Product information

PHOTORESISTS
The Allresist GmbH offers a wide range of resists and process chemicals for all standard applications of photo and e-beam lithography which are required for the fabrication of electronic components.

As independent resist manufacturer, we develop, produce and distribute our products worldwide. On the market since 1992, Allresist benefits from a comprehensive know-how gained in 30 years of resist research, and fabricates products with highest quality (ISO 9001).

As chemical company, we are particularly aware of our obligation to a healthy environment. A responsible and protective resource management and voluntary replacement of environmentally hazardous products is living politics for us. Allresist is environmentally certified (ISO 14001) and environmental partner of the Federal State of Brandenburg.

The company is represented worldwide with an extensive product range. In addition to our standard products, we also manufacture customer-specific products on request.

Allresist furthermore develops innovative products for future-oriented technologies like e.g. microsystems technologies and electron beam lithography. In these constantly growing markets, top performance resists with high sensitivity and a high resolution are in strong demand.

Our newly developed e-beam resists CSAR 62 and AR-N 7520 meet these demands, pushing forward innovative technologies with their excellent properties. With Electra 92 as top layer, e-beam resists can be processed also on insulating substrates like glass, quartz, or GaAs.

Our flexible approach to customer’s demands, together with effective production technologies, allows us to provide fast availability which results in very short delivery times, small packaging sizes from 1/4 l onwards, 30 ml test samples as well as an individually tailored advisory service.

Allresist received a number of awards for scientific and economic top performance (technology transfer prize, innovation award, customer’s champion, quality award and Ludwigs-Erhard-prize).

Interesting news and further information for you are compiled on our web page where you will find answers to many questions in our resist-WIKI and the FAQ.

WWW.ALLRESIST.COM
## Content and Product Overview Photoresists

We deliver our products within 1 week ex work, in-stock stock items are delivered immediately or on the requested date. Package sizes for resists: ¼ f, 0.5 f (2 x ¼), 1 f, 2.5 f, 6 x 1 f, 4 x 2.5 f, and for process chemicals: 1 f, 2.5 f, 5 f, 4 x 2.5 f, 4 x 5 f.

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**General Product Information on Allresist Photoresists**

This general part explains and completes our individual photoresist product information and provides a first overview as well as profound background knowledge. At www.allresist.de, you will find further information in our FAQ as well as our resist-WIKI and a detailed collection of product parameters.

### Overview of composition, mode of action and specific properties of photoresists

Photoresists (photo coatings) are in particular used in microelectronics and Microsystems technology for the fabrication of µm- and sub-µm-structures.

Resists are in most cases applied by spin coating. For thin resists, the optimum rotational speed ranges from 2000 to 4000 rpm, for thick resists between 250 and 2000 rpm. Generally utilizable is a spin speed of up to 9000 rpm to generate films of 30 nm to 200 µm depending on the respective type of resist used. Thicker films of up to 1 mm can be fabricated with coating procedures.

Alternative coating techniques are e.g. dip coating (for large and/or substrates with irregular surface geometry) and spray coating (for highly structured topologies, for complicated substrate shapes) or roller coating procedures.

Allresist offers a large variety of different types of resists which cover a wide range of possible applications:

**Positive photoresists** like e.g. AR-P 3100, 3200, 3500, 3700 are composed of a combination of film forming agents like e.g. cresol novolac resins and light-sensitive components such as e.g. naphthoquinone diazide, which are for example dissolved in solvents like methoxypropyl acetate (equivalent to PGMEA). The addition of the light-sensitive component to the alkali-soluble novolac results in a reduced alkaline solubility. After exposure to UV light (308 - 450 nm) using an exposure mask, the light-sensitive component is converted in exposed areas into the corresponding indene carboxylic acid derivative which then increases the alkaline solubility of positive resists by a factor of about 100. The refractive index of novolac-based resists is in a range of 1.60. After development, only areas protected by the mask remain while unexposed areas are still soluble and are dissolved by the developer.

Thick negative films up to 200 µm can be produced with CAR 44 (AR-N 4400). This resist which is highly sensitive in a range between 300 - 440 nm and to synchrotron radiation provides excellent structural quality.

**Negative photoresists** like AR-N 4300, 4400 are composed of novolac, acid generators and amine components (CAR) dissolved in solvents like e.g. methoxypropyl acetate (PGMEA). After exposure and subsequent tempering step, the composition of CAR leads to a crosslinking of the exposed negative-tone resist film. Irradiated areas are consequently rendered insoluble and remain after development, while unexposed areas are still soluble and are dissolved by the developer.

**Resists for lift-off applications** are the positive resist AR-P 3300 and the two-component resist system AR-BR 5400/AR-P 3510. Lift-off is also possible with negative resists AR-N 4300 and 4450 as well as with the image reversal resist AR-N 4500.

**Protective coatings** like AR-PC 500 and 5000 are offered...
As of January 2014, investigations may then be conducted within the scope of this product together on-site, if required. More detailed photoresists, due to its high competence and flexibility. It is already in early stages of design and development of new imide resists SX AR-PC 5000/80 and SX AR-P 5000/82.

AR products are available both for the deep UV range of 240 – 300 nm (AR-N 4300) as well as for the long-wavelength range up to 500 nm (SX AR-P 3500/6).

Temperature-stable resists up to 400 °C are the polyimide resists SX AR-PC 5000/80 and SX AR-P 5000/82.

User-oriented photoresists

Allresist is able to consider specific customer’s requests already in early stages of design and development of new photoresists, due to its high competence and flexibility. It is thus possible to create a modified product according to the respective demands of each technology and to adapt this product together on-site, if required.

Just ask us! Based on our innovative experience potential we are able to realise cost-efficient resist formulations also in small amounts within short time. More detailed investigations may then be conducted within the scope of R&D projects.

Safety and stability storage conditions

Photoresists are light-sensitive, they react to light exposure or high temperatures and also during storage, age-related changes occur. Resist are therefore filled in light-protected amber bottles, stored in a cool place and can only be processed under yellow light (λ > 500 nm). The date of expiry and the recommended storage temperature are indicated on the product label of each bottle. If these temperatures are maintained, resists in unopened bottles are stable until expiry date (which is in general 2 years after production), at least however for 6 month after date of sale. Brief temperatures deviations have no influence on general product properties.

If resists are to be used later than 6 month after date of sale or to be processed within a very small process window, storage at 4 – 8 °C is recommended. Expections are only resists with recommended storage temperatures between 18 – 25 °C. These resists should not be stored colder.

Photoresists stored for several years are outdated and may only be used with considerable restrictions. This also applies to resists stored at too high temperatures and to highly diluted resists which age faster than normal. Possible consequences are the formation of particles which is caused by a precipitation of the light-sensitive component. Repeated fine filtrations is however only helpful at an early stage. The steadily declining concentration of the light-sensitive component will successively lead to lower development rates, increased dark erosion and reduced resist adhesion properties.

Wastewater treatment

Up to 90 % of the organic material can be removed from developer wasters if the pH of used aqueous alkaline developing solution is adjusted to pH 9 to 10 by addition of acids, followed by subsequent separation of the precipitate.

Prior to waste disposal, filtered solutions have to be adjusted to pH 6.5 – 8.0. Solid wastes may be disposed of at sanitary landfills or by incineration in officially authorized plants. Collected resist and solvent wastes have to be disposed of in approved incinerators.

Safety instructions

Resists, thinner and remover contain organic solvents. Adequate ventilation in the working area is thus mandatory. Developer solutions are caustic alkaline liquids which may irritate the skin. Avoid direct contact with products and their vapours (wear safety goggles and gloves).

EG-safety data sheets of our products may be downloaded from www.allresist.de/products or be requested at info@allresist.de.

0. Adhesion – substrate pre-treatment

The adhesion between substrate and resist is of major importance for the safe processing of resists. Smallest changes of the cleaning procedure or the technology can exhibit a significant influence on the adhesive strength. Silicon, silicon nitride and base metals (aluminium, copper) are generally characterised by good resist adhesion properties, while adhesion is reduced on SiO2, glass, noble metals such as gold and silver or on gallium anide. For these substrates, adhesion promoters are absolutely required to improve the adhesion strength. High air humidity (＞60 %) also reduces adhesion substantially.

If new clean substrates (wafers) are used, a bake at approx. 200 °C (3 min, hot plate) is sufficient for drying, but substrates should be processed quickly thereafter. A temporary storage in a desiccator is highly recommended in order to prevent rehydration.

Pre-used wafers or wafers which are contaminated with organic agents require a previous cleaning in acetone, followed by isopropanol or ethanol treatment and subsequent drying if necessary. This procedure will improve adhesion of the resist. If only acetone is used for cleaning, the substrate must be dried in a drying oven to remove the condensed moisture.

If a technology involves repeated processing of wafers or subjecting these to various conditions, a thorough cleaning is recommended. The cleaning procedure is however highly process- and substrate-dependent (and depends also on the structures already deposited). The use of removers or acids (e.g. piranha) for removal, followed by rinsing and tempering, may be required. In very difficult cases, an ultra- or megasonic cleaning may be helpful.

To improve the adhesion features, adhesion-enhancing agents such as e.g. adhesion promoter AR 300-80 may be used which is applied immediately before resist coating in a very simple procedure by spin coating as thin layer of approx. 15 nm thickness and tempered. It is also possible to evaporate HMDS onto the substrates. The monomolecular layer on the wafer surface has an adhesion-promoting effect due to its hydrophobic properties which facilitate adsorption of the resist.

1. Coating

Substrates should be cooled down prior to coating, and resists have to be adjusted to the temperature of the (preferably air-conditioned) working area. If the resist is too cold, air moisture precipitates on the resist. Bottles removed from the refrigerator should therefore be warmed to room temperature for a few hours prior to opening. Air bubbles can be avoided if resist bottles are slightly opened a few hours before coating to allow for pressure compensation and then left undisturbed. Thick resists require several hours for this process, thin resists much less time. Applying the resist with caution and not too fast with a pipette or dispenser will also prevent bubbles and inhomogeneities in the resist films.

A repeated opening of resists bottles causes evaporation of the solvent and an increased viscosity of the resist. For resist films with a thickness of 1.4 µm, a loss of only 1 % of the solvent already increases the film thickness by 4 %, thus requiring considerably higher exposure doses.

Generally used coating conditions are temperatures of 20 to 25 °C with a temperature constancy of ± 1 °C (optimally 21 °C) and a relative humidity of 30 to 50 % (optimally 43 %). Above a humidity of 70 % tempering is basically impossible. The air moisture also affects the film thickness which is reduced with increasing humidity. For AR-P 3510, the film thickness decreases by 2 nm per percent of humidity.

If spin speeds of > 1500 rpm, 30 s are sufficient to obtain the desired film thickness. At lower spin speeds, the time should be extended to 60 s. For an exposure of rectangular masks, usually a Gyrset (closed chuck) system is used, which provides a better film quality and reduces edge beading formation. It has however to be taken into account that the film thickness decreases to approximately 70 % of the film thickness which is obtained with open chucks.

2. Tempering / Softbake

Resists films which have been previously coated still contain, depending on the film thickness, a substantial amount of residual solvent. A subsequent tempering at 90 – 100 °C is performed to dry and to harden the resist films. In addition to improved resist adhesion properties, also the dark erosion during development is reduced by these means.

The decision if a hot plate or a convection oven should be preferred depends for thin films (＜5 µm) on the availability, since technically none of the procedures offers a particular advantage. The fast through-put of a hot plate is compensated by the option for batch tempering (approx. 25 wafers in one step) in convection ovens. Dry-thermal films in a convection oven is however unsatisfactory since the dried resist surface induces a fast solvent evaporation. In these cases, a hot plate is recommended because more solvent is expelled from the bottom of the resist film.

Innovation
Creativity
Customer-specific solutions

by Allresist for a large variety of applications, e.g. for the backside protection of processed wafers during KOH and HF etchings, for a mechanical protection during transport, or as insulating layer. Protective coatings are not light-sensitive and can be patterned if used alone. They can however be patterned with photoresists within the context of a two-layer system.

Allresist also produces a wide range of special resists, e.g. electroplating-stable resists like SX AR-P 5900/4 for applications performed at a pH-value of 13.
Insufficiently tempered resist films (either too short or at too low temperatures) entail a variety of further problems. Air bubbles may develop successively which are due to an evaporation of residual solvent. Possible consequences are inaccurate structural images, a rounding of resist profiles as well as unacceptable high dark erosion during development.

If temperature-sensitive substrates are processed it is also possible to work at considerably lower softbake temperatures (< 60 °C). The development regime has to be adjusted accordingly.

If the hard bake of resist films was too rigid (temperature too high or tempered too long), a partial destruction of the light-sensitive component results which significantly increases exposure times and reduces the sensitivity.

After the softbake, substrates are cooled to room temperature prior to further use. Especially thick resists require an appropriate waiting time for rehydration before exposure.

3. Exposure

The exposure is performed through masks in suitable exposure systems such as e.g. steppers (-g, -i, -line), mask aligners or contact exposure systems in the respective spectral working range. Direct laser exposure without masks is also possible.

AR photo coatings are light-sensitive in the broad band UV range (300 - 450 nm) and thus also at the typical emission lines of mercury at 365 nm (i-line), 405 nm (h-line), and 436 nm (g-line) (→ Absorption spectra), with maximum sensitivity in the g- and h-line range. Values for recommended exposure dose as specified in our product information are only guideline values determined for our standard processes and have to be confirmed accordingly in own experiments.

Air bubbles may develop either during or after exposure and are e.g. caused by too high light doses or exposure intensities. This can be avoided if the optimum light dose is determined by exposure bracketing or in several consecutive exposure steps with intermediate pauses. A too short or too low tempering after coating results in insufficient drying of the resist film, since still too much solvent is present in the films which causes bubble formation due to outgassing.

The exposure dose which is required to develop a large area of positive resists without structures in a suitable development time is called “dose to clear”. This exposure dose should be increased slightly for patterning, depending on the desired resolution. The maximum resolution requires the highest exposure dose.

The dose to clear unexposed areas of negative resists is in a range of 30 - 40 s for films with a thickness of 1 - 2 µm. This exposure dose which produces a layer buildup of > 90 % should accordingly be increased by 10 - 20 % for patterning unill. poses. For thick films of more than 100 µm, development times of more than 1 hour may be required. Coated and tempered resist films can be stored for several weeks prior to exposure without quality loss. Photore sist s are however more sensitive directly after coating as compared to layers which were stored for several hours or days. The decrease in sensitivity is approximately 3 % after 3 h, 6 % after 72 h, and 8 % after 72 hours (in relation to the initial value) and remains then more or less constant for several weeks.

4. Development

During development, positive resist films are structured by dissolving exposed areas, while unexposed areas are removed if negative resists are developed. For reproducible results, temperatures between 21 and 23 °C with a temperature constancy of ± 0.5 °C should be maintained.

All offered developers (AR 300-35, AR 300-26, AR 300-40) are suitable both for immersion and puddle development, while developers AR 300-26 and 300-40 can additionally be used for spray development.

Optimally adapted developers and dilutions for each resist are specified in the product information. Entries like for example AR 300-26 -1 indicate a dilution of 1 part of developer AR 300-26 with 2 parts of DI water.

The optimal development time is dependent on the respective resist type and film thickness as well as on the exposure wavelength, tempering and development procedure. Favourable development times for films of up to 2 µm are e.g. for immersion or puddle development in a range between 20 and 60 s and should not exceed 120 s. Layers of up to 10 µm thickness require 2 to 10 min, while films with thickness values of up to 100 µm may need development times of more than 60 min. The more intensive spray developments require shorter times.

Developer concentrations as listed in our product information were determined for specific film thickness values or process parameters and can only serve as guideline values under other conditions. The exact developer concentration has always to be adjusted to specific demands (film thickness, development time, tempering).

5. Rinse

After development, substrates have to be rinsed immediately with deionised water until all residual developer is completely removed, and subsequently dried.

6. Postbake / hardbake

For specific process steps, a postbake at approximately 110 °C leads to a higher etch stability during wet-chemical and plasma-chemical etching procedures. Higher temperatures are possible for stronger etch conditions, may however result in a rounding of resist profiles.

Structures in very thick films (> 5 µm) may even converge. UV curing (short wave deep UV exposure with simultaneous heating of the wafer to up to 180 °C, if required) leads to strong hardening of resist structures. While the melting of structures is now prevented in most cases, a subsequent removal is extremely difficult.

7. Customer-specific technologies

Generation of semiconductor properties

The produced resist mask is utilised for technological processes according to the user’s requirements. Semiconduc-
tor properties are generated in a user-specific manner, e.g. by boron or phosphorous doping, by etch proces-
ses or by formation of conductor paths. Thereafter, the resist is in most cases no longer needed and removed.

8. Removal

For the removal of softbaked resist films, polar solvents like e.g. the thinner AR 300-12 and remover AR 600-70 are suitable.

For the wet chemical stripping of tempered resist films, the organic, highly versatile removers AR 300-70, AR 300-72 and AR 300-76 are available which may be heated to 80 °C to reduce the dissolution time. Due to a classification of the raw material NEP (Ar 300-70 and -72) as toxic for reproduction, Allresist strongly recommends to use the newly introduced, less harmful remover AR 300-76 which is equivalent with respect to its dissolving power.

Remover AR 300-73 which was designed for special resists may be heated to 50 °C, does however attack alu-

In semiconductor industries, the removal (stripping) is mostly performed by ashing in a plasma asher. The O2-plasma generated by microwave excitation is used for an isotropic etching of the photoresist. But also oxidising acid mixtures (piranha, nitrohydrochloric acid, nitric acid and others) may be applied in wet chemical removal procedures.
Positive / Negative Photoresists AR-P 1200 / AR-N 2200

AR-P 1200 / AR-N 2200 resist series for spray coating
Ready-to-use positive and negative spray resists for various applications

Characterisation
- broadband UV, i-line, g-line
- AR-P 1210 / AR-N 2210 positive/negative resists for a uniform coverage of vertical trenches
- AR-P 1220 / AR-N 2220 for etch profiles with 54° slopes
- AR-P 1230 / AR-N 2230 for planar wafers
- good adhesion, smooth surface
- combination of novolac and naphthoquinone diazide
- safer solvent PGMEA as well as methyl ethyl ketone

Structure resolution

Process parameters
- Substrate Si 6" wafer
- Tempering 82 °C, chuck
- Exposure broadband (h-, g-, i-line)
- Development AR 300-44, 4 min puddle

Parameters spray coater “EVG® 150”
- Spray coater EVG® 150, EV Group
- Resist flow (drops/min) 25
- Arm speed (mm/s) 200
- N₂ pressure (kPa) 50
- Exposure EVG® 6200NT Automated Mask Alignment System
- Sensitivity (film thickness) 170 ml/cm², 4.5 µm
- Development with AR 300-44 1:30 min
- Minimum resolution (µm) 1.4

Process chemicals
- Developer AR 300-44
- Remover AR 300-76, AR 300-73

Properties I
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<td>Solids content (%)</td>
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<td>Flash point (°C)</td>
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<td>Storage 6 month (°C)</td>
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Properties II
- Glass transition temperature
- Dielectric constant
- Cauchy coefficients
- Plasma etching rates (nm/min) (5 Pa, 240-250 V bias)
  - Ar-sputtering 8 / 8
  - O₂ 169 / 173
  - CF₄ 38 / 33
  - 80 CF₄ + 1 6 O₂ 90 / 93

Cross-linking bake for AR-N 2210-2230
- 90 °C, 5 min hot plate or 85 °C, 25 min convection oven

Development (21-23 °C ± 0.5 °C puddle)
- AR 300-44
- 4 min
- 3 : 1, 5 min
- 2 : 1, 6 min

Rinse DI-H₂O, 30 s

Removal
- AR 300-70 or O₂ plasma ashing

Important processing instructions regarding single process steps are described on the following page.

As of August 2016

5 µm resist structures of AR-N 2220 in 150 µm deep etch grooves
Aluminium conductor paths after etching

Copyright EVG
Processing Instructions for Spray Resists

Coating: For spray coating, resists are filled into the cartridges of the spray coater under yellow light. Gas formation in the resist supply line which is generally observed for AZ 4999 does not occur with AR resists. The quality of the coating largely depends upon the respective spray coating device which is used. The best experiences we have had with the devices of EV Group. Adjustable device parameters such as dispensing rate, scanning speed, spray distance and chuck temperature exhibit a major influence on the film forming process. Commercially available spraying devices differ considerably with respect to their coating properties, and own experiments to determine the optimum parameters are therefore absolutely necessary.

Resists 1220/2220 and 1230/2230 form very homogeneous surfaces. Due to their specific solvent composition, solvent evaporation is reduced, but nevertheless a complete and at the same time sufficient coverage of the substrate is provided. Surfaces are thus considerably less rough as compared to AZ 4999. If unheated chucks are used, coated substrates should be tempered on a hot plate at plate at 85 - 90 °C for 2-5 min or in a convection oven at 85 °C for 25 min to improve adhesion. A temperature of 90 °C should however not be exceeded to prevent edge retraction of the resist caused by possible softening processes.

With resists AR-P 1210 and 1220 as well as with AR-N 2210 and 2220 and under standard conditions, film thickness values of 4 - 8 µm can be obtained. Higher film thicknesses are possible with higher dispensing rates or using multiple coating steps.

In comparison with AZ 4999, these resists have a lower tendency to form disturbing beads. Resists AR-P 1230 and AR-N 2230 are thus well suited for the generation of thin films with a thickness of 0.5 - 1 µm and can be used for spray coating as well as for spin coating applications. The thickness of films produced via spin coating ranges between 50 to 120 nm.

Exposure: For an exposure of positive resists, the entire UV-range of 300 to 450 nm can be utilised, while for the exposure of negative resists, a range between 300 to 436 nm is recommended. The exposure time generally depends on the film thickness. For a film thickness of about 5 µm, the sensitivity of positive resists is approx. 200 mJ/cm². Negative-tone resists with approx. 70 mJ/cm² are substantially more sensitive and require shorter exposure times, which is advantageous for the exposure of wafers with extreme topologies in order to prevent undesirable reflexions. Thin films generated with AR-P 1230 and AR-N 2230 require lower exposure doses.

For negative resists, a cross-linking bake after exposure is mandatory!

Development: The development time strongly depends on the respective film thickness and amounts to approximately 5 minutes for 5 µm films. If edges are only marginally covered, a 3 : 1 dilution (3 parts developer : 1 part water) is recommended. For the development of thin films of about 0.5 µm, the developer should be diluted up to 2 : 1.
**Positive Photoresist AR-P 3100**

AR-P 3100 photoresist product series for mask production

Adhesion-enhanced positive resists for the production of masks and fine scale divisions

### Charactetisation
- broadband UV, i-line, g-line
- high photosensitivity, high resolution
- strong adhesion to critical glass/chromium surfaces for extreme stresses during wet-chemical etching processes
- for the production of CD masters and lattice structures
- 3170 also suitable for laser interference lithography
- plasma etching resistant
- combination of novolac and naphthoquinone diazide
- safer solvent PGMEA

### Properties I

<table>
<thead>
<tr>
<th>Parameter / AR-P</th>
<th>3110</th>
<th>3120</th>
<th>3170</th>
</tr>
</thead>
<tbody>
<tr>
<td>Solids content (%)</td>
<td>28</td>
<td>21</td>
<td>8</td>
</tr>
<tr>
<td>Viscosity 23 °C (mPas)</td>
<td>12</td>
<td>5</td>
<td>2</td>
</tr>
<tr>
<td>Film thickness/4000 rpm (nm)</td>
<td>1000</td>
<td>550</td>
<td>120</td>
</tr>
<tr>
<td>Resolution (μm)</td>
<td>0.5</td>
<td>0.4</td>
<td>0.4</td>
</tr>
<tr>
<td>Contrast</td>
<td>3.0</td>
<td>3.0</td>
<td>3.0</td>
</tr>
<tr>
<td>Flash point (°C)</td>
<td>42</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Storage 6 month (°C)</td>
<td>10 - 18</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Properties II

| Glass transition temperature | 108 |
|Dielectric constant | 3.1 |
|Cauchy coefficients N0 | 1.621 |
| N1 | 65.6 |
| N2 | 195.6 |
| Plasma etching rates (nm/min) | (5 Pa, 240-250 V bias) |
|Ar-sputtering | 7 |
|O2 | 165 |
|CF4 | 38 |
|80 CF4 + 16 O2 | 89 |

### Process conditions
This diagram shows exemplary process steps for AR-P 3100 resists. All specifications are guideline values which have to be adapted to own specific conditions. For further information on processing, see “Detailed instructions for optimum processing of photoresists”. For recommendations on waste water treatment and general safety instructions, see “General product information on Allresist photoresists”.

#### Coating
AR-P 3110  AR-P 3120  AR-P 3170
4000 rpm, 60 s  4000 rpm, 60 s  4000 rpm, 60 s
1000 nm  550 nm  120 nm

**Tempering (+/- 1 °C)**
100 °C, 1 min hot plate or 95 °C, 25 min convection oven

**UV exposure**
Broadband UV, 365 nm, 405 nm, 436 nm
Exposure dose (E0, broadband UV stepper):
70 mJ/cm²  65 mJ/cm²  60 mJ/cm²

**Development**
(21-23 °C ± 0,5 °C) puddle
AR 300-26 1 : 3  60 s
AR 300-47, 1 : 1  60 s
AR 300-47, 1 : 1,5  60 s
Rinse DI-H2O, 30 s

**Post-bake**
(115 °C, 1 min hot plate or 115 °C, 25 min convection oven

**Customer-specific technologies**
Generation of e.g. semi-conductor properties

**Removal**
AR 300-70 or O2 plasma ashing

### Resist / Developer

<table>
<thead>
<tr>
<th>Resist / Developer</th>
<th>AR-P 3110</th>
<th>AR-P 3120</th>
<th>AR-P 3170</th>
</tr>
</thead>
<tbody>
<tr>
<td>AR-P 3110 1 : 3</td>
<td>pure to 3 : 2</td>
<td>1.5 : 1</td>
<td></td>
</tr>
<tr>
<td>AR-P 3120 1 : 3</td>
<td>5 : 1</td>
<td>1 : 1</td>
<td></td>
</tr>
<tr>
<td>AR-P 3170 1 : 4</td>
<td>1 : 1</td>
<td>1 : 1,5</td>
<td></td>
</tr>
</tbody>
</table>
Positive Photoresist AR-P 3100

**Linearity**

Up to a structure width of 0.38 μm, a very good agreement is obtained. RGM measurement: Thickness 560 nm, i-line stepper (NA: 0.65 N.A.). Developer AR 300-47 1:1.

**Optimum exposure dose**

Undereposure leads in the case of complete development (more than 55 ml/cm²) to narrower trenches, while overexposure results in a widening of trenches.

**Focus variation**

The intended structure sizes can here be realised by varying the focus between -1.5 to 0.8 (parameter see graf: linearity).

**Focus variation (with and without PEB)**

Without PEB, a higher resolution is obtained since the focus curve is steeper (PEB 90 °C, 60 s).

**Optimum exposure dose**

Optimum dose, with hard bake (110 °C) and without hard bake. The additional hard bake requires 15% more light (PEB 90 °C, 60 s).

**Thermal properties of resist structures**

Untempered

Hard bake 115 °C
## Positive Photoresist AR-P 3200

**Photoresists**

**Innovation**

**Creativity**

**Customer-specific solutions**

**AR-P 3200 photoresist series for high film thicknesses**

Thick positive resists for electroplating and microsystems technology

### Properties I

<table>
<thead>
<tr>
<th>Parameter / AR-P</th>
<th>3210</th>
<th>3220</th>
<th>3250(T)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Solids content (%)</td>
<td>47</td>
<td>47</td>
<td>39</td>
</tr>
<tr>
<td>Viscosity 25 °C (mPas)</td>
<td>1990</td>
<td>1820</td>
<td>250</td>
</tr>
<tr>
<td>Film thickness/4000 rpm (µm)</td>
<td>10</td>
<td>10</td>
<td>5</td>
</tr>
<tr>
<td>Resolution (µm)</td>
<td>4.0</td>
<td>3.0</td>
<td>1.2</td>
</tr>
<tr>
<td>Contrast</td>
<td>2.0</td>
<td>2.0</td>
<td>2.5</td>
</tr>
<tr>
<td>Flash point (°C)</td>
<td>42</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Storage 6 month (°C)</td>
<td>10-18</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Properties II

| Glass transition temperature | 108  |
| Dielectric constant | 3.1  |
| Aruchi coefficients AR-P 3210 | N₀      | 1.597 |
|                         | N₁      | 79.5  |
|                         | N₂      | 105.1 |
| Plasma etching rates (nm/min) (5 Pa, 240-250 V bias) | Ar-sputtering | 7 |
|                         | O₂      | 170   |
|                         | CF₄     | 39    |
|                         | 80 CF₄  | 16 O₂ | 90     |

### Spin curve

### Structure resolution

### Resist structures

### Process parameters

| Substrate | Si 4” wafer |
| Tempering | 95 °C, 10-15 min, hot plate |
| Exposure | Maskaligner MJB 3, contact exposure |
| Development | AR-300-26, 1 : 3, 3 min, 22 °C |

### Process chemicals

| Adhesion promoter | AR 300-80 |
| Developer | AR 300-26 |
| Thinner | AR 300-12 |
| Remover | AR 300-76, AR 600-71 |

### Process conditions

**This diagram shows exemplary process steps for AR-P 3200 resists. All specifications are guideline values which have to be adapted to own specific conditions. For further information on processing, refer to “Detailed instructions for optimum processing of photoresists”. For recommendations on waste water treatment and general safety instructions, refer to “General product information on Allresist photoresists”.**

**Coating**

AR-P 3210

<table>
<thead>
<tr>
<th>Coating Process</th>
<th>4000 rpm, 90 s</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>10 µm</td>
</tr>
</tbody>
</table>

AR-P 3220

<table>
<thead>
<tr>
<th>Coating Process</th>
<th>600 rpm, 120 s; 30 µm</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>4000 rpm, 60 s; 5 µm</td>
</tr>
<tr>
<td></td>
<td>4000 rpm, 60 s; 5 µm</td>
</tr>
</tbody>
</table>

AR-P 3250(T)

<table>
<thead>
<tr>
<th>Coating Process</th>
<th>4000 rpm, 60 s; 5 µm</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>4000 rpm, 60 s; 5 µm</td>
</tr>
</tbody>
</table>

### Tempering (± 1 °C)

<table>
<thead>
<tr>
<th>Tempering Process</th>
<th>H* = hot plate or C* = convection oven</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>95 °C, 4 min; 95 °C, 15 min; 95 °C, 2 min; 95 °C, 2 min</td>
</tr>
<tr>
<td></td>
<td>90 °C, 40 min; 90 °C, 30 min; 90 °C, 30 min</td>
</tr>
</tbody>
</table>

### UV exposure

**Exposure**

Broadband UV, 365 nm, 436 nm

**Exposure dose (E₀, broadband UV stepper):**

<table>
<thead>
<tr>
<th>Exposure dose</th>
<th>450 mJ/cm²; 900 mJ/cm²</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>220 mJ/cm²; 300 mJ/cm²</td>
</tr>
</tbody>
</table>

### Development (21-23 °C ± 0.5 °C puddle)

<table>
<thead>
<tr>
<th>Development Process</th>
<th>AR 300-26, 1 : 2</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2 min</td>
</tr>
<tr>
<td></td>
<td>AR 300-35</td>
</tr>
<tr>
<td></td>
<td>AR 300-44</td>
</tr>
</tbody>
</table>

### Rinse

**Di-H₂O, 30 s**

### Post-bake (optional)

Not required

### Customer-specific technologies

Generation of e.g. semi-conductor properties, galvanic, MEMS

### Removal

AR 300-76 or O₂ plasma ashing

### Processing instructions (for the processing of thick films > 40 µm)

**Coating:** Coating should be performed in two or several steps using the same procedure. After a low initial spin speed (30 s), a main spin speed of 250 – 500 rpm for at least 2-5 min should be chosen. A brief subsequent spin-off at 600 – 800 rpm for 5 s reduces edge bead formation.

**Tempering:** Tempering should be performed in 2 steps: 1. 75 °C, 5 min hot plate or 70 °C, 30 min convection oven; 2. 90 °C, 20 min hot plate or 90 °C, 80 min convection oven. After tempering, a slow cooling is recommended to avoid stress cracks.

### Development recommendations

<table>
<thead>
<tr>
<th>Resist / Developer</th>
<th>AR 300-26</th>
<th>AR 300-35</th>
<th>AR 300-44</th>
</tr>
</thead>
<tbody>
<tr>
<td>AR-P 3210 (up to 20 µm)</td>
<td>1 : 3 (2-10 min)</td>
<td>undil. up to 10 µm (2-10 min)</td>
<td>-</td>
</tr>
<tr>
<td>AR-P 3220 (up to 10 µm)</td>
<td>1 : 3 (2-10 min)</td>
<td>undil. up to 10 µm (2-10 min)</td>
<td>-</td>
</tr>
<tr>
<td>AR-P 3250 (up to 5 µm)</td>
<td>1 : 3 (2-10 min)</td>
<td>undil. up to 5 µm (1-5 min)</td>
<td>-</td>
</tr>
</tbody>
</table>

### As of January 2018

As of March 2017
Positive Photoresist AR-P 3200

**Sensitivity vs. duration of the soft bake**

After 2 hours, the sensitivity remains nearly constant (broadband UV, resist thickness 20 µm).

**Residual solvent after tempering**

After a bake at 95 °C, approx. 7% of the solvent remain in the layer (initial solids content: 47%).

**Sensitivity in different developers**

Film thickness 20 µm, soft bake 85 °C, 1 h convection oven, bb UV.

**Dark erosion in different developers**

Erosion corresponding to determined sensitivities.

**Grey tone mask lithography**

28 µm-high 3D pyramids with AR-P 3220.

**Photolysis of photo-active compound (PAC)**

Chemical reaction for bleaching and full exposure of the layer (Süss-reaction)

The transparency of AR-P 3220 is higher compared to AR-P 3210, due to the lower concentration of the PAC. The gradation is accordingly relatively low. This fact can be used for the fabrication of three-dimensional structures using grey tone masks with AR-3220. Different exposure doses will result in different resist film thicknesses.
# Positive Photoresists AR-P 3500 / 3500 T

## Characterisation

- broadband UV, i-line, g-line
- high photosensitivity, high resolution
- very good adhesion properties
- 3500 T: robust processing, suitable for TMAH developer 0.26 n
- plasma etching resistant, temperature-stable up to 120 °C
- combination of novolac and naphthoquinone diazide
- safer solvent PGMEA

## Properties I

<table>
<thead>
<tr>
<th>Parameter / AR-P</th>
<th>AR-P 3510 / 3510 T</th>
<th>AR-P 3540 / 3540 T</th>
</tr>
</thead>
<tbody>
<tr>
<td>Solids content (%)</td>
<td>35 / 32</td>
<td>31 / 28</td>
</tr>
<tr>
<td>Viscosity 25 °C (mPas)</td>
<td>33 / 38</td>
<td>18 / 21</td>
</tr>
<tr>
<td>Film thickness / 4000 rpm (µm)</td>
<td>2.0</td>
<td>1.4</td>
</tr>
<tr>
<td>Resolution (µm)</td>
<td>0.8 / 0.6</td>
<td>0.7 / 0.5</td>
</tr>
<tr>
<td>Contrast</td>
<td>4.0 / 4.5</td>
<td>4.5 / 5.0</td>
</tr>
<tr>
<td>Flash point (°C)</td>
<td>42</td>
<td></td>
</tr>
<tr>
<td>Storage 6 month (°C)</td>
<td>10 - 18</td>
<td></td>
</tr>
</tbody>
</table>

## Properties II

| Glass transition temperature | 108 |
| Dielectric constant | 3.1 |
| Cauchy coefficients AR-P 3540 T | N0 1.627, N1 71.4, N2 164.8 |
| Plasma etching rates (nm/min) & (5 Pa 240-250 V bias) | Ar-sputtering 7, O2 165, CF4 37, 80 CF4 + 16 O2 88 |

## Process parameters

| Substrate | Si 4” wafer |
| Tempering | 95 °C, 90 s, hot plate |
| Exposure | g-line stepper (NA: 0.56) |
| Development | AR 300-44, 60 s, 22 °C |

## Process chemicals

| Adhesion promoter | AR 300-80 |
| Developer | AR 300-26, T: AR 300-44 |
| Thinner | AR 300-12 |
| Remover | AR 300-76, T: AR 300-76 |

## Process conditions

- **Coating**
  - AR-P 3510
    - 4000 rpm, 60 s, 2.0 µm
  - AR-P 3540 T
    - 4000 rpm, 60 s, 1.4 µm

- **Tempering (± 1 °C)**
  - 100 °C, 1 min, hot plate or 95 °C, 25 min, convection oven

- **UV exposure**
  - Broadband UV, 365 nm, 405 nm, 436 nm
  - Exposure dose (E0, broadband UV stepper): 55 mJ/cm², 120 mJ/cm²

- **Development**
  - AR 300-26, 1 : 5
    - 60 s
  - AR 300-44
    - 60 s
  - Rinse DI-H₂O, 30 s
  - Post-bake (optional)
    - 115 °C, 1 min, hot plate or 115 °C, 25 min convection oven
  - Customer-specific technologies
    - Generation of semiconductor properties or lift-off

- **Removal**
  - AR 300-70 or O₂ plasma ashing

- **Focus width**
  - AR-P 3540 T g-line stepper
  - AR-P 3540 T
    - Ridge DOF @ 230 mJ
      - 1.5 µm > 2.0 µm: 110-260 mJ/cm²
      - 1.0 µm > 1.5 µm: 130-260 mJ/cm²
      - 0.7 µm > 1.25 µm: 160-250 mJ/cm²
      - 0.5 µm > 1.0 µm: 190-240 mJ/cm²
    - Best edge steepness: 180-200 mJ/cm²

- **Resist structures**
  - AR-P 3500
    - Resist thickness 2 µm
    - Resist structures 5 µm
**Positive Photoresists AR-P 3540 T**

**Focus width**
Film thickness 1.5 µm on Si-wafer, dose: 230 mJ/cm²

<table>
<thead>
<tr>
<th>Focus</th>
<th>1.5 µm L/S</th>
<th>1.0 µm L/S</th>
<th>0.7 µm L/S</th>
<th>0.5 µm L/S</th>
</tr>
</thead>
<tbody>
<tr>
<td>- 1.0</td>
<td><img src="image1.png" alt="Image" /></td>
<td><img src="image2.png" alt="Image" /></td>
<td><img src="image3.png" alt="Image" /></td>
<td><img src="image4.png" alt="Image" /></td>
</tr>
<tr>
<td>- 0.75</td>
<td><img src="image5.png" alt="Image" /></td>
<td><img src="image6.png" alt="Image" /></td>
<td><img src="image7.png" alt="Image" /></td>
<td><img src="image8.png" alt="Image" /></td>
</tr>
<tr>
<td>- 0.5</td>
<td><img src="image9.png" alt="Image" /></td>
<td><img src="image10.png" alt="Image" /></td>
<td><img src="image11.png" alt="Image" /></td>
<td><img src="image12.png" alt="Image" /></td>
</tr>
<tr>
<td>- 0.25</td>
<td><img src="image13.png" alt="Image" /></td>
<td><img src="image14.png" alt="Image" /></td>
<td><img src="image15.png" alt="Image" /></td>
<td><img src="image16.png" alt="Image" /></td>
</tr>
<tr>
<td>0.0</td>
<td><img src="image17.png" alt="Image" /></td>
<td><img src="image18.png" alt="Image" /></td>
<td><img src="image19.png" alt="Image" /></td>
<td><img src="image20.png" alt="Image" /></td>
</tr>
<tr>
<td>+ 0.25</td>
<td><img src="image21.png" alt="Image" /></td>
<td><img src="image22.png" alt="Image" /></td>
<td><img src="image23.png" alt="Image" /></td>
<td><img src="image24.png" alt="Image" /></td>
</tr>
<tr>
<td>+ 0.5</td>
<td><img src="image25.png" alt="Image" /></td>
<td><img src="image26.png" alt="Image" /></td>
<td><img src="image27.png" alt="Image" /></td>
<td><img src="image28.png" alt="Image" /></td>
</tr>
<tr>
<td>+ 0.75</td>
<td><img src="image29.png" alt="Image" /></td>
<td><img src="image30.png" alt="Image" /></td>
<td><img src="image31.png" alt="Image" /></td>
<td><img src="image32.png" alt="Image" /></td>
</tr>
</tbody>
</table>

Tempering: 95 °C, 90 s, hot plate (contact), exposure: g-line stepper (NA: 0.56; 0.75 s).
Development: AR 300-44, 60 s, 22 °C, puddle

**Linearity**
Film thickness 1.5 µm on Si-wafer, focus: 0.0

<table>
<thead>
<tr>
<th>Dose</th>
<th>1.5 µm L/S</th>
<th>1.0 µm L/S</th>
<th>0.7 µm L/S</th>
<th>0.5 µm L/S</th>
</tr>
</thead>
<tbody>
<tr>
<td>160 mJ</td>
<td><img src="image33.png" alt="Image" /></td>
<td><img src="image34.png" alt="Image" /></td>
<td><img src="image35.png" alt="Image" /></td>
<td><img src="image36.png" alt="Image" /></td>
</tr>
<tr>
<td>190 mJ</td>
<td><img src="image37.png" alt="Image" /></td>
<td><img src="image38.png" alt="Image" /></td>
<td><img src="image39.png" alt="Image" /></td>
<td><img src="image40.png" alt="Image" /></td>
</tr>
<tr>
<td>210 mJ</td>
<td><img src="image41.png" alt="Image" /></td>
<td><img src="image42.png" alt="Image" /></td>
<td><img src="image43.png" alt="Image" /></td>
<td><img src="image44.png" alt="Image" /></td>
</tr>
<tr>
<td>230 mJ</td>
<td><img src="image45.png" alt="Image" /></td>
<td><img src="image46.png" alt="Image" /></td>
<td><img src="image47.png" alt="Image" /></td>
<td><img src="image48.png" alt="Image" /></td>
</tr>
</tbody>
</table>

**Dark field erosion**
Film thickness 1.5 µm on Si-wafer, focus: 0.0

<table>
<thead>
<tr>
<th>Dose</th>
<th>1.5 µm L/S</th>
<th>1.0 µm L/S</th>
<th>0.7 µm L/S</th>
<th>0.5 µm L/S</th>
</tr>
</thead>
<tbody>
<tr>
<td>190 mJ</td>
<td><img src="image49.png" alt="Image" /></td>
<td><img src="image50.png" alt="Image" /></td>
<td><img src="image51.png" alt="Image" /></td>
<td><img src="image52.png" alt="Image" /></td>
</tr>
<tr>
<td>210 mJ</td>
<td><img src="image53.png" alt="Image" /></td>
<td><img src="image54.png" alt="Image" /></td>
<td><img src="image55.png" alt="Image" /></td>
<td><img src="image56.png" alt="Image" /></td>
</tr>
<tr>
<td>230 mJ</td>
<td><img src="image57.png" alt="Image" /></td>
<td><img src="image58.png" alt="Image" /></td>
<td><img src="image59.png" alt="Image" /></td>
<td><img src="image60.png" alt="Image" /></td>
</tr>
</tbody>
</table>

Tempering: 95 °C, 90 s, hot plate (contact), exposure: g-line stepper (NA: 0.56; 0.75 s).
Development: AR 300-44, 60 s, 22 °C, puddle

As of January 2014
Positive Photoresists AR-P 3700 / 3800

AR-P 3700 / 3800 photoresists for sub-µm structures
Semi-sensitive positive-tone standard resists for the production of highly integrated circuits

Characterisation
- broadband UV, i-line, g-line
- high sensitivity, highest resolution up to 0.4 µm
- high contrast, excellent dimensional accuracy
- optimised coating properties on topologically complex substrate surfaces
- AR-P 3840 coloured to prevent the effect of standing waves
- plasma etching resistant, stable up to 120 °C
- combination of novolac and naphthoquinone diazide
- safer solvent PGMEA

Properties I

- Parameter / AR-P
  - AR-P 3740
  - AR-P 3840
- Solids content (%)
  - 29
  - 29
- Viscosity 25 °C (mPas)
  - 22
  - 22
- Film thickness / 4000 rpm (µm)
  - 1.4
  - 1.4
- Resolution (µm)
  - 0.4
  - 0.4
- Contrast
  - 6.0
  - 6.0
- Flash point (°C)
  - 42

Spin curve

Structure resolution

Resist structures

Process parameters

- Substrate: 4” wafer
- Tempering: 100 °C, 90 s, hot plate
- Exposure: i-line stepper (NA: 0.65)
- Development: AR 300-47, 60 s, 22 °C

Process chemicals

- Adhesion promoter: AR 300-80
- Developer: AR 300-47, AR 300-26
- Thinner: AR 300-12
- Remover: AR 300-76, AR 600-71

Positive Photoresists AR-P 3700 / 3800

Process conditions

This diagram shows exemplary process steps for AR-P 3700 / 3800 resists. All specifications are guideline values which have to be adapted to own specific conditions. For further information on processing, refer to “Detailed instructions for optimum processing of photoresists”. For recommendations on waste water treatment and general safety instructions, refer to “General product information on Allresist photoresists”.

- Coating
  - AR-P 3740
  - AR-P 3840
  - 4000 rpm, 60 s
  - 1.4 µm
- Tempering (± 1 °C)
  - 100 °C, 1 min hot plate or
  - 95 °C, 25 min convection oven
- UV exposure
  - Broadband UV, 365 nm, 405 nm, 436 nm
  - Exposure dose (E₀, broadband UV stepper):
    - 55 mJ/cm²
    - 72 mJ/cm²
- Development
  - (21-23 °C ± 0.5 °C) puddle
    - AR 300-47
    - 60 s
  - Rinse
    - DI-H₂O, 30 s
- Post-bake (optional)
  - 115 °C, 1 min hot plate or
  - 115 °C, 25 min convection oven
- Customer-specific technologies
  - Generation of semiconductor properties
- Removal
  - AR 300-70 or O₂ plasma ashing

Development recommendations

Resist / Developer

- AR-P 3740, 3840
- 1 : 3
- AR-P 3740, 3840
- 4 : 1
- AR 300-47, 60 s
- 300-46 high speed
- 300-47 high contrast
Positive Photoresists AR-P 3700 / 3800

Dark erosion

AR-P 3700 may be developed with any of the four TMAH developers. A high sensitivity is associated with high erosion rates. No dark erosion is obtained if weaker developers are chosen (see diagram Influence of developer strength).

Influence of developer strength of the dark erosion

Influence of developer strength of exposure dose

Dependency of sensitivity (exposure dose) on resist drying

Using coated Cr-substrates (thickness 1.5 µm), 15 – 350 nm are removed within 10 min depending on the respective developer strength. The highest erosion is obtained with the strong developer AR 300-46 (0.24 n).

Using coated Cr-substrates (thickness 1.5 µm), 15 – 350 nm are removed within 10 min depending on the respective developer strength. The highest erosion is obtained with the strong developer AR 300-46 (0.24 n).

Using the strong developer AR 300-46, short exposure times can be realized. The highest contrast and thus a slightly higher resolution is obtained with the weak developer AR 300-475 (0.17 n).

Using the strong developer AR 300-46, short exposure times can be realized. The highest contrast and thus a slightly higher resolution is obtained with the weak developer AR 300-475 (0.17 n).

Dependency of film thickness on air humidity

As of January 2014

Linearity

Optimum exposure dose

Focus variation

Dependency of film thickness on air humidity

As of January 2014

Thermal behaviour of resist structures

It is also possible to develop resists which were only dried at room temperature (24 h). In this case, resists are technically very sensitive, but are however also characterized by high dark erosion. A good development is provided for resists baked at up to 110 °C (AR 300-35, 1 : 1), while developers with higher strength are required for bake temperatures above 120 °C (AR 300-35, 2 : 1). Resist layers tempered at 130 °C are basically non-developable any more.
Positive Photoresist for Lift-off AR-P 5300

AR-P 5300 photoresist series for lift-off applications
Sensitive positive-tone resists for the production of evaporation samples

Characterisation
- broadband UV, i-line, g-line
- high photosensitivity, high resolution
- good adhesion properties
- for undercut structures for the production of evaporation samples, in particular of metal using lift-off techniques e.g. for conductor paths
- plasma etching resistant, temperature stable up to 120 °C
- combination of novolac and naphthoquinone diazide
- safer solvent PGMEA

Properties I

<table>
<thead>
<tr>
<th>Parameter / AR-P</th>
<th>AR-P 5320</th>
<th>AR-P 5350</th>
</tr>
</thead>
<tbody>
<tr>
<td>Solids content (%)</td>
<td>39</td>
<td>28</td>
</tr>
<tr>
<td>Viscosity 25 °C (mPas)</td>
<td>250</td>
<td>13</td>
</tr>
<tr>
<td>Film thickness 4000 rpm (µm)</td>
<td>5.0</td>
<td>1.0</td>
</tr>
<tr>
<td>Resolution (µm)</td>
<td>2.0</td>
<td>0.5</td>
</tr>
<tr>
<td>Contrast</td>
<td>4.0</td>
<td>5.0</td>
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<tr>
<td>Flash point (°C)</td>
<td>42</td>
<td></td>
</tr>
<tr>
<td>Storage 6 month (°C)</td>
<td>10 - 18</td>
<td></td>
</tr>
</tbody>
</table>

Spin curve

Lift-off resist structures
AR-P 5350
Lift-off resist structure after metal evaporation

Properties II

<table>
<thead>
<tr>
<th>Property</th>
<th>AR-P 5320</th>
<th>AR-P 5350</th>
</tr>
</thead>
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<tr>
<td>Glass transition temperature</td>
<td>108</td>
<td></td>
</tr>
<tr>
<td>Dielectric constant</td>
<td>3.1</td>
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<tr>
<td>Cauchy coefficients</td>
<td>N0</td>
<td>1.623</td>
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<tr>
<td></td>
<td>N1</td>
<td>166.8</td>
</tr>
<tr>
<td></td>
<td>N2</td>
<td>10</td>
</tr>
<tr>
<td>Plasma etching rates (nm/min) (5 Pa, 240–250 V bias)</td>
<td>Ar-sputtering</td>
<td>7</td>
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<tr>
<td></td>
<td>O2</td>
<td>161</td>
</tr>
<tr>
<td></td>
<td>CF4</td>
<td>39</td>
</tr>
<tr>
<td></td>
<td>80 CF4 + 16 O2</td>
<td>90</td>
</tr>
</tbody>
</table>

Resist structures

AR-P 5320
Lift-off resist structure after development

Process parameters
Substrate Si 4” wafer
Tempering 105 °C, 4 min, hot plate
Exposure g-line stepper (NA: 0.56)
Development AR 300-35, 1 : 2, 60 s, 22 °C

Process chemicals
Adhesion promoter AR 300-80
Developer AR 300-26, 300-35
Thinner AR 300-12
Remover AR 300-76, AR 600-71

Positive Photoresist for Lift-off AR-P 5300

Process conditions
This diagram shows exemplary process steps for AR-P 5300 resists. All specifications are guideline values which have to be adapted to own specific conditions. For further information on processing, see “Detailed instructions for optimum processing of photoresists”. For recommendations on waste water treatment and general safety instructions, see “General product information on Allresist photoresists”.

Coating
AR-P 5320 | AR-P 5350
6000 rpm, 60 s | 4000 rpm, 60 s
4.0 µm | 1.0 µm

Tempering (± 1 °C)
105 °C, 4 min hot plate or
100 °C, 40 min convection oven

UV exposure
Broadband UV, 365 nm, 405 nm, 436 nm
Exposure dose (E0, broadband UV stepper):
58 mJ/cm² | 55 mJ/cm²

Development
AR 300-26, 3 : 2
2 min
AR 300-35, 1 : 2
60 s

Rinse
DI-H2O, 30 s

Post-bake (optional)
Not required

Customer-specific technologies
Generation of e.g. semiconductor properties or lift-off

Removal
AR 300-76 or O2 plasma ashing

Processing instructions
Tempering: Higher tempering temperatures are required to produce the undercut.
Development: The undercut of resist structures is generated during aqueous-alkaline development.

Development recommendations
Resist / Developer AR-P 5320 | AR-P 5350
2 : 1 to 3 : 2 (1-3 min) | -
AR 300-26 | AR 300-35 | AR 300-40
AR-P 5320 | AR-P 5350
1 : 7 | 1 : 2
300-47, 2 : 3
Positive and Negative Photoresists AR-U 4000

Image reversal resist for the fabrication of integrated circuits

Characterisation
- bb UV, line, g-line, neg exposure up to 450 nm
- high photosensitivity, high resolution
- depending on the processing protocol, pos. or neg. image with structures in the sub-µm range
- positive working without additional process steps
- high contrast in the negative mode, pronounced undercut profiles are possible (lift-off)
- combination of novolac and bisazide
- safer solvent PGMEA

Properties I

<table>
<thead>
<tr>
<th>Parameter / AR-U</th>
<th>4030</th>
<th>4040</th>
<th>4060</th>
</tr>
</thead>
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<tr>
<td>Solids content (%)</td>
<td>37</td>
<td>34</td>
<td>23</td>
</tr>
<tr>
<td>Viscosity 25 °C (mPas)</td>
<td>28</td>
<td>19</td>
<td>6</td>
</tr>
<tr>
<td>Film thickness/4000 rpm (µm)</td>
<td>1.8</td>
<td>1.4</td>
<td>0.6</td>
</tr>
<tr>
<td>Resolution (µm)</td>
<td>0.8</td>
<td>0.7</td>
<td>0.5</td>
</tr>
<tr>
<td>Contrast</td>
<td>3.0</td>
<td>3.0</td>
<td>3.5</td>
</tr>
<tr>
<td>Flash point (°C)</td>
<td>42</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Storage 6 month (°C)</td>
<td>8</td>
<td>12</td>
<td></td>
</tr>
</tbody>
</table>

Properties II

| Glass transition temperature | 108 |
| Dielectric constant | 3.1 |
| Cauchy coefficients unexposed/exposed | N0 1.620 / 1.618 |
| N1 57.0 / 82.8 |
| N2 220.4 / 130.5 |
| Plasma etching rates (nm/min) (5 Pa, 240-250 V Bias) | Ar-sputtering 9 |
| CF2 1.69 |
| CF2 40 |
| 80 CF4 + 16 O2 89 |

Spin curve

Structure resolution

Resist structures

Process parameters

- Substrate Si 4" wafer
- Tempering 90 °C, 1 min, hot plate
- Exposure g-line stepper (NA: 0.56)
- Development AR 300-35, 1 : 1, 60 s, 22 °C

Process chemicals

- Adhesion promoter AR 300-80
- Developer AR 300-35, AR 300-26
- Thinner AR 300-12
- Remover AR 300-76, AR 300-72

AR-U 4030
- 1.8 µm positive structures at a film thickness of 2.5 µm

AR-U 4040
- 1.0 µm positive structures at a film thickness of 1.4 µm

AR-U 4060
- Undercut negative structures at a film thickness of 2.5 µm

Positive and Negative Photoresists AR-U 4000

Process conditions

This diagram shows exemplary process steps for AR-U 4000 resists. All specifications are guideline values which have to be adapted to own specific conditions. For further information on processing, refer to "Detailed instructions for optimum processing of photoresists". For recommendations on waste water treatment and general safety instructions, refer to "General product information on Allresist photoresists".

Coating
- AR-U 4030 4000 rpm, 60 s 1.8 µm
- AR-U 4040 4000 rpm, 60 s 1.4 µm
- AR-U 4060 4000 rpm, 60 s 0.6 µm

Tempering (± 1 °C)
- 90 °C, 1 min hot plate or 85 °C, 25 min convection oven

UV exposure
- Broadband UV, 365 nm, 436 nm
- Exposure dose (E0, broadband UV stepper):
  - 38 ml/cm²
  - 34 ml/cm²
  - 28 ml/cm²

Development
- AR 300-35, 1 : 1 60 s
- AR 300-35, 1 : 2 60 s
- AR 300-35, 1 : 3 60 s

Rinse DI-H2O, 30 s

Post-bake (optional)
- Not required

Customer-specific technologies
- Generation of e.g. semiconductor properties or lift-off

Removal
- AR 300-76 or O2 plasma ashing

Development recommendations

Resist / Developer positive process
- AR-U 4030 AR-U 4040 AR-U 4060
- AR 300-26 AR 300-35 AR 300-47

AR-U 4030 (1.8 µm)
- 1 : 4
- 1 : 1
- 1 : 2

AR-U 4040 (1.4 µm)
- 1 : 5
- 1 : 1
- 1 : 2

AR-U 4060 (0.6 µm)
- 1 : 8
- 1 : 2
- 1 : 3
Positive and Negative Photoresists AR-U 4000

Process conditions negative process

This diagram shows exemplary process steps for AR-U 4000 resists. All specifications are guideline values which have to be adapted to own specific conditions. For further information on processing, see “General product information on Allresist photoresists”.

Coating
- AR-U 4030, 4000 rpm, 60 s, 1.8 µm
- AR-U 4040, 4000 rpm, 60 s, 1.4 µm
- AR-U 4060, 4000 rpm, 60 s, 0.6 µm

Tempering (± 1 °C)
- 90 °C, 1 min hot plate or 85 °C, 25 min Convection oven

Image-wise UV exposure
- Broadband UV, 365 nm, 405 nm, 436 nm; 90 % layer build up

Exposure dose (E₀, broadband UV stepper):
- 42 mJ/cm²
- 36 mJ/cm²
- 30 mJ/cm²

Flood exposure
- Broadband UV stepper: approx. twice of image-wise without mask

Exposure dose (E₀, broadband UV stepper):
- 74 mJ/cm²
- 68 mJ/cm²
- 55 mJ/cm²

Development
- AR 300-35, 4 : 3
  - 60 s
- AR 300-35, 1 : 1
  - 60 s
- AR 300-35, 2 : 3
  - 60 s

Post-bake (optional)
- DI-H₂O, 30 s

Removal
- AR 300-70 or O₂ plasma ashing

Development recommendations

Resist / Developer negative process
- AR 300-26
- AR 300-35
- AR 300-47
- AR-U 4030 (1.8 µm)
  - 1 : 4
  - 4 : 3
  - 3 : 2
- AR-U 4040 (1.4 µm)
  - 1 : 5
  - 1 : 1
  - 2 : 3
- AR-U 4060 (0.6 µm)
  - 1 : 6
  - 2 : 3
  - 1 : 2

Positive and Negative Photoresists AR-U 4000

Processing instructions

Positive resist:
- The image reversal resist can be used as normal positive-tone resist. Since this resist has the potential to be cross-linked due to its specific components, a softbake at only 85 °C (oven) or 90 °C (hot plate) after coating is recommended. A relatively high exposure dose has to be chosen for the generation of vertical edges. If trenches with falling edges (e.g., 60° angles) are desired, the image-wise exposure has to be reduced considerably. An undercut cannot be obtained in positive processes.
- During uv exposure, the alkali-insoluble naphthoquinone diazides (NCDs) are converted into alkali-soluble indenecarboxylic acid derivatives which then are removed together with the likewise alkali-soluble novolac during the development. A high exposure dose ensures a complete photolysis of NCDs in the entire layer. As a result of the high and constant development rate, vertical edges are produced. With these short exposure times, lower layers of the resist are only incompletely exposed, the development rate is thus slowed down towards the bottom and a slope is generated.
- The temperature stability of positively developed structures can be significantly increased if a final flood exposure and tempering at 95-105 °C is carried out.

Negative resist:
- This resist also allows for the production of negative-structures. The resist contains an amine component which exhibits no influence during positive processes. If however the image-wise exposed resist layer is tempered after exposure, the amine in exposed areas reacts with indenecarboxylic acid and a crosslinking results which renders exposed areas alkali-insoluble. To increase the efficiency of the negative process, an exposure of still un-exposed areas using flood exposure is required. During flood exposure, the alkali-soluble indenecarboxylic acid is formed, in the up to this step unexposed areas, however crosslinked structures remain unchanged. The following development produces then a negative image.
- To generate of vertical edges, a high image-wise expose dose has to be chosen in the negative mode. Intensifying the reversal bake supports the formation of vertical walls. For the generation of lift-off structures, the image-wise expose dose should be rather low.
Protective Coatings AR-PC 500(0)

AR-PC 503, 504(0) adhesion-enhanced KOH-resistant resists
Wafer backside protection during front side etchings for the production of deep structures in silicon

Characterisation
- not light-sensitive > 300 nm, no yellow light required
- protection of wafer backside when etching the front side
- offers reliable protection against mechanical damage during handling and transport
- temperature-stable up to 250°C
- PMMA with different molecular weights, 503 in addition dyed dark
- solvent 503, 504 chlorobenzene; 5040 anisole

Spin curve

Photo of coated wafer

Topography of the backside

Structural formula poly(methyl methacrylate)

Properties I
<table>
<thead>
<tr>
<th>Parameter / AR-PC</th>
<th>503</th>
<th>504</th>
<th>5040</th>
</tr>
</thead>
<tbody>
<tr>
<td>Solids content (%)</td>
<td>10</td>
<td>13</td>
<td>17</td>
</tr>
<tr>
<td>Viscosity 25 °C (mPas)</td>
<td>190</td>
<td>350</td>
<td>550</td>
</tr>
<tr>
<td>Film thickness/4000 rpm (µm)</td>
<td>1.0</td>
<td>2.2</td>
<td>2.8</td>
</tr>
<tr>
<td>Resolution (µm)</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Contrast</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Flash point (°C)</td>
<td>28</td>
<td>42</td>
<td></td>
</tr>
<tr>
<td>Storage 6 month (°C)</td>
<td>18 - 25</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Properties II

Glass transition temperature | 105
Dielectric constant | 2.6
Cauchy coefficients AR-PC 503 | N0 1.528
                      | N1 34.6
                      | N2 0
Plasma etching rates (nm/min) (5 Pa, 240-250 V Bias)
Ar-sputtering | 20
O2 | 240
CF4 | 61
80 CF4 + 16 O2 | 160

Process chemicals
| Adhesion promoter | AR-300-80 |
| Developer | |
| Thinner | AR-600-01 |
| Remover | AR-300-76, AR-600-71 |

Process conditions

This diagram shows exemplary process steps for AR-PC 500(0) resists. All specifications are guideline values which have to be adapted to own specific conditions. For further information on processing, see “Detailed instructions for optimum processing of photoresists”. For recommendations on waste water treatment and general safety instructions, see “General product information on Allresist photoresists”.

Pre-coating with AR-300-80
Adhesive bonding, resulting film thickness 15 nm

1. Tempering
180 °C, 2 min hot plate or 180 °C, 25 min convection oven

Coating protective film
AR-PC 503
1000 rpm, 60 s, 2.0 µm
AR-PC 504
1000 rpm, 60 s, 4.5 µm

2. Tempering (± 1 °C)
140 °C, 1.5 min hot plate or 135 °C, 60 min convection oven

Fabrication of etch mask on the backside
Customer-specific process to generate the hard mask

Customer-specific technologies

Removal of protective coating
AR-300-76 or O2 plasma ashing

Processing instructions

Pre-treatment prior to coating: The protective effect during etching can be extended to up to 8 hours if the surface is pre-treated with adhesion promoter AR-300-80. The coating is preferably performed at 4000 rpm. After tempering at 180 °C for 2 min (hot plate), a uniform, 15 nm thin layer of adhesion promoter is formed (-> Product information AR-300-80).

Coating: A rotational speed of 1000 rpm is recommended for protective coatings, since at a film thickness of 2 - 5 µm wafer edges are best protected due to a certain “edge wrapping” of the resist. At higher spin speeds or if 6-inch wafers and above are used, the relatively high amount of resist which is deposited on the wafer may cause the so-called candy-floss effect. Low spin speeds, local exhaustion or removal of the “candy floss” with a glass rod during coating reduces these highly disturbing effects.

Tempering: To obtain a particularly high protective effect for the fabrication of hard-baked films, tempering temperatures of 190 °C are recommended.

Etch process: The protective coating is even after hours not attacked by 40 % KOH. Possibly occurring problems only derive from insufficient adhesive strength and can be significantly reduced with a pre-treatment with AR-300-80.
### 2L-Lift-off System with AR-BR 5400 (positive or negative)

#### AR-BR 5400 bottom resist for two-layer lift-off systems

Positive or negative system for optically transparent and thermally resistant structures

**Characterisation**
- Bottom resist not light sensitivity
- Broadband UV, i-line, g-line for top resist
- For lift-off structures
- For optically transparent structures from 270 nm to IR with thermally stable structures up to 250 °C
- Aqueous-alkaline development
- Temperature-stable up to 140 °C (with AR-P 3500)
- 5400 copolymer methyl methacrylate/methacrylic acid
- 3-safer solvent PM (5400), PGMEA (3500, 4340)

#### Properties I

<table>
<thead>
<tr>
<th>Parameter / AR-BR</th>
<th>5460</th>
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<tbody>
<tr>
<td>Solids content (%)</td>
<td>12</td>
<td>9.5</td>
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<tr>
<td>Viscosity 25 °C (mPas)</td>
<td>73</td>
<td>33</td>
</tr>
<tr>
<td>Film thickness/4000 rpm (µm)</td>
<td>1.0</td>
<td>0.5</td>
</tr>
<tr>
<td>Resolution top resist 2 L (µm)</td>
<td>3.0</td>
<td>1.5</td>
</tr>
<tr>
<td>Contrast</td>
<td>Lift-off</td>
<td>Lift-off</td>
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<tr>
<td>Flash point (°C)</td>
<td>30</td>
<td>30</td>
</tr>
<tr>
<td>Storage 6 month (°C)</td>
<td>10 - 18</td>
<td></td>
</tr>
</tbody>
</table>

#### Properties II

- Glass transition temperature: 125
- Dielectric constant: 2.9
- Cauchy coefficients: N0 1.526, N1 0, N2 117
- Plasma etching rates (nm/min)
  - (5 Pa, 240-250 V Bias): Ar-sputtering 14, O2 283, CF4 51, 80 CF4 + 16 O2 1.33

#### Spin curve

![Spin curve graph]

#### Structure resolution of positive system

![Structure resolution of positive system graph]

#### Structure resolution of negative system

![Structure resolution of negative system graph]

#### Process parameters

- Substrate: Si 4” wafer
- Tempering: 150 °C, 5 min, hot plate
- Exposure: Maskaligner MJB 3
- Development: AR 300-47, 1 : 1, 2 min, 22 °C

#### Process chemicals

- Adhesion promoter: AR 300-80
- Developer: AR 300-47
- Thinner: AR 600-07
- Remover: AR 300-76, AR 300-73

### 2L-Lift-off System with AR-BR 5400 - AR-P 3500

#### Process conditions positive process

This diagram shows exemplary process steps for the positive system AR-BR 5400 – AR-P 3500. All specifications are guideline values which have to be adapted to own specific conditions. For further information on processing, please refer to “Detailed instructions for optimum processing of photoresists”. For recommendations on waste water treatment and general safety instructions, please refer to “General product information on Allresist photoresists”.

1. Coating
   - AR-BR 5460 (bottom resist for lower layer)
   - AR-BR 5480 (bottom resist for lower layer)
   - 2000 rpm, 60 s
   - 1.4 µm

2. Tempering
   - ± 1 °C
   - 150 °C, 5 min hot plate or 145 °C, 30 min convection oven

3. Coating
   - AR-P 3540 (top resist for upper layer)
   - 4000 rpm, 60 s
   - 1.4 µm

4. Tempering
   - 100 °C, 2 min hot plate or 95 °C, 30 min convection oven

5. UV exposure
   - Broadband UV, 365 nm, 405 nm, 436 nm
   - Exposure dose (E0, bb UV st.): 42 mJ/cm², 1.4 µm (upper layer)

6. Development
   - (21-23 °C ± 0.5 °C) puddle
   - AR 300-47, 1 : 1
   - Rinse: DI-H2O, 50 s
   - Selective removal of the photoresist film (optional)
   - AR 600-70, 35 s
   - Post-bake (optional)
   - Not required
   - Evaporation / sputtering of metal onto lift-off structures
   - AR 300-76

Important processing instructions on single process steps are outlined on the following page.
Processing instructions for positive two-component system

**Coating:** The substrate is first coated with the copolymer AR-BR 5400 and tempered. After cooling to room temperature, the photoresist is applied onto the copolymer. Dwell times are to be avoided; the liquid photoresist should not be left for more than 10 s on the standing wafer. The film thickness may be varied in a range between 1.6 - 4.0 µm. Subsequently, the two-component system is tempered. 

**Exposure:**

AR-P 3500: Exposure and aqueous-alkaline development are carried out as usual (≈ Product information AR-P 3500). AR-BR 5400: The copolymer itself is not sensitive in the UV-range between 300-450 nm. The properties of the layer are however adjusted such that the polymer will dissolve quickly in the recommended aqueous-alkaline developer.

**Development:** After the upper photoresist layer is entirely developed in exposed areas, the developer begins to dissolve the copolymer. The dissolution process now takes place in an undirected manner (isotropic). AR-BR 5400 is in this process removed both towards the bottom and towards the left or right side so that the undercut is formed. The longer the developer can exert its effect, the more of the copolymer under the photoresist film is removed by dissolution. For a reduction of the dissolving rate, a higher temperature of up to 180 °C has to be chosen (instead of 150 °C). The desired undercut can thus be adjusted via the parameters temperature and development time (≈ see images below).

**Selective removal of the photoresist layer (optional):**

For transparent and temperature-stable films, the copolymer layer is used alone. In this case, the residual photoresist is selectively removed after development with remover AR 600-70. The substrate is briefly immersed in remover AR 600-70 and dried immediately with compressed air.

**Lifting / Removal:**

Removers AR 300-73 and AR 300-76 are both suitable for lifting undilposses. If lift-off structures are not thermally stressed during evaporation or sputtering, lifting will take place within a minute. After high thermal load (> 150 °C), the time required for lifting increased considerably. Ultra sound and heating facilitate a removal. Remover AR 300-73 may in this case be heated up to 50 °C max.

**Adjustment of the undercut via development time**

- 25 s development: 0.8 µm undercut
- 40 s development: 1.6 µm undercut
- 90 s development: 4.6 µm undercut

---

**Process conditions negative process**

This diagram shows exemplary process steps for the positive system AR-BR 5400 – AR-P 4340/7. All specifications are guideline values which have to be adapted to own specific conditions. For further information on processing, ≈ “Detailed instructions for optimum processing of photoresists”. For recommendations on waste water treatment and general safety instructions, ≈ “General product information on Allresist photoresists”.

1. **Coating**
   - AR-BR 5400 (bottom resist for lower layer)
   - 2000 rpm, 60 s, 1.4 µm
   - AR-P 4340 (bottom resist for lower layer)
   - 2000 rpm, 60 s, 0.7 µm

2. **Tempering (± 1 °C)**
   - 150 °C, 5 min hot plate or 
   - 145 °C, 30 min convection oven

3. **Coating**
   - SX AR-N 4340/7 (top resist for upper layer)
   - 4000 rpm, 60 s, 1.4 µm

4. **Tempering (± 1 °C)**
   - 90 °C, 2 min hot plate or 
   - 85 °C, 30 min convection oven

5. **UV exposure**
   - Broadband UV, 365 nm, 405 nm, 436 nm
   - Exposure dose (E<sub>0</sub>, bb UV st.): 20 mJ/cm², 1.4 µm (upper layer)

6. **Tempering (± 1 °C)**
   - 95 °C, 2 min hot plate or 
   - 90 °C, 30 min convection oven

**Development**

- 50 s 35 s
- AR 300-47, 1 : 1 AR 300-47, 1 : 1
- AR 600-70 AR 600-70
- 10 s 10 s
- DI-H<sub>2</sub>O, 30 s

**Rinse**

- Selective removal of the photoresist film (optional)
- AR 600-70 AR 600-70

**Post-bake (optional)**

- Not required

**Customer-specific technologies**

- Evaporation/sputtering of metal onto lift-off structures

**Lifting / Removal**

- AR 300-73 or AR 300-76

---

**Important processing instructions on single process steps are outlined on the following page**

≈
2L-Lift-off Negative System AR-BR 5400 - SXAR-N 4340/7

Processing instructions for negative two-component system

The negative two-layer lift-off system is characterised by a particularly high temperature resistance up to 250 °C after development.

Coating: The substrate is at first coated with the co-polymer AR-BR 5400 and tempered. After cooling to room temperature, the negative resist SX AR-N 4340/7 which was specifically designed for two-layer systems is applied onto the copolymer. Dwell times are to be avoided; the liquid photoresist should not be left for more than 10 seconds on the standing wafer. The film thickness may be varied in a range between 1.0 – 2.5 µm. Subsequently, the two-component system is tempered.

Note: The ratio of film thicknesses of both films will affect the structural geometry. For a strong lift-off effect, a thin photoresist layer and a thick copolymer layer is advantageous. For a dimensionally accurate transfer of structures into the copolymer layer however, both layers should have approximately the same thickness. The entire system always has to be optimised for the particular application.

Exposure:
SX AR-N 4340/7: Exposure and aqueous-alkaline development are carried out according to the general process descriptions which require an additional crosslinking bake in the negative mode.
AR-BR 5400: The copolymer itself is not sensitive in the UV-range between 300-450 nm. The properties of the layer are however adjusted such that the polymer will dissolve quickly in the recommended aqueous-alkaline developer.

Development: After the upper photoresist layer is entirely developed in exposed areas, the developer begins to dissolve the copolymer. The dissolution process now takes place in an undirected manner (isotropic).

AR-BR 5400 is in this process removed both towards the bottom and towards the left or right side so that the undercut is formed. The longer the developer can exert its effect, the more of the copolymer under the photoresist film is removed by dissolution. For a reduction of the dissolving rate, a higher temperature of up to 180 °C has to be chosen (instead of 150 °C). The desired undercut can thus be adjusted via the parameters temperature and development time (see images below). In addition, the steepness can be influenced by the exposure time of the negative resist.

Selective removal of the photoresist layer (optional): For transparent and temperature-stable films, the copolymer layer is used alone. For this undiluted, the residual photoresist is selectively removed after development with remover AR 600-70. The substrate is briefly immersed in remover AR 600-70 and dried immediately with compressed air.

Lifting / Removal:
Removers AR 300-73 and AR 300-76 are both suitable for lifting. If lift-off structures are not thermally stressed during evaporation or sputtering, lifting will take place within a minute.

After high thermal load (> 250 °C), the time required for lifting increased considerably. Ultrasound and heating facilitate a removal. Remover AR 300-73 may in this case be heated up to 50 °C max.
HF-stable Positive Photoresist AR-P 5900

AR-P 5910 photoresist for hydrofluoric acid etchings up to 5%
Adhesion-enhanced positive-tone resist for complicated patternings with HF etching mixtures

Characterisation
- broadband UV, i-line, g-line
- highly enhanced adhesion, retarded diffusion of hydrofluoric acid in BOE-mixture 5:1 (>1 h)
- stable against 5% hydrofluoric acid (>15 min)
- plasma etching resistant up to 120 °C
- combination of novolac and naphthoquinone diazide, crosslinking agent, adhesion promoter; safer solvent PGMEA

Properties I
- Parameter / AR-P: 5910
- Solids content (%): 39
- Viscosity 25°C (mPas): 250
- Film thickness/4000 rpm (µm): 5
- Resolution (µm): 2.0
- Contrast: 2.0
- Flash point (°C): 42
- Storage 6 month (°C): 10 - 18

Properties II
- Glass transition temperature: 108
- Dielectric constant: 3.1
- Cauchy coefficients
  - N₀: 1.623
  - N₁: 166.8
  - N₂: 10
- Plasma etching rates (nm/min)
  - Ar-sputtering: 7
  - O₂: 161
  - CF₄: 38
  - 80 CF₄ + 16 O₂: 89

Structure resolution
AR-P 5910 3 µm-bars at a film thickness of 5 µm

Resist structures
Resist structures of AR-P 5910

Process parameters
- Substrate: Si 4" wafer
- Tempering: 90 °C, 2 min, hot plate
- Exposure: Maskaligner MJB 3, contact exposure
- Developm. AR 300-26 undil., 90 s, 22 °C

Process chemicals
- Adhesion promoter: AR 300-80
- Developer: AR 300-26
- Thinner: AR 300-12
- Remover: AR 300-76, AR 300-73

Process conditions
This diagram shows exemplary process steps for resist AR-P 5910. All specifications are guideline values which have to be adapted to own specific conditions. For further information on processing, refer to "Detailed instructions for optimum processing of photoresists." For recommendations on waste water treatment and general safety instructions, refer to "General product information on Allresist photoresists."

Pre-coating with AR 300-80
- Adhesive bonding, resulting film thickness 15 nm
- 1. Tempering
  - 180 °C, 2 min hot plate or 180 °C, 25 min convection oven

Coating
- AR-P 5910
  - 4000 rpm, 60 s, 5.0 µm

2. Tempering (± 1 °C)
- 90 °C, 2 min hot plate or 85 °C, 25 min convection oven

Development
- Broadband UV, 365 nm, 405 nm, 436 nm
  - Exposure dose (E₀, broadband UV stepper): 380 ml/cm², 5.0 µm
  - Exposure (21-23 °C ± 0.5 °C) puddle: AR 300-26, 60 s
  - Rinse: DI-H₂O, 30 s

Post-bake
- 110 °C, 2 min hot plate or 105 °C, 25 min convection oven

Removal
- AR 300-76 or O₂ plasma ashing

Processing instructions
Etching process: The resist is able to withstand 5% HF or HF/isopropanol mixtures for some time (up to 15 minutes). Stability is increased if a pre-treatment with AR 300-80 is performed. A hydrofluoric acid solution buffered with ammonium fluoride (5% HF, 5% NH₄F) etches about as fast as 5% HF alone, but resist structures are stable for up to one hour in this case. If BOE-mixtures of 5:1 (40% NH₄F; conc. HF) are used, etching is possible for an even longer period of time.

Development recommendations
- Resist / Developer: AR 300-26
- AR 5910 undil.

As of January 2014
Negative Photoresist AR-N 4300

AR-N 4340 photoresist for the mid UV range
Highly sensitive negative resist for the production of integrated circuits

Characterisation
- i-line, g-line
- highest sensitivity, excellent resolution
- good adhesion, high contrast, chemically enhanced
- undercut profiles (lift-off) are possible
- plasma etching resistant, temperature-stable up to 220 °C after subsequent treatment
- novolac with photochemical acid generator and amine-based crosslinking agent
- safer solvent PGMEA

Properties I

<table>
<thead>
<tr>
<th>Parameter / AR-N</th>
<th>ABS 4340</th>
</tr>
</thead>
<tbody>
<tr>
<td>Solids content (%)</td>
<td>32</td>
</tr>
<tr>
<td>Viscosity 25 °C (mPas)</td>
<td>18</td>
</tr>
<tr>
<td>Film thickness (µm)</td>
<td>1.4</td>
</tr>
<tr>
<td>Resolution (µm)</td>
<td>0.5</td>
</tr>
<tr>
<td>Contrast</td>
<td>5.0</td>
</tr>
<tr>
<td>Flash point (°C)</td>
<td>42</td>
</tr>
<tr>
<td>Storage 6 month (°C)</td>
<td>10 - 18</td>
</tr>
</tbody>
</table>

Properties II

| Glass transition temperature | 102 |
| Dielectric constant | 3.1 |
| Cauchy coefficients | N0 1.593, N1 75.4, N2 80.0, 81.4 |
| Plasma etching rates (mm/min) | Ar-sputtering 8, O2 173, CF4 33, 80 CF4 + 16 O2 93 |

Structure resolution

Resist structures

Process parameters

Substrate | Si 4” wafer |
Tempering | 85 °C, 60 s, hot plate |
Exposure | i-line stepper (NA: 0.65) |
Development | AR 300-475, 60 s, 22 °C |

Process chemicals

Adhesion promoter | AR 300-80 |
Developer | AR 300-475 |
Thinner | AR 300-12 |
Remover | AR 300-76, AR 300-72 |

TCD vs. bake temperature

<table>
<thead>
<tr>
<th>Temperature °C</th>
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<td>70</td>
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As of January 2016

AR-N 4340 for the mid UV range

Photoresists
Innovation
Creativity
Customer-specific solutions

AR-N 4340 photoresist for the mid UV range
Highly sensitive negative resist for the production of integrated circuits

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Structure resolution

Resist structures

Process parameters

Substrate | Si 4” wafer |
Tempering | 85 °C, 60 s, hot plate |
Exposure | i-line stepper (NA: 0.65) |
Development | AR 300-475, 60 s, 22 °C |

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As of January 2016

AR-N 4340 for the mid UV range
Highly sensitive negative resist for the production of integrated circuits

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Process parameters

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<td>130</td>
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</table>
Negative Photoresist AR-N 4300

**Linearity**

Up to a line width of 0.7 µm, the linearity is in the desired range (parameter see graphic Focus variation).

**Optimum exposure dose**

The optimum exposure dose for 1 µm bars is 56 mJ/cm² (parameter see graphic Focus variation).

**Focus variation**

The resist achieves a resolution of 0.8 µm optimal focus adjustment REM measurement. Thickness 1.5 µm, PEB 105 °C, 180 s, 1-line stepper (NA: 0.65), Developer AR 300-475.

**Sensitivity in dependency on the bake**

Samples were both dried and crosslinked at temperatures as indicated. The optimum working range is between 90 and 110 °C.

**Time for complete development vs. bake**

The time for complete development is very short at bake temperatures of < 50 °C, even if weak developers are used. With increasing temperature, the time for complete development (TCD) is considerably prolonged. Above a temperature of 120 °C, complete development of the resist is no longer possible.

**Temperature stability after hardening**

The developed structures are stable between 140 - 160 °C, depending on the drying procedure (hot plate or oven). Structures can be stabilized up to temperatures of 220 °C by flood exposure and a subsequent bake at 120 °C.

As of January 2014
**Negative Photoresists AR-N 4400 (CAR 44)**

**AR-N 4400 photoresist series for high film thickness values**

Thick negative resists for electroplating, microsystems technology and LIGA ≤ 20 µm

### Properties I

**Characterisation**
- i-, g-line, e-beam, X-ray, synchrotron, broadband UV
- chemically enhanced, very good adhesion, electroplating-stable
- very high sensitivity, easy removal
- profiles with high edge steepness for excellent resolution, covering of topologies
- 4400-05/-10 for films up to 10 µm/20 µm (250 rpm)
- 4450-10T for film thicknesses up to 20 µm and lift-off
- novolac, crosslinking agent, amine-based acid generator
- safer solvent PGMEA

**Properties II**

**Glass transition temperature** 102

**Dielectric constant** 3.1

**Cauchy coefficients**
- \( N_0 = 1.615 \)
- \( N_1 = 77.6 \)
- \( N_2 = 64.1 \)

**Plasma etching rates (nm/min)**
- Ar-sputtering: 3
- \( O_2 \): 122
- \( CF_4 \): 31
- 80% \( CF_4 \) + 16% \( O_2 \): 81

**Resist structures**

**Process parameters**
- **Substrate**: Si 4” wafer
- **Tempering**: 95 °C, 10 min, hot plate
- **Exposure**: Maskaligner MJB 3, contact exposure
- **Development**: AR 300-47, undil, 3 min, 22 °C

**Process chemicals**
- **Adhesion promoter**: AR 300-80
- **Developer**: AR 300-47, AR 300-44
- **Thinner**: AR 300-12
- **Remover**: AR 600-71, AR 600-70

---

**Negative Photoresists AR-N 4400 (CAR 44)**

**AR-N 4400 photoresist series for high film thickness values**

Thick negative resists for electroplating, microsystems technology and LIGA ≥ 50 µm

### Properties I

**Characterisation**
- i-, g-line, e-beam, X-ray, synchrotron, broadband UV
- chemically enhanced, very good adhesion, electroplating-stable
- very high sensitivity, easy removal
- profiles with high edge steepness for excellent resolution, covering of topologies
- 4400-25 for very thick films up to 50 µm (250 rpm)
- 4400-50 for highest film thicknesses up to 100 µm
- novolac, crosslinking agent, amine-based acid generator
- safer solvent PGMEA

**Properties II**

**Glass transition temperature** 102

**Dielectric constant** 3.1

**Cauchy coefficients**
- \( N_0 = 1.615 \)
- \( N_1 = 77.6 \)
- \( N_2 = 64.1 \)

**Plasma etching rates (nm/min)**
- Ar-sputtering: 3
- \( O_2 \): 122
- \( CF_4 \): 31
- 80% \( CF_4 \) + 16% \( O_2 \): 81

**Resist structures**

**Process parameters**
- **Substrate**: Si 4” wafer
- **Tempering**: 95 °C, 10 min, hot plate
- **Exposure**: Maskaligner MJB 3, contact exposure
- **Development**: AR 300-47, undil, 90 min, 22 °C

**Process chemicals**
- **Adhesion promoter**: AR 300-80
- **Developer**: AR 300-46, AR 300-44
- **Thinner**: AR 300-12
- **Remover**: AR 600-71, AR 600-70
Negative Photoresists AR-N 4400 (CAR 44)

**Process conditions**

This diagram shows exemplary process steps for AR-N 4400 resists. All specifications are guideline values which have to be adapted to own specific conditions. For further information on processing, see "General instructions for optimum processing of photoresists". For recommendations on waste water treatment and general safety instructions, see "General product information on Allresist photoresists".

<table>
<thead>
<tr>
<th>Coating (open chuck)</th>
<th>4400-05</th>
<th>4400-10</th>
<th>4400-25</th>
<th>4400-50</th>
<th>4450-10T</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1000 rpm</td>
<td>1000 rpm</td>
<td>1000 rpm</td>
<td>1000 rpm</td>
<td>1000 rpm</td>
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<td></td>
<td>5 µm</td>
<td>10 µm</td>
<td>25 µm</td>
<td>50 µm</td>
<td>10 µm</td>
</tr>
</tbody>
</table>

**Tempering (+/- 1 °C)**

- H*: Hot plate or C*: Convection oven
- H*: 90 °C 4 min, 90 °C 10 min, 90 °C 45 min, 90 °C 90 min, 90 °C 10 min
- C*: 85 °C 30 min, 85 °C 60 min, 85 °C 4 h, 85 °C 7 h, 85 °C 60 min

**UV exposure**

- Maskaligner, broadband UV
- Exposure dose (E, broadband UV):
  - 22 mJ/cm²
  - 26 mJ/cm²
  - 33 mJ/cm²
  - 52 mJ/cm²
  - 95 mJ/cm²

**Crosslinking bake (+/- 1 °C)**

- H*: 100 °C 5 min, 100 °C 10 min, 100 °C 10 min, 100 °C 10 min, 100 °C 10 min
- C*: 95 °C 30 min, 95 °C 40 min, 95 °C 60 min, 95 °C 80 min, 95 °C 40 min

**Development**

- (21-23 °C ± 0,5 °C) puddle
- 300-47, 3 : 2
- 300-47
- 300-46
- 300-44
- 300-44
- 300-44

**Rinse**

- DI-H₂O, 30 s and dry with caution

**Hardening of structures up to 300 °C (optional)**

- Flood exposure 100 mJ/cm², bake 120 °C, 5 min hot plate

**Customer-specific technologies**

- Generation of e.g. semiconductor properties or lift-off (4450-10T) and galvanic, MEMS

**Development recommendations**

<table>
<thead>
<tr>
<th>Resist / Developer</th>
<th>AR-N 4400-05 3-10 µm</th>
<th>AR-N 4400-10 5-20 µm</th>
<th>AR-N 4400-25 13-25 µm</th>
<th>AR-N 4400-50 25-100 µm</th>
<th>AR-N 4450-10T 5-20 µm</th>
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<tbody>
<tr>
<td>AR 300-44</td>
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<td>AR 300-46</td>
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<td>AR 300-47</td>
<td>6:1 to undil.</td>
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<td>AR 300-475</td>
<td>undil.</td>
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</table>

**Sensitivity of AR-N 4400-05**

The sensitivity increases considerably with increasing bake temperatures (broadband UV Maskeliner, thickness 5.0 µm).

**Time for complete development of AR-N 4400-05**

With increasing temperature, the TCD increases considerably. > 130 °C, no development is possible even if strong developers (AR 300-44) are used.

**Resolution of AR-N 4400-05**

The resolution is 3.5. The sensitivity was determined with 21.5 mJ/cm² for a structure build up of 90% (H90).

**Picture of Albert Einstein**

Test structure produced on the occasion of the "Einsteinjahr" in 2006.

**Lift-off structures**

Developed lines with a width of 10 – 20 µm were hardened by flood exposure and subsequent bake step. These lines were tempered stepwise until 300 °C. Up to a temperature of 200 °C, structures remain more or less unchanged.

**Crosslinking bake**

AR 300-76 for low crosslink density, AR 600-71 for high crosslink density, O₂ plasma ashing is also possible for high film thicknesses.
Negative Photoresists AR-N 4400 (CAR 44)

Processing instructions for the handing of thick films

Coating: In order to avoid the formation of bubbles, the resist should be left undisturbed for at least one day prior to processing. For resist with higher viscosity from AR-N 4400-25 onwards, degassing with ultrasound or vacuum is advisable.

The resist should be applied slowly, from a low height and always using the same amount of resist (e.g., 100 ml for 4-inch wafers) onto the standing wafer. Subsequently, a formation for 10 s a low rotational speed (250 - 400 rpm) is recommended, followed by slow increase of the spin speed up to the desired final speed. To achieve a high resist film quality, rotational speeds above 2000 rpm should be avoided for the highly viscous AR-N 4400-50. Shorter coating times at final spin speed will increase the film thickness.

Multiple coating steps (up to 4 x) are possible for film thicknesses between 50 and 150 µm. A particularly high edge steepness of structures results in this case from an improved drying procedure. After each coating step, the resist is dried at 85 °C (hot plate) or 90 °C (convection oven) according to the specifications as given in the process conditions.

Tempering: The required tempering times are highly dependent on the respective film thickness:

Drying times hot plate/convection oven:
- 10 µm: 10 min/1 h
- 25 µm: 45 min/4 h
- 50 µm: 90 min/7 h

The use of temperature ramps is highly recommended, since too fast cooling may lead to tension cracks. Long intensive drying procedures result in decreased sensitivities and prolonged development times.

Crosslinking: The crosslinking temperature can be varied in the range from 85 °C to 105 °C. The bake can be performed a few days after exposure without loss of sensitivity. Higher temperatures lead to a slower development.

Development: longer development times with weaker developer provide a higher imaging quality. For AR-N 4450-10T, the undercut (lift-off) of resist structures can be achieved by extending the development time at the minimum required exposure dose.

Removal: Crosslinked structures can easily be removed by wet- or plasma chemical procedures using removers AR 600-71 and AR 300-76. Complicated electroplating structures as well as substrates treated with high temperatures require removers AR 600-71 or AR 600-70.

Comparison CAR44 and SU-8

<table>
<thead>
<tr>
<th>CAR 44</th>
<th>Resist properties – Suitability</th>
<th>SU-8</th>
</tr>
</thead>
<tbody>
<tr>
<td>✓</td>
<td>thick films</td>
<td>✓</td>
</tr>
<tr>
<td>✓</td>
<td>high resolution</td>
<td>✓</td>
</tr>
<tr>
<td>✓</td>
<td>excellent aspect ratio</td>
<td>✓</td>
</tr>
<tr>
<td>✓</td>
<td>high sensitivity at i-line, deep UV, e-beam, X-ray</td>
<td>✓</td>
</tr>
<tr>
<td>✓</td>
<td>good sensitivity at g-line</td>
<td>✗</td>
</tr>
<tr>
<td>✓</td>
<td>low-stress tempering – easy handling</td>
<td>✗</td>
</tr>
<tr>
<td>✓</td>
<td>aqueous-alkaline development</td>
<td>✗</td>
</tr>
<tr>
<td>✓</td>
<td>easy removal</td>
<td>✓</td>
</tr>
</tbody>
</table>
Negative Photoresist AR-N 4600 S/R (Atlas 46)

AR-N 4600 Photo resist series for high film thicknesses
Thick negative resists for electroplating, microsystems technologies and LIGA < 20 µm

Characterization
- i-line, broadband UV
- very good adhesion properties
- very high sensitivity
- 4600-10 for stable layers of 5 µm - 15 µm
- 4650-10 for removable layers of 5 µm - 15 µm
- further film thicknesses up to about 200 µm available on request
- polystyrene glycol (polyglycol ether) co-formaldehyde and acid generator
- safer solvent PGMEA

Properties I
- Parameter / AR-N 4600-10 (S) 4650-10 (R)
- Solids content (%) 50 50
- Viscosity 25°C (mPas) 172 314
- Film thickness/1000 rpm (µm) 10
- Resolution (µm) 2
- Contrast 4
- Flash point (°C) 46
- Storage 6 month (°C) 11-22 < 10

Properties II
- Glass trans. temperature (°C) 34 - 44
- Softening point (°C) 99
- Dielectric constant N0 1.675
- Cauchy coefficients
  - N1 67
  - N2 101
- Plasma etching rates (nm/min)
  - O2 400
  - (1 Pa, O2 plasma, 230 W (ICP), 160 W (HF))
  - 5 CF4 + 30 O2 450

Spin curve

Resist structures

Atlas S (© Martin Luther University Halle-Wittenberg)
Atlas R (© Martin Luther University Halle-Wittenberg)

Process parameter
- Substrate Si 4” wafer
- Softbake 95°C, 5 min, hot plate
- Exposure BB UV, Soft-contact
- Development AR 300-12 pure, 120 sec, 20°C

Process chemicals
- Remover AR 300-12, AR 600-70
- Thinner AR 300-12
- Developer AR 300-12, AR 600-70
- Stopper AR 600-60

Process conditions
This diagram shows exemplary process steps for resist AR-N 4600. All specifications are guideline values which have to be adapted to own specific conditions. For further information on processing, u "Detailed instructions for optimum processing of photoresists". For recommendations on waste water treatment and general safety instructions, u "General product information on Allresist photoresists".

Coating (open chuck)
- AR-N 4600-10 (Atlas S) 1,000 rpm, 10 µm
- AR-N 4650-10 (Atlas R)

Softbake
- Hot plate: 95°C, 5 min
- (65°C, 2 min - 95°C, 4 min)

UV exposure
- Red contact, broadband UV, i-line
- Exposure dose (E0, BB-UV):
  - 120 mJ/cm² 140 mJ/cm²

Crosslinking bake
- Hot plate: 105°C, 5 min
- (65°C, 2 min - 95°C, 7 min - 2 min 105°C)

Development
- (21-23°C ± 0,5°C) Puddle
- 120 mJ/cm²
- AR 600-60, H2O - drying (hot plate)

Customer-specific Technologies
- Hardbake (optional)
  - (95°C, 10 min / 105°C, 5 min) up to 200°C (gradually)

Removing
- O2 plasma ashing
- AR 600-70, 30-45 min
- O2 plasma ashing

Development recommendations
- Resist / Developer
  - AR-N 4600-10 fast
  - AR-N 4650-10 fast
  - AR 600-70 slow
**Negative Photoresist AR-N 4600 S/R (Atlas 46)**

**UV/VIS NIR**


UV/VIS spectra of Atlas 46. Yellowing caused by varying the duration of broadband UV exposure after curing.

**Imprinting**

Combined nano- and microstructures, produced by imprinting of AR-N 4600 (© Uni Wuppertal).

Close-up view of AR-N 4600 (© Uni Wuppertal).

**DSC**

Dynamic differential scanning calorimetry (DSC) of polymers used (left Atlas S, right Atlas R).

---

**Negative Photoresist AR-N 4600 S/R (Atlas 46)**

**Bridges**

Bridge structure of two-layer system with AR-N 4600-10 (bottom) and 5X AR-N 4620-10I (top).

Process description of "bridge construction" with AR-N 4600-10 (bottom, BB-UV) and 5X AR-N 4620-10I (top, g-line).

**Additional information**

**Processing**

Layer thickness values of Atlas R and Atlas S are pre-adjusted to 10 µm at a spin speed of 1000 rpm. It is recommended to perform the subsequent tempering step on the hotplate at 95 °C for 5 min. Temperature ramps or stepwise drying, e.g., 65 °C for 2 minutes, followed by 95 °C for 4 minutes, can improve the resolution.

Both resists can be structured by i-line or broadband UV exposure. Prior to irradiation, substrates should be cooled to room temperature. It is recommended to perform the following tempering step for cross-linking on the hotplate at 105 °C for 2 min.

Ramps or stepwise cross-linking procedures like e.g., 65 °C for 2 minutes, followed by 95 °C for 7 minutes and 105 °C for 2 minutes, can improve the resolution. In general, the stability of resists increases with higher temperatures and longer bake times, but this requires on the other side longer development times. The use of temperature ramps is also recommended for cooling since cooling too fast may result in stress cracking.

**Development**

AR 300-12 is recommended as standard developer, but also AR 600-07 (fast development) or AR 600-70 (gentle development) is suitable. If AR-N 4600-10 (S) is used for development, no dark erosion is observed even after comparably long development times. If the development with AR 300-12 is performed for too long, increased dark erosion of AR-N 4650-10 may result, and a too long development with AR 600-70 can even cause complete removal.

Stopper AR 600-60 is recommended for a particularly residue-free rinsing after development, followed by rinsing with DI water. It is also possible to rinse resist layers immediately after development directly with DI water and to dry them on the hotplate.

The sensitivity for a layer thickness of 10 µm is about 110 – 160 mJ/cm² in the broadband UV range (process description on page 3).

**Removal**

Coated structures of AR-N 4650-10 (R) can be removed with thinner AR 300-12 or AR 600-70. Depending on the degree of cross-linking (dose, temperature and bake time), required removal times may be considerably longer than 30 minutes.
Different coloured, optionally also fluorescent dyes can be embedded into the negative-working Atlas 46 S. These dyes are process-stable, and structuring is performed in the same manner as in standard processes with uncoloured Atlas 46 S films.

No mixing occurred since the already produced structures turned out to be highly stable. The second exposure and PEB step analogous to the first step allowed a selective structuring of the upper layer. After development with AR 300-12, the differently fluorescing areas on the substrate become visible in black light:

Also two-colour fluorescent resist architectures could be realized. For this purpose, glass panes were pre-treated with AR 300-80new to optimize the adhesive properties and subsequently coated with different fluorescent Atlas 46 S variants. Exposure was carried out using different masks. After the following PEB, development was carried out with AR 300-12 and films were dried. The developed structures were then coated with a second, differently coloured resist variant with the greatest possible colour contrast, e.g. blue – yellow or red – yellow.

Differently fluorescing Atlas 46 films (irradiation with black light)

Also differently fluorescent lines adjacent to each other (or optionally overlapping) can be created in the same way:

Dyed and fluorescent films with Atlas 46

The use of different fluorescent dyes allows a defined adjustable emission in variable wavelength ranges. Fluorescent resist films are e.g. applied in microscopy. By embedding dyes into Atlas 46 S, resist films can be created that optionally show violet, blue, green, yellow, orange or red fluorescence. The intense fluorescence is retained even after a tempering at 150 °C, and the intense UV exposure required for cross-linking of Atlas films exhibits no adverse effect on the emission properties of these layers.

Varicoloured company logo with Atlas 46 S, film thickness 5 µm

Also differently fluorescent lines adjacent to each other (or optionally overlapping) can be created in the same way:

AR logo realised with two-coloured emission in black light

Differently fluorescing Atlas 46 films (irradiation with black light)

Differently fluorescing line patterns, left: parallel arrangement, right: overlapping lines

Negative Photoresist AR-N 4600 S/R (Atlas 46)
As of January 2016

**Photoresists**

For adjusting the film thickness of photoresists and e-beam resists

AR 300-12, 600-01, 600-02, 600-07, 600-09 thinner

- ultra-filtered, colourless, high-purity organic solvent mixtures
- adjustment of resist film thickness by defined dilution:
  - AR 300-12 for photoresists, AR 600-01…09 for e-beam resists
  - edge bead removal of coated substrates as well as clearing of equipment
  - AR 300-12: removal of photoresist films tempered at up to 150 °C and of non-tempered e-beam resist films

**Properties**

<table>
<thead>
<tr>
<th>Parameter / AR</th>
<th>300-12</th>
<th>600-01</th>
<th>600-02</th>
<th>600-07</th>
<th>600-09</th>
</tr>
</thead>
<tbody>
<tr>
<td>Main component</td>
<td>PGMEA</td>
<td>chlorobenzene</td>
<td>anisole</td>
<td>methoxypropanol</td>
<td>ethyl lactate</td>
</tr>
<tr>
<td>Density at 20 °C (g/cm³)</td>
<td>0.970</td>
<td>1.108</td>
<td>0.990</td>
<td>0.960</td>
<td>1.036</td>
</tr>
<tr>
<td>Refractive index at 20 °C</td>
<td>1.402</td>
<td>1.524</td>
<td>1.517</td>
<td>1.403</td>
<td>1.413</td>
</tr>
<tr>
<td>Water content max. (%)</td>
<td>0.1</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Non-volatiles max. (%)</td>
<td>0.002</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Flash point (°C)</td>
<td>42</td>
<td>28</td>
<td>44</td>
<td>38</td>
<td>46</td>
</tr>
<tr>
<td>Filtration (µm)</td>
<td>0.2</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Suitable for dilution of AR photoresists</td>
<td>3000, 4000, 5000</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>Suitable for dilution of AR e-beam resists</td>
<td>6510, 7000</td>
<td>631, 641, 661, 671</td>
<td>632, 642, 662, 672, 6200</td>
<td>617</td>
<td>639, 649, 665, 679</td>
</tr>
<tr>
<td>Storage 6 month (°C)</td>
<td>10-22</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Application**

Dilution is performed as follows: 1. placing of defined amount of resist, 2. addition of defined amount of thinner, 3. homogenisation by stirring (both liquids should be mixed quickly), and 4. fine filtration (0.2 µm).

**Information on dilution**

Higher dilutions of resists may cause gel formation of the polymers which leads to particle deposition in the resist film during the coating step. Diluted resists should therefore be subjected to ultra-filtration (0.2 µm) prior to use. In most cases it is more advantageous to adjust the desired film thickness by varying the spin speed or to utilise a film during the coating step. Diluted resists should therefore be subjected to ultra-filtration (0.2 µm) prior to use.

**Formula for dilutions**

\[
\text{m thinner} = \frac{m \text{ resist} (c \text{ resist} - c \text{ desired})}{1000} = \frac{(0.35 - 0.31)}{1000} = 0.129 \text{ g thinner} \\
\text{c desired} = 0.31
\]

If 100.0 g resist (35 % solids content = AR-3510) are diluted with 12.9 g thinner in defined manner, 112.9 g diluted resist (31 % solids content = AR-3540) will be obtained.

With this dilution, the film thickness is reduced from 2.0 to 1.4 µm at a spin speed of 4000 rpm.

**Developer for AR resists**

AR 300-26 and AR 300-35 buffered developers

For the development of photoresists and novolac-based e-beam resist films

- buffered, colourless aqueous-alkaline solutions for photoresist development with low dark erosion
- AR 300-26 high contrast, steep edges, fast development, particularly suited for thick films
- AR 300-35 universal, wide process range for layers up to 6 µm

**Characterisation**

- buffered, colourless aqueous-alkaline solutions for photoresist development with low dark erosion

**Properties**

<table>
<thead>
<tr>
<th>Parameter / AR</th>
<th>300-26</th>
<th>300-35</th>
</tr>
</thead>
<tbody>
<tr>
<td>Normality (n)</td>
<td>1.10</td>
<td>0.33</td>
</tr>
<tr>
<td>Density at 20 °C (g/cm³)</td>
<td>1.06</td>
<td>1.02</td>
</tr>
<tr>
<td>Filtration (µm)</td>
<td>0.2</td>
<td></td>
</tr>
<tr>
<td>Storage 6 month (°C)</td>
<td>10-22</td>
<td></td>
</tr>
</tbody>
</table>

**Application properties**

- AR resists
- AR photoresists
- AR e-beam resists
- ultra-filtered, colourless, high-purity organic solvent mixtures
- adjustment of resist film thickness by defined dilution:
  - AR 300-12 for photoresists, AR 600-01…09 for e-beam resists
  - edge bead removal of coated substrates as well as clearing of equipment

**Developer processing**

AR 300-26

- optimal developer for AR 300-26 photoresists

AR 300-35

- optimal developer for AR 300-35 e-beam resists

**Information on developer processing (applies to buffered developer and TMAH developers)**

Higher developer concentrations result in a formally higher light-sensitivity of the resist-developer system, thus minimising the required exposure intensity, reducing the development times and allowing for a high throughput in production. It must however be taken into account that an increased dark erosion is associated with stronger developers which successively attacks unexposed structures. More diluted developers provide, depending on the kind of resist, higher contrast and reduce the thickness loss in unexposed or only partly exposed interface areas even with longer development times. This particularly selective working method ensures a high degree of detail reproduction, while the intensity required for exposure is inevitably increased at the same time. To obtain a high contrast, more diluted developer and longer development times are recommended. Substrates have to be rinsed in deionised water immediately after development until complete removal of all residual developer, and are subsequently dried.

**Developer application**

AR 300-26

- AR 300-12 for photoresists, AR 600-01…09 for e-beam resists
- adjustment of resist film thickness by defined dilution:
  - ultra-filtered, colourless, high-purity organic solvent mixtures

AR 300-35

- AR 300-26 high contrast, steep edges, fast development, particularly suited for thick films
- AR 300-35 universal, wide process range for layers up to 6 µm
### Developer for AR resists

**AR 300-40 metal ion-free developer**

For the development of photoresists and novolac-based e-beam resist films

**Characterisation**
- metal ion-free aqueous-alcoholic solutions for the processing of photo/e-beam resists
- reduce the risk of metal ion contamination at the substrate surface
- residue-free development
- metal ion content < 0.1 ppm
- main component TMAH

**Properties**
- Parameter / AR
  - 300-44
  - 300-46
  - 300-47
  - 300-475
- Normality (n)
  - 0.26
  - 0.24
  - 0.20
  - 0.17
- Density at 20 °C (g/cm³)
  - 0.99
- Surface tension (mN/m)
  - 32 max.
- Filtration (µm)
  - 0.2
- Storage 6 month (°C)
  - 10-22

**Development recommendations**

<table>
<thead>
<tr>
<th>AR-resists</th>
<th>AR 300-44</th>
<th>AR 300-46</th>
<th>AR 300-47</th>
<th>AR 300-475</th>
</tr>
</thead>
<tbody>
<tr>
<td>Applications / conditions</td>
<td>immersion, puddle and spray development</td>
<td>21-23 °C ± 0.5 °C, approx. 40-60 s (max. 120 s)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

- **AR-P 1200, AR-N 2200**
  - 2 : 1 to 3 : 1
- **AR-P 3110, 3120, 3170**
  - 1.5 : 1 to 1 : 1.5
- **AR-P 3510, 3540, 3510T, 3540T**
  - undil.
- **AR-P 3740, 3840**
  - pure
- **AR-U 4030, 4040, 4060**
  - 1 : 2, 2 : 3
- **AR-P 5320, AR-P 5350**
  - undil.
- **AR-BR 5460, 5480**
  - 1 : 1
- **AR-P 5910 new (formerly X AR-P 3100/10)**
  - undil.
- **AR-N 4340**
  - undil.
- **AR-N 4400-10, 4450-10**
  - 3 : 2 to undil.
- **AR-N 4400-25**
  - 1 : 1
- **AR-N 4400-50**
  - 8 : 1 to undil.
- **AR-P 7400, 23**
  - 1 : 3
- **AR-N 7500.18, 7500.08**
  - undil.: 1 : 1
- **AR-N 7520.17, 7520.11, 07 new**
  - undil.
- **AR-N 7520.18, 7520.073**
  - 4 : 1
- **AR-N 7700.18, 7700.08**
  - undil.: 1 : 1
- **AR-N 7720.30, 7720.13**
  - undil.: 4 : 1

**Information on developer processing**

- If metal ion-free developers are diluted, it is recommended to adjust the desired normality immediately prior to use with very careful dilution (with scales) of the stronger developer with DI water. Even small differences in normality may cause larger differences in the development rate. Developers should be used as fast as possible, since otherwise developer efficacy may be reduced.

---

### Remover for AR Resists

**AR-P 600-70, 600-71, 300-76, 300-70, 300-72, 300-73 remover**

For the stripping of tempered photoresist and e-beam resist films

**Characterisation**
- aqueous-alkaline solution (AR 300-73) or organic solvents (all others)

**Remover recommendations after tempering**

- photoresists up to 180 °C: AR 600-71, 300-76
- photoresists up to 200 °C: AR 300-76, 300-71
- PMMA up to 200 °C: AR 600-71, 300-76
- copolymers up to 210 °C: AR 600-71, 300-76
- CSAR 62 up to 210 °C: AR 600-71, 300-76, 300-73 remover

**Properties**
- Main component
  - acetone
  - dimethylacetamide (DMA)
  - dimethylformamide (DMF)
  - TMAH
- Density at 20 °C (g/cm³)
  - 0.79
  - 1.02
  - 1.08
  - 1.03
  - 1.00
- Non-volatiles (%)
  - 0.002
- Flash point (°C)
  - -17
  - 103
  - 98
- Filtration (µm)
  - 0.2
- Storage up to 6 month (°C)
  - 10-22
  - 10-18
  - 15-25
  - 10-22
  - 10-22

**Remover recommendations**

<table>
<thead>
<tr>
<th>Properties / Remover AR average time for removal at 1.5 µm</th>
<th>600-70</th>
<th>600-71</th>
<th>300-76 new</th>
<th>300-70, 72 new</th>
<th>300-73</th>
</tr>
</thead>
<tbody>
<tr>
<td>Temperature (°C)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>120 °C</td>
<td>15 s</td>
<td>10 s</td>
<td>25 s</td>
<td>20 s</td>
<td>30 s</td>
</tr>
<tr>
<td>150 °C</td>
<td>20 s</td>
<td>15 s</td>
<td>1 min</td>
<td>25 s</td>
<td>2 min</td>
</tr>
<tr>
<td>180 °C</td>
<td>5 min</td>
<td>4 min</td>
<td>2 h</td>
<td>60 s</td>
<td>2 h</td>
</tr>
<tr>
<td>200 °C</td>
<td></td>
<td></td>
<td>30 min</td>
<td>25 min</td>
<td>30 min</td>
</tr>
</tbody>
</table>

**Remover recommendations for tempered photoresist films (21 °C)**

<table>
<thead>
<tr>
<th>Properties / Remover AR average time for removal at 1.5 µm</th>
<th>600-70</th>
<th>600-71</th>
<th>300-76 new</th>
<th>300-70, 72 new</th>
<th>300-73</th>
</tr>
</thead>
<tbody>
<tr>
<td>Temperature (°C)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>120 °C</td>
<td>15 s</td>
<td>10 s</td>
<td>25 s</td>
<td>20 s</td>
<td>30 s</td>
</tr>
<tr>
<td>150 °C</td>
<td>20 s</td>
<td>15 s</td>
<td>1 min</td>
<td>25 s</td>
<td>2 min</td>
</tr>
<tr>
<td>180 °C</td>
<td>5 min</td>
<td>4 min</td>
<td>2 h</td>
<td>60 s</td>
<td>2 h</td>
</tr>
<tr>
<td>200 °C</td>
<td></td>
<td></td>
<td>30 min</td>
<td>25 min</td>
<td>30 min</td>
</tr>
</tbody>
</table>

**Remover recommendations for tempered e-beam resist films (21 °C)**

<table>
<thead>
<tr>
<th>Properties / Remover AR average time for removal at 1.5 µm</th>
<th>600-70</th>
<th>600-71</th>
<th>300-76 new</th>
<th>300-70, 72 new</th>
<th>300-73</th>
</tr>
</thead>
<tbody>
<tr>
<td>Temperature (°C)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>120 °C</td>
<td>15 s</td>
<td>10 s</td>
<td>25 s</td>
<td>20 s</td>
<td>30 s</td>
</tr>
<tr>
<td>150 °C</td>
<td>20 s</td>
<td>15 s</td>
<td>1 min</td>
<td>25 s</td>
<td>2 min</td>
</tr>
<tr>
<td>180 °C</td>
<td>5 min</td>
<td>4 min</td>
<td>2 h</td>
<td>60 s</td>
<td>2 h</td>
</tr>
<tr>
<td>200 °C</td>
<td></td>
<td></td>
<td>30 min</td>
<td>25 min</td>
<td>30 min</td>
</tr>
</tbody>
</table>

**Remover recommendations**

- photoresists up to 200 °C: AR 300-76, 300-71
- photoresists up to 180 °C: AR 600-71, 300-76
- photoresists up to 120 °C: PMMA
- photoresists up to 85 °C: CSAR 62, PMMA 150 °C
- photoresists up to 45 °C: Copolymer
- photoresists up to 35 °C: PMMA 150 °C
- photoresists up to 25 °C: Copolymer
- photoresists up to 15 °C: PMMA 150 °C

**Processing instructions for removers**

Substrates coated with resist are exposed to the effect of the remover by immersion (pudle or dip). To reduce the dissolution time for tempered layers, removers AR 300-70, 300-72 and 300-76 may be heated to up to 80 °C, remover AR 300-73 up to 50 °C or megasound may be helpful in this case. It is recommended to rinse off the remover with DI water, clean remover or with a suitable thinner. A stripping of very hard-baked layers (> 220 °C) with remover is hardly possible any more. In this case, oxidizing acids or oxygen plasma may be used for stripping. Further detailed remover specifications for a large variety of resists are listed on the following pages.
### Remover for AR Resists

<table>
<thead>
<tr>
<th>Remover recommendations</th>
<th>optimally suitable</th>
<th>suitable</th>
<th>limited suitability</th>
<th>unsuitable</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Product AR</strong></td>
<td><strong>Film thickness (µm)</strong></td>
<td><strong>Temperture (°C)</strong></td>
<td><strong>Recom.</strong></td>
<td><strong>600-70</strong></td>
</tr>
<tr>
<td><strong>AR-P 3100</strong></td>
<td>Example 3110</td>
<td>1.5</td>
<td>95 - 120</td>
<td>300-76</td>
</tr>
<tr>
<td></td>
<td>150</td>
<td></td>
<td>200</td>
<td>60 s</td>
</tr>
<tr>
<td></td>
<td>180</td>
<td></td>
<td>200</td>
<td>30 min</td>
</tr>
<tr>
<td><strong>AR-P 3200</strong></td>
<td>Example 3220</td>
<td>10</td>
<td>95</td>
<td>300-76</td>
</tr>
<tr>
<td></td>
<td>120</td>
<td></td>
<td>180</td>
<td>1 h</td>
</tr>
<tr>
<td></td>
<td>150</td>
<td></td>
<td>200</td>
<td>2 h</td>
</tr>
<tr>
<td><strong>AR-P 3500</strong></td>
<td>Example 3540</td>
<td>1.5</td>
<td>95 - 150</td>
<td>300-620-71</td>
</tr>
<tr>
<td></td>
<td>180</td>
<td></td>
<td>200</td>
<td>1 h</td>
</tr>
<tr>
<td><strong>AR-P 3700 / 3800</strong></td>
<td>Example 3740</td>
<td>1.5</td>
<td>95</td>
<td>300-620-71</td>
</tr>
<tr>
<td></td>
<td>120</td>
<td></td>
<td>180</td>
<td>1 h</td>
</tr>
<tr>
<td><strong>AR-P 5000</strong></td>
<td>Example 5310</td>
<td>1.5</td>
<td>95 - 150</td>
<td>300-620-71</td>
</tr>
<tr>
<td></td>
<td>180</td>
<td></td>
<td>200</td>
<td>1 h</td>
</tr>
<tr>
<td><strong>AR-U 4000</strong></td>
<td>Example 4040</td>
<td>1.5</td>
<td>95</td>
<td>300-130-72</td>
</tr>
<tr>
<td></td>
<td>120</td>
<td></td>
<td>150</td>
<td>5 min</td>
</tr>
<tr>
<td></td>
<td>180</td>
<td></td>
<td>200</td>
<td>30 min</td>
</tr>
<tr>
<td><strong>AR-PC 5000</strong></td>
<td>Example 5040</td>
<td>2.0</td>
<td>95</td>
<td>300-620-71</td>
</tr>
<tr>
<td></td>
<td>150</td>
<td></td>
<td>180</td>
<td>1 h</td>
</tr>
<tr>
<td><strong>AR-P 5900</strong></td>
<td>Example 5910</td>
<td>5.0</td>
<td>85 - 120</td>
<td>300-76</td>
</tr>
<tr>
<td></td>
<td>150</td>
<td></td>
<td>180</td>
<td>2 h</td>
</tr>
</tbody>
</table>

The average times required for removal as listed under “properties” are divided into time clusters (< 20 s, 20 s - 60 s). For better orientation, Remover recommendations generally apply to the commonly used tempering at 150 °C and 180 °C. The recommendation for remover AR 300-72 is indicated in brackets, since this remover is highly effective, but also classified as toxic for reproduction and thus not prioritized by Allresist. As replacement, we recommend the equivalent removers AR 300-76 and 600-71.
Adhesion Promoter for AR Resists

AR 300-80 (new) and HMDS adhesion promoter
For improving the adhesive strength of photo and e-beam resists

<table>
<thead>
<tr>
<th>Characterisation</th>
<th>Properties</th>
</tr>
</thead>
<tbody>
<tr>
<td>- improvement of the adhesive strength of photo and e-beam resist films</td>
<td>Parameter / AR</td>
</tr>
<tr>
<td>- especially for surfaces with low adhesion properties, e.g. metal, SiO₂, GaAs</td>
<td>Density at 20 °C (g/cm³)</td>
</tr>
<tr>
<td>- AR 300-80 (new): spin coating of a silicium organic solution = improved adhesion properties and simple, cheaper alternative to HDMS</td>
<td>Flash point (°C)</td>
</tr>
<tr>
<td>- HMDS: evaporation of HMDS on the substrate surface (equipment required)</td>
<td>Filtration (µm)</td>
</tr>
<tr>
<td></td>
<td>Storage 6 month (°C)</td>
</tr>
</tbody>
</table>

Processing information AR 300-80 and AR 300-80 (new)
AR 300-80 (new) is applied by spin coating between 1000 and 6000 rpm. The film thickness can be adjusted by varying the spin speed to the optimum conditions of the respective process.

Higher spin speeds and thus thinner films are preferable, e.g. 4000 rpm with approx. 15 nm thickness. Too high concentrations (film thickness values) may reduce or neutralise the adhesion-promoting effect.

It is recommended for AR 300-80 to perform the subsequent tempering on a hot plate for 2 min or in a convection oven for 25 min at 180 °C. AR 300-80 new offers the big advantage for sensitive substrates that a bake step at only 60 °C for the same amount of time is sufficient, even though higher temperatures are well tolerated. The previous AR 300-80 product will only be sold as long as it is in stock.

During tempering, a very uniform, extremely thin layer of adhesion promoter is generated on the substrate (approx. 15 nm). After cooling of the substrate, the resist can be applied as usual.

An excess of adhesion promoter may be rinsed off with organic solvents like e.g. AR 600-70 or AR 600-71. The optimised surface properties are maintained without restriction.

Processing information HMDS
Appropriate equipment is required for the processing of HMDS. For large scale production, hot plates with HMDS vapor deposition are used. If no such equipment is available, the following procedure should be applied:

The pre-treatment should be performed immediately prior to resist coating. Generally, hot plates with integrated HMDS-evaporation are used in the production. If this option is not available, the substrate is placed in a desiccator where HMDS evaporates at room temperature or at temperatures up to 160 °C max. HMDS is under these conditions deposited as monomolecular layer (approx. 5 nm) on the substrate surface.

The treated substrate can be coated with resist immediately after HMDS-deposition without subsequent tempering, or stored in a closed container for a couple of days.

The storage stability may be limited due to an uptake of water from the atmosphere. Storage in open containers should thus be avoided.
### Product Portfolio Photoresists

<table>
<thead>
<tr>
<th>Resist system</th>
<th>Product</th>
<th>Characteristic Properties</th>
<th>Application</th>
<th>Resolution [μm]</th>
<th>Contrast</th>
<th>Expose- sure</th>
<th>Thinner</th>
<th>Deve-loper</th>
<th>Remover</th>
</tr>
</thead>
<tbody>
<tr>
<td>AR-P 1200</td>
<td>1210, 1220, 1230</td>
<td>spray resist, var. applications</td>
<td>MEMS</td>
<td>1</td>
<td>3</td>
<td>-</td>
<td>300-44</td>
<td>600-71</td>
<td>300-76</td>
</tr>
<tr>
<td>AR-P 3100</td>
<td>3110, 3120, 3170</td>
<td>high resolution, adhesion-enhanced</td>
<td>masks, liquids</td>
<td>0.5 ; 0.4</td>
<td>3</td>
<td>300-12</td>
<td>300-35</td>
<td>300-26</td>
<td>300-76</td>
</tr>
<tr>
<td>AR-P 3200</td>
<td>3210, 3220, 3250</td>
<td>thick resist with high dimen. accuracy</td>
<td>electro-plating, MST</td>
<td>4 ; 3 : 12</td>
<td>2.0 ; 2.0 ; 2.5</td>
<td>300-12</td>
<td>300-26</td>
<td>300-76</td>
<td></td>
</tr>
<tr>
<td>AR-P 3510</td>
<td>3510, 3540</td>
<td>wide process range, high resolution</td>
<td>ICs</td>
<td>0.8 ; 0.7</td>
<td>4.0 ; 4.5</td>
<td>300-12</td>
<td>300-35</td>
<td>300-76</td>
<td></td>
</tr>
<tr>
<td>AR-P 3550 T</td>
<td>3510 T, 3540 T</td>
<td>wide process range, high res. developable</td>
<td>ICs</td>
<td>0.6 ; 0.5</td>
<td>4.5 ; 5.0</td>
<td>300-12</td>
<td>300-44</td>
<td>300-26</td>
<td>300-76</td>
</tr>
<tr>
<td>AR-P 3700, 3800</td>
<td>3740, 3840</td>
<td>highest resolution, sub-μm, high contrast, 3840 dyed</td>
<td>VSSLIC</td>
<td>0.4 ; 0.4</td>
<td>6.0 ; 6.0</td>
<td>300-12</td>
<td>300-47</td>
<td>300-76</td>
<td></td>
</tr>
<tr>
<td>AR-P 5320, 5350</td>
<td>5320, 5350</td>
<td>undercut structures (single layer lift-off)</td>
<td>evaporation structures</td>
<td>2 ; 0.5</td>
<td>4 ; 5</td>
<td>300-12</td>
<td>300-26</td>
<td>300-76</td>
<td>300-71</td>
</tr>
<tr>
<td>AR-U 4030, 4040, 4060</td>
<td>1.8 ; 1.4</td>
<td>optimally pos. or neg. lift-off</td>
<td>ICs</td>
<td>0.8 ; 0.7 ; 0.5</td>
<td>3 ; 3 ; 3.5</td>
<td>300-12</td>
<td>300-35</td>
<td>300-26</td>
<td>300-76</td>
</tr>
<tr>
<td>AR-P 500, 504, 5040</td>
<td>500, 504, 5040</td>
<td>protective coating, 40% KCI etch-stable</td>
<td>protective film</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>600-01</td>
<td>-</td>
<td>600-71</td>
</tr>
<tr>
<td>AR-RR 5400, 5480</td>
<td>10.0 ; 0.5</td>
<td>bottom resist for 2L lift-off</td>
<td>lift-off (pox/seg)</td>
<td>3 ; 1.5</td>
<td>lift-off</td>
<td>-</td>
<td>600-07</td>
<td>300-47</td>
<td>300-76</td>
</tr>
<tr>
<td>AR-P 5900</td>
<td>5910.0</td>
<td>complicated pattern, up to 5 % Hf/SiO2</td>
<td>MEMS</td>
<td>2</td>
<td>2.0</td>
<td>i-line, g-line, BB/UV</td>
<td>300-12</td>
<td>300-26</td>
<td>300-76</td>
</tr>
<tr>
<td>AR-N 2200, 2210, 2220, 2230</td>
<td>0.5 - 1.0</td>
<td>spray resist, var. applications</td>
<td>MEMS</td>
<td>1</td>
<td>3</td>
<td>-</td>
<td>300-44</td>
<td>600-71</td>
<td>300-76</td>
</tr>
<tr>
<td>AR-N 4300</td>
<td>4340</td>
<td>highest sensitivity, high resolution, CAR</td>
<td>ICs</td>
<td>0.5 ; 5</td>
<td>i-line, g-line</td>
<td>300-12</td>
<td>300-26</td>
<td>300-475</td>
<td>600-76</td>
</tr>
<tr>
<td>AR-N 4400-5000, 4400-05.0</td>
<td>50.0 - 25.0 ; 10.5</td>
<td>thick films up to 100, 50, 20, 10 μm, easy removal</td>
<td>electro-plating, MST, LIGA</td>
<td>2.0 ; 3.5</td>
<td>6.0 ; 5.0 ; 4.0</td>
<td>X-ray, e-beam, i-line</td>
<td>300-12</td>
<td>300-44</td>
<td>600-71</td>
</tr>
<tr>
<td>AR-N 4400-4450</td>
<td>100 ppm</td>
<td>thick films up to 20 μm, lift-off</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>300-12</td>
<td>300-47</td>
<td>600-71</td>
<td>300-71</td>
</tr>
</tbody>
</table>

### Product Portfolio E-Beam Resists

<table>
<thead>
<tr>
<th>Resist system</th>
<th>Product</th>
<th>Characteristic Properties</th>
<th>Application</th>
<th>Resolution [μm]</th>
<th>Contrast</th>
<th>Expose- sure</th>
<th>Thinner</th>
<th>Deve-loper</th>
<th>Remover</th>
</tr>
</thead>
<tbody>
<tr>
<td>AR-P 617</td>
<td>copolymer PMMA-PMMA 33%</td>
<td>highest resolution, 2x more sensitive than PMMA, IR off</td>
<td>ICS, masks</td>
<td>0.09 - 1.75</td>
<td>6.0</td>
<td>10 / 100</td>
<td>300-76</td>
<td>600-71</td>
<td></td>
</tr>
<tr>
<td>AR-P 631- 671</td>
<td>PMMA 50K, 200K, 600K, 950K</td>
<td>highest resolution, process stable, universally simple processing</td>
<td>ICS, masks</td>
<td>0.02 - 1.70</td>
<td>7.0</td>
<td>6 / 100</td>
<td>100-76</td>
<td>600-76</td>
<td></td>
</tr>
<tr>
<td>AR-P 632- 672</td>
<td>PMMA 50K, 200K, 600K, 950K</td>
<td>highest resolution, process stable, universally simple processing</td>
<td>ICS, masks</td>
<td>0.01 - 1.87</td>
<td>7.0</td>
<td>6 / 100</td>
<td>100-76</td>
<td>600-76</td>
<td></td>
</tr>
<tr>
<td>AR-P 639- 679</td>
<td>PMMA 50K, 200K, 600K, 950K</td>
<td>highest resolution, process stable, universally simple processing</td>
<td>ICS, masks</td>
<td>0.02 - 0.74</td>
<td>7.0</td>
<td>6 / 100</td>
<td>100-76</td>
<td>600-76</td>
<td></td>
</tr>
<tr>
<td>AR-P 6200 CSAR-62</td>
<td>6200.04, 6200.13 styrene acryl</td>
<td>highest resolution, sensitivity, plas- ma etching-resistant</td>
<td>ICS, sensors, masks</td>
<td>0.08</td>
<td>0.02</td>
<td>6</td>
<td>600-09</td>
<td>300-55</td>
<td>300-76</td>
</tr>
<tr>
<td>AR-P 6500</td>
<td>6510.13, 6510.19</td>
<td>thin PMMA films up to 250 μm, PMA, PMA etching-resistant</td>
<td>microcomp- onents</td>
<td>1 μm (x-ray)</td>
<td>10</td>
<td>600-02</td>
<td>600-54</td>
<td>600-54</td>
<td></td>
</tr>
<tr>
<td>AR-P 7400</td>
<td>7400.23 novolac</td>
<td>mixedmatch, high resolution, plasma etching-resistant, also neg.</td>
<td>ICS, masks</td>
<td>0.6</td>
<td>40</td>
<td>150</td>
<td>600-76</td>
<td>600-71</td>
<td></td>
</tr>
<tr>
<td>AR-N 7500</td>
<td>7500.08, 7500.18 novolac</td>
<td>mixedmatch, high resolution, plasma etching-resistant, pos/neg.</td>
<td>ICS, masks</td>
<td>0.1 ; 0.4</td>
<td>40</td>
<td>100</td>
<td>600-76</td>
<td>600-71</td>
<td></td>
</tr>
<tr>
<td>AR-N 7520</td>
<td>7520.07, 7520.17 novolac</td>
<td>mixedmatch, highly sensitive, highest resolution</td>
<td>ICS, masks</td>
<td>0.1 ; 0.2 ; 0.4</td>
<td>80</td>
<td>600-03</td>
<td>600-76</td>
<td>600-76</td>
<td></td>
</tr>
<tr>
<td>AR-N 7700</td>
<td>7700.08, 7700.18 novolac</td>
<td>mixedmatch, highest resolution, high- precision edges</td>
<td>ICS, masks</td>
<td>0.1 ; 0.4</td>
<td>28</td>
<td>600-10</td>
<td>600-76</td>
<td>600-76</td>
<td></td>
</tr>
<tr>
<td>AR-P 6200 CSAR-62</td>
<td>7720.07, 7720.30 novolac</td>
<td>CAR, high resolution, high sensitivity, steep gradation</td>
<td>ICS, masks</td>
<td>0.08</td>
<td>1.0</td>
<td>600-12</td>
<td>600-76</td>
<td>600-76</td>
<td></td>
</tr>
<tr>
<td>AR-P 617, 631-671, 6200</td>
<td>require brief stopping in stopper AR 600-60 after development.</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

All resist systems show optimal adhesion features with adhesion promoter AR 300-80 which is applied prior to the resist. Resist AR-P 617, 631-671, 6200 require brief stopping in stopper AR 600-60 after development.
We deliver our products within 1 week ex work, in-stock stock items are delivered immediately or on the desired date. Resists are available in package sizes of \( \frac{1}{4}, 0.5, 1, 2.5, 6 \times 1 \), \( 4 \times 2.5, 4 \times 5 \) and corresponding process chemicals in package sizes of \( 1, 2.5, 5, 4 \times 2.5, 4 \times 5 \). Test samples/smallest quantities of 30 ml and 100 ml are possible. Please request our price lists.

### Product Portfolio Experimental Samples

<table>
<thead>
<tr>
<th>Special product</th>
<th>Do/µm rpm</th>
<th>Type</th>
<th>Characteristic properties / Application</th>
<th>Resolution [µm]</th>
<th>-</th>
<th>Exposure</th>
<th>Thinner Developer</th>
<th>Remover</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Market-ready experimental samples</strong></td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>X AR-P 3220/7</td>
<td>6.0</td>
<td>positive</td>
<td>temperature-/ plasma etching stable thick resist</td>
<td>2</td>
<td>-</td>
<td>i-line, g-line, BB-UV</td>
<td>300-12</td>
<td>300-26</td>
</tr>
<tr>
<td>X AR-P 5900/4</td>
<td>1.4</td>
<td>positive</td>
<td>positive photoresist, alkali-stable up to pH 13</td>
<td>1</td>
<td>-</td>
<td>i-line, g-line</td>
<td>300-12</td>
<td>300-26</td>
</tr>
<tr>
<td>X AR-N 7700/30</td>
<td>0.4</td>
<td>neg</td>
<td>highly sensitive, highest-resolution CA negative e-beam resist</td>
<td>0.2</td>
<td>5</td>
<td>e-beam, deep UV</td>
<td>300-12</td>
<td>300-475</td>
</tr>
<tr>
<td><strong>Special designs / Experimental samples</strong></td>
<td></td>
<td></td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SX AR-P 3500/6</td>
<td>2.0</td>
<td>positive</td>
<td>positive photoresist for holography (488 nm)</td>
<td>1</td>
<td>3</td>
<td>i-line, g-line, BB-UV</td>
<td>300-12</td>
<td>300-47</td>
</tr>
<tr>
<td>SX AR-P 3500/8</td>
<td>1.4</td>
<td>positive</td>
<td>temperature-stable positive photoresist up to 300 °C</td>
<td>1</td>
<td>3</td>
<td>i-line, g-line, BB-UV</td>
<td>300-12</td>
<td>300-47</td>
</tr>
<tr>
<td>SX AR-P 3740/4</td>
<td>1.4</td>
<td>positive</td>
<td>positive photoresist, highly process-stable, high contrast</td>
<td>0.6</td>
<td>5</td>
<td>i-line, g-line, BB-UV</td>
<td>300-12</td>
<td>300-475</td>
</tr>
<tr>
<td>SX AR-N 4340/7</td>
<td>1.4</td>
<td>neg</td>
<td>temperature stable negative resist up to 270 °C (1/-2L-system)</td>
<td>0.5</td>
<td>5</td>
<td>i-line, g-line</td>
<td>300-12</td>
<td>300-47</td>
</tr>
<tr>
<td>SX AR-PC 5000/40</td>
<td>5.0</td>
<td>-</td>
<td>protective coating 40% KOH- and 50% HF-resistant</td>
<td>1 L: 10</td>
<td>2 L: 1</td>
<td>1 L: 2 L: i-line</td>
<td>300-74/1</td>
<td>300-26</td>
</tr>
<tr>
<td>SX AR-PC 5000/80.2</td>
<td>0.4</td>
<td>-</td>
<td>polyimide photoresist, protective coating for 2 L-patterning</td>
<td>1 L: 2</td>
<td>2 L: 1</td>
<td>1 L: 2 L: i-line</td>
<td>300-12/3</td>
<td>-</td>
</tr>
<tr>
<td>SX AR-P 5000/82.7</td>
<td>0.8</td>
<td>-</td>
<td>polyimide photoresist, structurable and temperature-stable</td>
<td>1.5</td>
<td>2</td>
<td>i-line</td>
<td>300-12/3</td>
<td>300-26</td>
</tr>
</tbody>
</table>

All resist systems show optimal adhesion features with adhesion promoter AR 300-80 (new) which is applied prior to resist deposition.

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