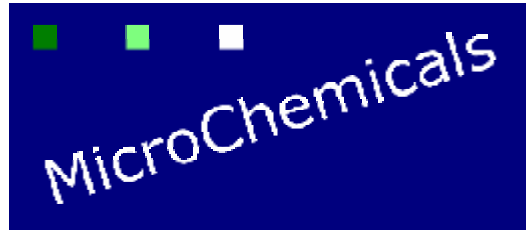


# Resists and Developers

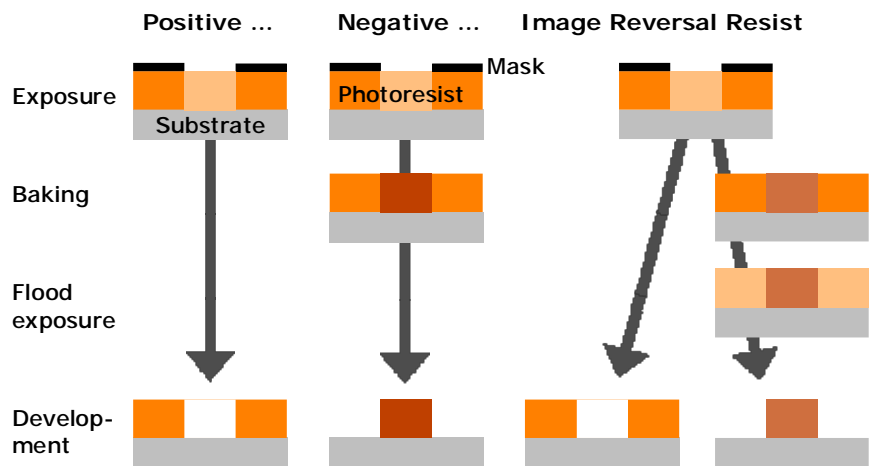


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Source: [www.microchemicals.eu/technical-information](http://www.microchemicals.eu/technical-information)

## Positive, Negative or Image Reversal Resists?

Positive tone resists develop where they have been exposed, while the unexposed areas remain on the substrate. Negative tone resists such as the AZ<sup>®</sup> nLOF 2000 series crosslink after exposure and a subsequent baking step, the unexposed part of the resist gets dissolved in the developer. Image reversal resists can either be processed in positive or negative mode. The latter requires an image reversal bake after the (first) exposure, followed by a flood exposure without mask



## Purpose of the Resist Mask

The most photoresists are either optimized for a good adhesion to the substrate for wet chemical processes (e. g. AZ<sup>®</sup> 1500 or 4500 series), or a high thermal stability for dry chemical etching (e. g. AZ<sup>®</sup> 701MiR or 6600 series) or lift-off (e. g. AZ<sup>®</sup> 5214E, nLOF 2000 series, or TI 35ES). The key for this behaviour is the cresole resin molecule chain length: Smaller units improve the adhesion to the substrate, while longer chains increase the softening point of the resist towards 130°C and beyond.

## Lateral Resolution and Aspect Ratio

The photoresist itself as well as the resist film thickness limit the theoretical resolution limit. Under optimum conditions, high-resolution thin resists such as the AZ<sup>®</sup> 701MiR allow feature sizes of approx. 300 nm under i-line exposure. However, in many cases not the resist, but equipment and process parameters limit the attainable resolution.

Beside a high absolute resolution, some processes require a high aspect ratio (ratio of the feature height to their width). Modern thick resists such as the AZ<sup>®</sup> 9260 allow an aspect ratio of 6-10, and even higher values under optimized process conditions.

## Spectral Sensitivity

The optical absorption (fig. overleaf) of unexposed photoresist ranges from approx. 460 nm in the VIS to near UV, which is matched to the emission spectrum of Hg lamps in mask aligners. This absorption spectrum causes the typical reddish-brownish colour of many photoresists. During exposure, photoresists almost completely bleach down to approx. 300 nm.

The optical absorption range does not end abruptly towards higher wavelengths. Therefore, high illumination intensities (e. g. laser scribing) or -times allow an exposure also some 10 nm towards the visible part of the spectrum.

Photoresists, developers, remover, adhesion promoters, etchants, and solvents ...

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## Resist Film Thickness

Generally, the last two digits of the resist name (e. g. AZ<sup>®</sup> 6632) indicate the film thickness  $d$  attained by spin coating (without gyrset) at  $v = 4000$  rpm in 100 nm units. The thickness approximately decreases with the (increasing) square-root of the spin speed (in rpm), so a given resist allows a certain range in the attainable resist film thickness. If the desired resist film thickness can/should not be realized by varying the spin speed, the usage of a different available viscosity of the given resist is recommended. Otherwise, the following has to be considered:

**Dilution** of high-viscosity resists with PGMEA (= AZ<sup>®</sup> EBR Solvent) allows to perform several applications with different film thicknesses using only one resist. However, diluted resists are sensitive to particle formation with a reduced expiry date depending on the resist, the dilution ratio and the storage temperature and -time for the diluted resist. Since the particles partially consist of the photo active compound, a particle filtration before usage increases the dark erosion and decreases the development rate of the resist. For information on specific dilution recipes consult the following sections or contact us.

Realizing thick films with low-viscosity resists is problematic for two main reasons: i) The required low spin speeds increase the edge bead, and ii) the rather high concentration of the photo active compound (low optical transparency) in typical 'thin resists' requires high exposure doses for a sufficient exposure, which makes steep resist profiles hard to realize and may cause popping and foaming by N<sub>2</sub>-bubbles formed during exposure.

## Which Developer for which Purpose?

First of all, it has to be checked whether the developer has to be metal ion free (MIF) or if alternatively metal ion containing (MIC) developers can be used. Most MIF developers are ready-to-use solutions, while typical MIC developers are supplied as a concentrate which has to be diluted before use.

AZ<sup>®</sup> 326 MIF is 2.38 % TMAH (*TetraMethylAmmoniumHydroxide*) in H<sub>2</sub>O.

AZ<sup>®</sup> 726 MIF is 2.38 % TMAH in H<sub>2</sub>O with surfactants added for fast and homogeneous substrate wetting.

AZ<sup>®</sup> 826 MIF is 2.38 % TMAH in H<sub>2</sub>O with surfactants added for fast and homogeneous substrate wetting, and further additives for removal of resist residuals occasionally remaining after development. These additives, however, slightly increase the dark erosion.

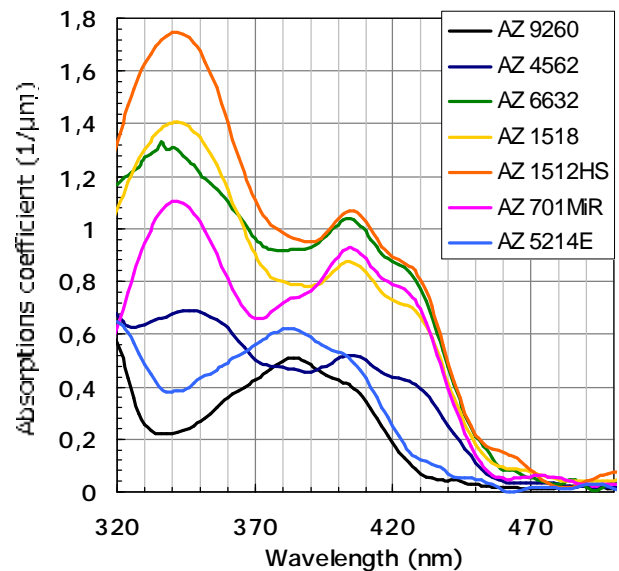
AZ<sup>®</sup> Developer (MIC) is optimized for minimum Al attack. It is typically applied 1 : 1 diluted in DI-H<sub>2</sub>O for high contrast, or undiluted for a high development rate. The dark erosion of AZ<sup>®</sup> Developer is slightly higher as compared to other developers.

AZ<sup>®</sup> 351B (MIC) is based on buffered NaOH and typically used in 1 : 4 dilution.

AZ<sup>®</sup> 400K (MIC) is based on buffered KOH and typically used in 1 : 4 dilution.

AZ<sup>®</sup> 303 (MIC) is based on KOH and NaOH and designed for the resist AZ<sup>®</sup> 111 XFS.

The next selection characteristics is the **compatibility** of the developer to a certain photore-



sist or/and a certain substrate material (table overleaf, bottom).

attainable resist thickness range (micron)		0.5	1.0	1.5	2.0	2.5	3.0	3.5	4	5	6	8	10	15	20	25	50
standard/ wet chemical etching	AZ® 1505	green															
	AZ® 1512HS	yellow	green	green	green												
	AZ® 1514H			green	green	green											
	AZ® 1518				green	green	green	green	green	green							
	TI 35E					green	green	green	green	green	green						
thick resists	AZ® 4533					green	green	green	green	green	green	green	green	green	green	green	green
	AZ® 4562						yellow	yellow	yellow	yellow	green	green	green	green	green	yellow	yellow
	AZ® 9260			yellow	yellow	yellow	yellow	yellow	yellow	green	green	green	green	green	green	yellow	yellow
	TI Plating									green	green	green	green	green	green	green	green
	TI xLift									green	green	green	green	green	green	green	green
dry chemical etching	AZ® 6612			green	green	green	green	green	green	green							
	AZ® 6624			green	green	green	green	green	green	green							
	AZ® 6632				green	green	green	green	green	green							
	TI 35ES					green	green	green	green	green							
high resolution	AZ® MiR 701	yellow	green	green	green	green	green	green	green	green	green	green	green	green	green	green	green
	AZ® ECI 3027			yellow	green	green	green	green	green	green	green	green	green	green	green	green	green
	AZ® 9260			yellow	yellow	yellow	yellow	yellow	green	green	green	green	green	green	green	yellow	yellow
image reversal/ lift-off	AZ® 5214E			green	green	green	green	green	green	green							
	TI 35E/ES					green	green	green	green	green							
	TI Spray		green	green	green	green	green	green	green	green	green	green	green	green	green	green	green
	TI Plating												green	green	green	green	green
	TI xLift												yellow	yellow	green	green	green
lift-off/ negative resist	AZ® nLOF 2000			green	green	green	green	green	green	green	green	green	green	green	green	green	green
spray coating	AZ® 4999 TI Spray		green	green	green	green	green	green	green	green	green	green	green	green	green	green	green

green: standard    yellow: dilution/multiple coating

**Our Photoresists**

Available sales volumes: 250 ml, 500 ml, 1000 ml, 2.5/5 L

Our Developers		AZ® 1500 AZ® 1514H AZ® 1518	AZ® 4500 TI 35E TI Spray	AZ® 6600	AZ® 9200	AZ® MiR 701	PL 177 TI 35ES TI xLift	AZ® nLOF 2000
metal ion free	AZ® 326 MIF	yellow	orange	green	green	yellow	green	yellow
	AZ® 726 MIF	green	orange	green	green	green	green	yellow
	AZ® 826 MIF	yellow	green	green	green	orange	yellow	green
metal ion contain.	AZ® Dev.	yellow	orange	yellow	yellow	yellow	yellow	orange
	AZ® 351B	1:4	orange	yellow	yellow	yellow	yellow	orange
	AZ® 400K	yellow	1:4	yellow	1:4	yellow	green	orange
		recommended		possible		not recommended		

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