Product information

PHOTORESISTS
As of January 2017

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.

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 and protective coatings can be applied on PMMA, CSAR 62, and AR-PC 5090 and 5091 were specifically developed for the efficient dissipation of electrical charges during e-beam lithography on insulating substrates. The new, highly conductive protective coatings are in strong demand.

With the new e-beam resist AR-N 7520/4 (replacing resist AR-N 7520 new), Allresist introduces a high-resolution and at the same time sensitive new resist onto the market. In contrast to currently available e-beam resists, this resist is characterised by a 7-fold higher sensitivity. The dose to clear a 100-nm layer reduces the writing times at 30 KV to 35 µC/cm².

18 new anisole-PMMA resists AR-P 632...672 of types 50K, 200K, 600K and 950K complement the current anisole PMMA resist palette which also, just like the chlorobenzene PMMAs, meet the high demands of e-beam lithography.

Allresist offers the new ready-to-use spray resist series AR-P 1200 and AR-N 2200 which are suitable for an even coverage of vertical trenches, for etched 54° slopes as well as for the deposition of resists by spin coating.

Other new products are polyimide resists which are temperature-stable up to 400 °C; protective coating SX AR-PC 5000/80 and the positive resist AR-P 5000/82.

Currently still in development

Within the scope of the Eurostar project „PPA-Litho“, thermally developable 10 nm resists for NanoFrazor procedures and e-beam lithography are developed. It should also be possible to structure silylated PPAs (polystyrylaldehydes) with the aforementioned methods which then, in the case of success, provide an alternative to HSQ.
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.

Packaging sizes for resist: ¼, ½, 0.5 l (2 x ¼), 1 l, 2.5 l, 6 x 1 l, 4 x 2.5 l, and for process chemicals: 1 l, 2.5 l, 5 l, 4 x 2.5 l, 4 x 5 l.

Positive system

<table>
<thead>
<tr>
<th>Applications/properties</th>
<th>Product</th>
</tr>
</thead>
<tbody>
<tr>
<td>AR-P 1200</td>
<td>spray coating for various applications</td>
</tr>
<tr>
<td>AR-P 3100</td>
<td>mask production, fine gradations, high resolution</td>
</tr>
<tr>
<td>AR-P 3200</td>
<td>thick resist of high dimensions, accuracy up to 40/100/20 µm</td>
</tr>
<tr>
<td>AR-P 3500 (T)</td>
<td>wide process range, high resolution</td>
</tr>
<tr>
<td>AR-P 3700/3800</td>
<td>high contrast, highest resolution, sub-µm</td>
</tr>
<tr>
<td>AR-P 5300</td>
<td>undercut structures (one layer lift-off)</td>
</tr>
</tbody>
</table>

Special system

<table>
<thead>
<tr>
<th>Applications/properties</th>
<th>Product</th>
</tr>
</thead>
<tbody>
<tr>
<td>AR-U 4000</td>
<td>image reversal – optionally positive or negative</td>
</tr>
<tr>
<td>AR-PC 500(0)</td>
<td>protective coating, 40 % KOH etch-stable</td>
</tr>
<tr>
<td>AR-BR 5400</td>
<td>bottom resist for 2L lift-off system (pos/neg)</td>
</tr>
<tr>
<td>AR-P 5900</td>
<td>complicated patterning with hydrofluoric acid (5 %)</td>
</tr>
</tbody>
</table>

Negative system

<table>
<thead>
<tr>
<th>Applications/properties</th>
<th>Product</th>
</tr>
</thead>
<tbody>
<tr>
<td>AR-N 2200</td>
<td>spray coating for various applications</td>
</tr>
<tr>
<td>AR-N 4200</td>
<td>high sensitivity, sub-µm, mid and deep UV</td>
</tr>
<tr>
<td>AR-N 4300</td>
<td>highest sensitivity, sub-µm, i-line, g-line</td>
</tr>
<tr>
<td>AR-N 4400</td>
<td>films up to 100/50 µm, i-line, X-ray, e-beam</td>
</tr>
<tr>
<td>Series CAR 44</td>
<td>films up to 20/10 µm, easy removable, additionally for lift-off structures</td>
</tr>
</tbody>
</table>

Process chemistry

<table>
<thead>
<tr>
<th>Applications/properties</th>
<th>Product</th>
</tr>
</thead>
<tbody>
<tr>
<td>Thinner</td>
<td>safer solvent for photoresists</td>
</tr>
<tr>
<td>Developer</td>
<td>buffer system for photo-e-beam resists</td>
</tr>
<tr>
<td>Developer</td>
<td>metal ion-free for photo/e-beam resists</td>
</tr>
<tr>
<td>Remover</td>
<td>organic solvents and aqueous-alkaline solutions for photo-e-beamresist</td>
</tr>
<tr>
<td>Adhesion promoter</td>
<td>organic solutions for resists</td>
</tr>
</tbody>
</table>

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 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 (PGMEA). The addition of the light-sensitive component to the alkali-soluble novolac resists by a factor of about 100. The refractive index of novolacs, acid generators and amine components (4300, 4400, CAR) dissolved in solvents like e.g. methoxypropyl acetate (PGMEA).

After exposure and subsequent tempering step, the composition of the exposed portion 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.

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.

Image reversal resists like the AR-U 4000 series which are positive resists containing an additional amine. Depending on the respective manufacturing process, positive or negative images can be generated. Negative images are produced if an additional tempering step and a flood exposure of the entire surface is performed after image-wise exposure.
General Product Information on Allresist Photoresists

Protective coatings like AR-PC 500 and 5000 are offered 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 an insulating layer. Protective coatings are not light-sensitive and cannot 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.

For hydrofluoric acid etchings and BOE-processes (up to 5 % HF), the 5 µm-resist AR-P 5910 (formerly X AR-P 3100/10) offers considerably better adhesion properties than all other photoresists.

For a patterning of glass/SiO2 substrates in concentrated HF, the positive-tone two-component system SX AR-PC 5000/40 – AR-P 3540 T or the negative-tone two-component system SX AR-PC 5000/40 – AR-N 4400-10 is recommended. The upper photoresist layer is initially developed under aqueous-alkaline conditions before the lower SX AR-PC 5000/40 film is developed with solvents. AR products are available both for the deep UV range of 240 – 400 nm (AR-N 4200, 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 the respective demands of each technology and to adapt 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!

Detailed Instructions for Optimum Processing of Photoresists

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 arsenide. 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 approximately 200 °C minutes (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 the 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 adhesion 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 need 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 resist 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 (optimum 21 °C) and a relative humidity of 30 to 50 % (optimum 40 %). Above a humidity of 70 %, coating 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 approx. 2 nm per each percent of humidity.

At 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 bead 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 for a hot plate or a convection oven depends on whether a hot plate or a convection oven should be preferred depends for thin films (< 5 µm) on the availabilty, 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. Drying thicker films in a convection oven is however unfavourable since the dried resist surface inhibits a fast solvent evaporation. In these cases, a hot plate is recommended because more solvent is expelled from the bottom of the resist film.
Detailed Instructions for Optimum Processing of Photoresists

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 (i-, g-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 a 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 undil. profiles. 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 / 2 indicate a dilution of 1 part developer AR 300-26 with 2 parts 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).

The parameters contrast and sensitivity are adjusted via the developer concentration by defined dilution of the developer with DI water.

Note: Metal ion-free developers are more sensitive to dilution differences than buffered systems. These developers should be diluted immediately prior to use and extremely thoroughly, if possible with scales, in order to assure reproducible results. Higher developer concentrations formally result in an increased light sensitivity of positive resist developer systems. The required exposure energy is minimised and the development time is reduced, which allows for a high process throughput. Possible disadvantages are an increased dark erosion and (in some cases) a too low process stability (too fast). Negative resists require a higher exposure dose for crosslinking at higher developer concentrations.

Lower developer concentrations provide a higher contrast for positive resist films and reduce resist erosion in unexposed regions or only partly exposed interface areas even at longer development times. This particularly selective working method ensures a high detail rendition.

The effectiveness of the developing bath for immersion development is limited by factors such as process throughput and CO₂ absorption from air. The throughput depends on the fraction of exposed areas. CO₂ absorption is also caused by frequent opening of the developer bottle and leads to a reduced development rate. This effect is avoided if the surface of the developer bath is kept under nitrogen.

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 processes 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 aluminium surfaces.

Remover AR 600-71 which is already highly efficient at room temperature is particularly suitable for customers who are able to use removers with low flash point.

In semiconductor industries, the removal (striping) 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

**Properties I**

<table>
<thead>
<tr>
<th>Parameter / AR-P</th>
<th>AR-N</th>
<th>1210</th>
<th>2210</th>
<th>1220</th>
<th>2220</th>
<th>1230</th>
<th>2230</th>
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<tbody>
<tr>
<td>Solids content (%)</td>
<td>4</td>
<td>4</td>
<td>4</td>
<td>4</td>
<td>4</td>
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<tr>
<td>Film thickness (µm)</td>
<td>4 - 10</td>
<td>3 - 8</td>
<td>0.5 - 1</td>
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<tr>
<td>Resolution (µm)</td>
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<tr>
<td>Contrast</td>
<td>3.0</td>
<td>3.0</td>
<td>3.0</td>
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<tr>
<td>Flash point (°C)</td>
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<td>9</td>
<td>37</td>
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<tr>
<td>Storage 6 month (°C)</td>
<td>10 - 18</td>
<td></td>
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</tr>
</tbody>
</table>

**Properties II**

| Glass transition temperature | 108 |
| Cauchy coefficients | N₀ 1.625 / 1.595 |
| AR-P 1220 | N₁ 74.4 / 72.5 |
| AR-N 2220 | N₂ 170 / 85.0 |

**Process parameters**

| Substrate | Si 6” wafer |
| Tempering | 82 °C, chuck |
| Exposure | broadband (h-, p-, i-line) |
| Development | AR 300-44, 4 min puddle |

**Parameters spray coater “EVD® 150”**

| Spray coater | Positive resist | Negative resist |
| EVG® 150, EV Group | AR-P 1210 | AR-N 2210 |
| Resist flow (drops/min) | 25 | 25 |
| Arm speed (mm/s) | 200 | 200 |
| N₂ pressure (kPa) | 50 | 50 |
| Exposure | EVG® 6200NT Automated Mask Alignment System |
| Sensitivity (film thickness) | 170 ml/cm², 4.5 µm | 50 ml/cm², 4.5 µm |
| Development with AR 300-44 | 1:30 min | 2 min |
| Minimum resolution (µm) | 1.4 |

**Process chemicals**

| Developer | AR 300-44 |
| Remover | AR 300-76, AR 300-73 |

**Process conditions**

This diagram shows exemplary process steps for AR-P/N 1200/2200 resists with the EVG® 150. 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 Arellis photoresists”.

- **Coating**
  - AR-P 1210
  - AR-N 2210
  - AR-P 1220
  - AR-N 2220
  - AR-P 1230
  - AR-N 2230
  - 5 µm
  - 3 µm
  - 1.0 µm

- **Tempering (±1 °C)**
  - For heated chucks: 70 - 80 °C without further drying
  - For non-heated chucks:
    - 90 °C, 2 min hot plate or 85 °C, 25 min convection oven

- **UV exposure**
  - Broadband UV, 365 nm, 405 nm, 436 nm
  - Exposure dose (E₀, EVG® 6200NT Automated Mask Aligner):
    - AR-P 1210: 170 ml/cm², 4.5 µm; AR-N 2210: 50 ml/cm², 4.5 µm

- **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
  - AR 300-44
  - AR 300-44
  - 4 min
  - 3 : 1, 5 min
  - 2 : 1, 6 min

- **Rinse**
  - DI-H₂O, 30 s

- **Post-bake (optional)**
  - Not required

- **Customer-specific technologies**
  - Generation of semi-conductor properties

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

**Important processing instructions regarding single process steps are described on the following page**
Positive / Negative Photoresists AR-P 1200 / AR-N 2200

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 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 reflections.

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.

As of August 2016

Lift-off structures with AR-N 2220 after spray coating

Very good coverage of groove bottom and of upper edge
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

**Characterisation**
- 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 25 °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 |

**Spin curve**

**Structure resolution**

**Resist structures**

**Process parameters**

Substrate | Si 4” wafer |
Tempering | 95 °C, 90 s, hot plate |
Exposure | i-line stepper (NA: 0.65) |
Development | AR 300-47, 1 : 1, 60 s, 22 °C |

**Process chemicals**

Adhesion promoter | AR 300-80 |
Developer | AR 300-26, AR 300-47 |
Thinner | AR 300-12 |
Remover | AR 300-76, AR 300-73 |

**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, “Detailed instructions for optimum processing of photoresists”. For recommendations on waste water treatment and general safety instructions, “General product information on Allresist photoresists”.

- **Coating**
  - AR-P 3110 4000 rpm, 60 s 1000 nm
  - AR-P 3120 4000 rpm, 60 s 550 nm
  - AR-P 3170 4000 rpm, 60 s 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)
  - AR 300-26 1 : 3 60 s
  - AR 300-47, 1 : 1 60 s
  - AR 300-47, 1 : 1.5 60 s
  - AR 300-70 or O₂ plasma ashing

- **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 e.g. semi-conductor properties

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

**Development recommendations**

<table>
<thead>
<tr>
<th>Resist / Developer</th>
</tr>
</thead>
<tbody>
<tr>
<td>AR-P 3110 1 : 3</td>
</tr>
<tr>
<td>AR-P 3120 1 : 3</td>
</tr>
<tr>
<td>AR-P 3170 1 : 4</td>
</tr>
</tbody>
</table>

As of December 2016
Positive Photoresist AR-P 3100

**Linearity**

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

**Optimum exposure dose**

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

**Focus variation**

The intended structure sizes can here be realized by varying the focus between -1.5 to 0.8 (parameter see graphic 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**

Optimum dose, with hard bake (115 °C). Untempered and hard bake 115 °C.
Positive Photoresist AR-P 3200

AR-P 3200 photoresist series for high film thicknesses
Thick positive resists for electroplating and microsystems technology

Characterisation
- broadband UV, i-line, g-line
- high photosensitivity, high resolution
- profiles with high edge steepness, accuracy
- plasmaetch resistant, electroplating-stable
- 3210/3250 for film thicknesses up to 40 µm/20 µm
- 3220 transparent for thick films up to 100 µm in multiple coating steps, 100 µm development in one step
- combination of novolac and naphthoquinone diazide
- safer solvent PGMEA

Properties I

<table>
<thead>
<tr>
<th>Parameter / AR-P</th>
<th>AR-P 3210</th>
<th>AR-P 3220</th>
<th>AR-P 3250</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

<table>
<thead>
<tr>
<th>Property</th>
<th>AR-P 3210</th>
<th>AR-P 3220</th>
<th>AR-P 3250</th>
</tr>
</thead>
<tbody>
<tr>
<td>Glass transition temperature</td>
<td>108</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dielectric constant</td>
<td>3.1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cauchy coefficients AR-P 3210</td>
<td>N0 1.597</td>
<td>N1 79.5</td>
<td>N2 105.1</td>
</tr>
<tr>
<td>Plasma etching rates (mm/min)</td>
<td>Ar-sputtering 7</td>
<td>O2 170</td>
<td>CF4 39</td>
</tr>
<tr>
<td>(5 Pa, 240-250 V bias)</td>
<td>80 CF4 + 16 O2 90</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

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, AR 300-35 |
| 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, see “General product information on Allresist photoresists”.

Coating

| AR-P 3210 | AR-P 3220 | AR-P 3250 |
| 4000 rpm, 90 s | 600 rpm, 120 s | 4000 rpm, 60 s |
| 10 µm | 30 µm | 5.0 µm |

Tempering (± 1 °C)

| H* | 95 °C, 4 min | 95 °C, 15 min | 95 °C, 2 min |
| C* | 90 °C, 40 min | 90 °C, 90 min | 90 °C, 30 min |

UV exposure

| Bandwidth UV, 365 nm, 405 nm, 436 nm |
| Exposure dose (E 0, broadband UV stepper): | 450 mJ/cm² | 900 mJ/cm² | 220 mJ/cm² |

Development

| AR 300-26, 1 : 2 | 2 min |
| AR 300-26, undil. | 3 min |
| AR 300-26, 3 : 2 | 2 min |

Rinse

| DI-H2O, 30 s |
| AR 300-76 or O2 plasma ashing |

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 spinning 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

| Resist / Developer | AR 300-26 | AR 300-35 |
| AR-P 3210 (up to 20 µm) | 1 : 2 to 1 : 3 | 2 to 1 : 3 (3-10 min) | undil. up to 10 µm (2-10 min) |
| AR-P 3220 (up to 20 µm) | 3 : 1 to 2 : 1 | 1 : 2 to 1 : 2 (5-15 min) | - |
| AR-P 3250 (up to 10 µm) | 2 : 1 to 3 : 2 | 1 : 1 (1-5 min) | - |
Positive Photoresist AR-P 3200

Sensitivity vs. duration of the soft bake

Residual solvent after tempering

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

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

Sensitivity in different developers

Dark erosion in different developers

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

Erosion corresponding to determined sensitivities

Grey tone mask lithography

Photolysis of photo-active compound (PAC)

28 µm-high 3D pyramids with AR-P 3220

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

The transparency of AR-P 3220 is higher as 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

AR-P 3500 (T) photoresist series with wide process range
Sensitive positive-tone standard resists for the production of integrated circuits

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>3510 / 3510 T</th>
<th>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
<table>
<thead>
<tr>
<th>Property</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Glass transition temperature</td>
<td>108</td>
</tr>
<tr>
<td>Dielectric constant</td>
<td>3.1</td>
</tr>
<tr>
<td>Cauchy coefficients</td>
<td>N0: 1.627 N1: 71.4 N2: 164.8</td>
</tr>
<tr>
<td>Plasma etching rates (nm/min) (5 Pa, 240-250 V bias)</td>
<td>Ar–sputtering: 7, O2: 165, CF4: 37, 80 CF4 + 16 O2: 88</td>
</tr>
</tbody>
</table>

Structure resolution
AR-P 3540 T
Film thickness 1.5 µm
Resist structures 0.5 µm

Temperature stability
AR-P 3540 T
Film thickness 1.5 µm
Resist structures 0.5 µm

Properties

AR-P 3500 (T) photoresist series with wide process range
Sensitive positive-tone standard resists for the production of integrated circuits

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

Structures without hard bake and with tempering at 140 °C (hot plate, 1 min) with AR-P 3540

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, 1:1, 60 s
- Rinse DI-H2O, 30 s
- Post-bake (optional): 115 °C, 1 min, hot plate or 115 °C, 25 min convection oven

Removal
- AR 300-70 or O2 plasma ashing

Customer-specific technologies
- Generation of semiconductor properties or lift-off

Development recommendations
- AR-P 3510, 3540
  - Resist / Developer: AR 300-26, 1:5, 60 s
  - AR 300-35, 1:1, 300-47, 1:1, undil.
  - AR-P 3540, 3540 T
  - Resist / Developer: AR 300-26, 1:5, 60 s

Focus width AR-P 3540 T g-line stepper
- Ridge DOF @ 230 mJ Dose range
  - 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
  - Film thickness 2 µm
  - Resist structures 5 µm

As of January 2014
**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.jpg" alt="Image" /></td>
<td><img src="image2.jpg" alt="Image" /></td>
<td><img src="image3.jpg" alt="Image" /></td>
<td><img src="image4.jpg" alt="Image" /></td>
</tr>
<tr>
<td>- 0.75</td>
<td><img src="image5.jpg" alt="Image" /></td>
<td><img src="image6.jpg" alt="Image" /></td>
<td><img src="image7.jpg" alt="Image" /></td>
<td><img src="image8.jpg" alt="Image" /></td>
</tr>
<tr>
<td>- 0.5</td>
<td><img src="image9.jpg" alt="Image" /></td>
<td><img src="image10.jpg" alt="Image" /></td>
<td><img src="image11.jpg" alt="Image" /></td>
<td><img src="image12.jpg" alt="Image" /></td>
</tr>
<tr>
<td>- 0.25</td>
<td><img src="image13.jpg" alt="Image" /></td>
<td><img src="image14.jpg" alt="Image" /></td>
<td><img src="image15.jpg" alt="Image" /></td>
<td><img src="image16.jpg" alt="Image" /></td>
</tr>
<tr>
<td>0.0</td>
<td><img src="image17.jpg" alt="Image" /></td>
<td><img src="image18.jpg" alt="Image" /></td>
<td><img src="image19.jpg" alt="Image" /></td>
<td><img src="image20.jpg" alt="Image" /></td>
</tr>
<tr>
<td>+ 0.25</td>
<td><img src="image21.jpg" alt="Image" /></td>
<td><img src="image22.jpg" alt="Image" /></td>
<td><img src="image23.jpg" alt="Image" /></td>
<td><img src="image24.jpg" alt="Image" /></td>
</tr>
<tr>
<td>+ 0.5</td>
<td><img src="image25.jpg" alt="Image" /></td>
<td><img src="image26.jpg" alt="Image" /></td>
<td><img src="image27.jpg" alt="Image" /></td>
<td><img src="image28.jpg" alt="Image" /></td>
</tr>
<tr>
<td>+ 0.75</td>
<td><img src="image29.jpg" alt="Image" /></td>
<td><img src="image30.jpg" alt="Image" /></td>
<td><img src="image31.jpg" alt="Image" /></td>
<td><img src="image32.jpg" 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.jpg" alt="Image" /></td>
<td><img src="image34.jpg" alt="Image" /></td>
<td><img src="image35.jpg" alt="Image" /></td>
<td><img src="image36.jpg" alt="Image" /></td>
</tr>
<tr>
<td>190 mJ</td>
<td><img src="image37.jpg" alt="Image" /></td>
<td><img src="image38.jpg" alt="Image" /></td>
<td><img src="image39.jpg" alt="Image" /></td>
<td><img src="image40.jpg" alt="Image" /></td>
</tr>
<tr>
<td>210 mJ</td>
<td><img src="image41.jpg" alt="Image" /></td>
<td><img src="image42.jpg" alt="Image" /></td>
<td><img src="image43.jpg" alt="Image" /></td>
<td><img src="image44.jpg" alt="Image" /></td>
</tr>
<tr>
<td>230 mJ</td>
<td><img src="image45.jpg" alt="Image" /></td>
<td><img src="image46.jpg" alt="Image" /></td>
<td><img src="image47.jpg" alt="Image" /></td>
<td><img src="image48.jpg" 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.

**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.jpg" alt="Image" /></td>
<td><img src="image50.jpg" alt="Image" /></td>
<td><img src="image51.jpg" alt="Image" /></td>
<td><img src="image52.jpg" alt="Image" /></td>
</tr>
<tr>
<td>210 mJ</td>
<td><img src="image53.jpg" alt="Image" /></td>
<td><img src="image54.jpg" alt="Image" /></td>
<td><img src="image55.jpg" alt="Image" /></td>
<td><img src="image56.jpg" alt="Image" /></td>
</tr>
<tr>
<td>230 mJ</td>
<td><img src="image57.jpg" alt="Image" /></td>
<td><img src="image58.jpg" alt="Image" /></td>
<td><img src="image59.jpg" alt="Image" /></td>
<td><img src="image60.jpg" 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.
Positive Photoresists AR-P 3700 / 3800

AR-P 3700 / 3800 photoresists for sub-µm structures
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
- 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

Spin curve

Structure resolution

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

Properties I
- Parameter / AR-P: 3740, 3840
- Solids content (%): 29
- Viscosity 25 °C (mPas): 22
- Film thickness / 4000 rpm (µm): 1.4
- Resolution (µm): 0.4
- Contrast: 6.0
- Flash point (°C): 42
- Storage 6 month (°C): 10 - 18

Properties II
- Glass transition temperature: 108
- Dielectric constant: 3.1
- Cauchy coefficients
  - AR-P 3740: N\textsubscript{2} = 1.623, N\textsubscript{1} = 81.8, N\textsubscript{0} = 160.4
- Plasma etching rates (nm/min)
  - (5 Pa, 240-250 V bias)
    - Ar-sputtering: 8
    - O\textsubscript{2}: 154
    - CF\textsubscript{4}: 38
    - 80 CF\textsubscript{4} + 16 O\textsubscript{2}: 88

Resist structures

Process conditions

- Coating
  - AR-P 3740: 4000 rpm, 60 s, 1.4 µm
  - 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 (E\textsubscript{0}, broadband UV stepper): 55 mJ/cm\textsuperscript{2} (72 mJ/cm\textsuperscript{2})

- Development
  - (21-23 °C ± 0.5 °C) puddle
    - AR 300-47, 60 s
  - Rinse
    - DI-H\textsubscript{2}O, 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 O\textsubscript{2} plasma ashing

Development recommendations

- Resist / Developer: AR 300-26, AR 300-35, AR 300-40
- AR-P 3740, 3840: 1 : 3, 4 : 1
- AR 300-47, 60 s, 22 °C
- 300-46 high speed
- 300-47 high contrast

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

**Dark erosion**

AR-P 3740 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**

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 nm).

**Influence of developer strength of exposure dose**

Using a dilution series of AR 300-26, the desired development properties can be adjusted accordingly. A dilution of 3:2 (3 parts AR 300-26, 2 parts DI water) is not recommended, due to the high erosion rate. More suitable in this case is a dilution of 1:1 to 2:1.

**Dependency of sensitivity (exposure dose) on resist drying**

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

**Linearity**

Up to a structure width of 0.5, a very good agreement is obtained.

**Optimum exposure dose**

The optimum exposure dose for 1 µm lines is 88 mJ/cm².

**Focus variation**

The intended structure sizes can be realised by varying the focus between -1.0 to 1.0.

**Dependency of film thickness on air humidity**

With increasing humidity, the resulting film thickness during coating of the resist decreases.

**Thermal behaviour of resist structures**

The resist layers tempered at 130 °C are basically non-developable any more.

---

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 characterised 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

Charakterisation
- 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>
</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: N0 = 1.623, N1 = 166.8, N2 = 10

Lift-off resist structures

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

Resist structures

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
- Thinner: AR 300-12
- Remover: AR 300-76, AR 300-73

Positve 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: 6000 rpm, 60 s
- AR-P 5350: 4000 rpm, 60 s

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
- (21-23 °C ± 0.5 °C) puddle
  - AR 300-26, 3 : 2
  - 2 min
  - DH-H2O, 30 s

Rinse
- Not required

Post-bake (optional)

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

Removal
- AR 300-76 or O3 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

<table>
<thead>
<tr>
<th>Resist / Developer</th>
<th>AR-P 5320</th>
<th>AR-P 5350</th>
<th>AR 300-35</th>
<th>AR 300-40</th>
</tr>
</thead>
<tbody>
<tr>
<td>2 : 1 to 3 : 2 (1-3 mm)</td>
<td>-</td>
<td>-</td>
<td></td>
<td></td>
</tr>
<tr>
<td>AR 300-26</td>
<td>-</td>
<td>-</td>
<td></td>
<td></td>
</tr>
<tr>
<td>AR-P 5320</td>
<td>AR 300-26</td>
<td>AR 300-35</td>
<td>AR 300-40</td>
<td>AR-P 5350</td>
</tr>
<tr>
<td>1 : 7</td>
<td>1 : 2</td>
<td>300-47, 2 : 3</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Positive and Negative Photoresists AR-U 4000

AR-U 4000 image reversal resist series
Image reversal resist for the fabrication of integrated circuits

**Characterisation**
- bb UV, g-line, i-line 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**
- Parameter / AR-U
  - 4030
  - 4040
  - 4060
- Solids content (%)
  - 37
  - 34
  - 23
- Viscosity 25 °C (mPas)
  - 28
  - 19
  - 6
- Film thickness/4000 rpm (µm)
  - 1.8
  - 1.4
  - 0.6
- Resolution (µm)
  - 0.8
  - 0.7
  - 0.5
- Contrast
  - 3.0
  - 3.0
  - 3.5
- Flash point (°C)
  - 42
- Storage 6 month (°C)
  - 8 - 12

**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

**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, ⇢ "Detailed instructions for optimum processing of photoresists". For recommendations on waste water treatment and general safety instructions, ⇢ "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, 405 nm, 436 nm
  - Exposure dose (E₀, broadband UV stepper): 38 mJ/cm² 34 mJ/cm² 28 mJ/cm²

**Development**
- (21 ± 2 °C ± 0.5 °C) puddle
  - AR 300-35, 1 : 1 60 s
  - AR 300-35, 1 : 2 60 s
  - 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

**Development recommendations**
- Resist / Developer positive process
  - 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 “Detailed 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</th>
<th>Tempering (± 1 °C)</th>
<th>Image-wise UV exposure</th>
<th>Image reversal bake</th>
<th>Flood exposure</th>
<th>Development (21–23 °C ± 0.5 °C) puddle</th>
<th>Rinse</th>
<th>Post-bake (optional)</th>
<th>Customer-specific Technologies</th>
<th>Removal</th>
</tr>
</thead>
<tbody>
<tr>
<td>AR-U 4030</td>
<td>90 °C, 1 min hot plate or 85 °C, 25 min convection oven</td>
<td>Broadband UV, 365 nm, 405 nm, 436 nm; 90 % layer build up</td>
<td>115 °C, 4 min hot plate or 110 °C, 25 min convection oven</td>
<td>Broadband UV stepper: approx. twice of image-wise without mask</td>
<td>AR 300-35, 4 : 3</td>
<td>Di-H2O, 30 s</td>
<td>Not required</td>
<td>Generation e.g. semiconductor properties or lift-off</td>
<td>AR 300-70 or O2 plasma ashing</td>
</tr>
<tr>
<td>AR-U 4040</td>
<td>4000 rpm, 60 s 1.8 µm</td>
<td></td>
<td></td>
<td></td>
<td>AR 300-35, 1 : 1 60 s</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>AR-U 4060</td>
<td>4000 rpm, 60 s 1.4 µm</td>
<td></td>
<td></td>
<td></td>
<td>AR 300-35, 2 : 3 60 s</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>4000 rpm, 60 s 0.6 µm</td>
<td>Exposure dose (E0, broadband UV stepper): 74 mJ/cm²</td>
<td>68 mJ/cm²</td>
<td>55 mJ/cm²</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

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

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. Note: 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 unexposed 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 the image-wise exposed resist layer is tempered which exhibits no influence during positive processes. If a final flood exposure and tempering at 95-105 °C is carried out.

Increasing the undercut:
- low image-wise exposure
- low temperature during reversal bake
- extension of development time

Vertical edges:
- high image-wise exposure
- high temperature during reversal bake
- reduction of development time

As described for the positive mode, a trench with a slope will be formed in this case. During the reversal bake, the trench becomes alkali-insoluble again, while the subsequent flood exposure renders all other areas alkali-soluble. The typical undercut structures particularly well suited for lift-off processes will remain after development.

Exposure dose should be rather low.
For the generation of lift-off structures, the image-wise exposure has to be chosen in the negative mode. Intensifying the image-wise exposure has to be reduced considerably. An undercut cannot be obtained in positive processes.

Vertical edges:
- extension of development time
- high temperature during reversal bake
- reduction of development time

For lift-off processes will remain after development.

Positive image with “slope”, low exposure dose

Practical use:
- Generation of e.g. semiconductor properties or lift-off structures. The resist contains an amine component which exhibits no influence during positive processes. If however the image-wise exposed resist 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 unexposed 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 the image-wise exposed resist layer is tempered which exhibits no influence during positive processes. If a final flood exposure and tempering at 95-105 °C is carried out.

Increasing the undercut:
- low image-wise exposure
- low temperature during reversal bake
- extension of development time

Vertical edges:
- high image-wise exposure
- high temperature during reversal bake
- reduction of development time

As described for the positive mode, a trench with a slope will be formed in this case. During the reversal bake, the trench becomes alkali-insoluble again, while the subsequent flood exposure renders all other areas alkali-soluble. The typical undercut structures particularly well suited for lift-off processes will remain after development.

To generate of vertical edges, a high image-wise exposure 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 exposure 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 PGMEA

### 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>
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</tbody>
</table>

### Properties II

<table>
<thead>
<tr>
<th>Property</th>
<th>AR-PC 503</th>
<th>AR-PC 504</th>
</tr>
</thead>
<tbody>
<tr>
<td>Glass transition temperature</td>
<td>105</td>
<td></td>
</tr>
<tr>
<td>Dielectric constant</td>
<td>2.6</td>
<td></td>
</tr>
<tr>
<td>Cauchy coefficients AR-PC 503</td>
<td>N₀ 1.528</td>
<td>N₁ 34.6</td>
</tr>
<tr>
<td></td>
<td>N₂ 0</td>
<td></td>
</tr>
<tr>
<td>Plasma etching rates (nm/min)</td>
<td>Ar-sputtering 20</td>
<td>O₂ 240</td>
</tr>
<tr>
<td>(5 Pa, 240-250 V Bias)</td>
<td>CF₄ 61</td>
<td>80 CF₄ + 16 O₂ 160</td>
</tr>
</tbody>
</table>

### Spin curve

- Photo of coated wafer
- Topology of the backside

### Structural formula poly(methyl methacrylate)

### Process chemicals

- Adhesion promoter: AR 300-80
- Developer: AR 600-01
- Remover: AR 300-76, AR 600-71

---

**Processing instructions**

- **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, AR-PC 504
  - 1000 rpm, 60 s, 2.0 µm
  - 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
- **Removal of protective coating**: AR 300-76 or O₂ plasma ashing

---

**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-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 - 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, 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.”

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

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

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

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

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

1.2.3. Development
   - (21-23 °C ± 0.5 °C) puddle
   - AR 300-47, 1:1
   - 50 s
   - 35 s
   - DI-H2O, 30 s

1.2.3.1. Rinse
   - AR 600-70
   - 10 s

1.2.3.2. Selective removal of the photoresist film (optional)
   - AR 600-70
   - AR 600-70
   - 10 s

1.2.3.3. Post-bake (optional)
   - Not required

1.2.3.4. Customer-specific technologies
   - Evaporation/sputtering of metal onto lift-off structures

1.2.3.5. Lifting / Removal
   - AR 300-76

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

---

**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>
<th>5480</th>
</tr>
</thead>
<tbody>
<tr>
<td>Solids content (%)</td>
<td>12</td>
<td>9</td>
</tr>
<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>
</tr>
<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: 1.17
- Plasma etching rates (mm/min)
  - (5 Pa, 240-250 V Bias)
  - Ar-sputtering: 14
  - O₂: 283
  - CF₂: 51
  - 80 CF₄ + 16 O₂: 1.33

**Spin curve**

**Structure resolution of positive system**

**Structure resolution of negative system**

**Process conditions**

**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 parameters**

**Process chemicals**

- Adhesion promoter: AR 300-80
- Developer: AR 300-47
- Thinner: AR 600-07 / AR 300-12
- Remover: AR 300-76, AR 300-73

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As of January 2017
### 2L-Lift-off Positive System AR-BR 5400 - AR-P 3500

**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.

**Note:** The ratio of film thicknesses of both films will affect 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:**

AR-P 3500: Exposure and aqueous-alkaline development are carried out as usual (see Product information AR-P 3500). AR-P 4340: 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.

**Note:** The dissolution process now takes place in undirected manner (isotropic). AR-P 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 parameter 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 undiposes. 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**

<table>
<thead>
<tr>
<th>Development Time</th>
<th>Undercut Thickness</th>
</tr>
</thead>
<tbody>
<tr>
<td>25 s</td>
<td>0.8 µm undercut</td>
</tr>
<tr>
<td>40 s</td>
<td>1.6 µm undercut</td>
</tr>
<tr>
<td>90 s</td>
<td>4.6 µm undercut</td>
</tr>
</tbody>
</table>

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

**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, 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”.

<table>
<thead>
<tr>
<th>Process Step</th>
<th>AR-BR 5400 (bottom resist for lower layer)</th>
<th>SXAR-N 4340/7 (top resist for upper layer)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Coating</td>
<td>AR 300-47, 1 : 1</td>
<td>SX AR-N 4340/7</td>
</tr>
<tr>
<td>Tempering</td>
<td>150 °C, 5 min hot plate or</td>
<td>90 °C, 2 min hot plate or</td>
</tr>
<tr>
<td></td>
<td>145 °C, 30 min convection oven</td>
<td>85 °C, 30 min convection oven</td>
</tr>
<tr>
<td>Exposure</td>
<td>Broadband UV, 365 nm, 405 nm, 436 nm</td>
<td>Exposure dose (E©, bb UV st): 20 mJ/cm², 1.4 µm (upper layer)</td>
</tr>
<tr>
<td></td>
<td>95 °C, 2 min hot plate or</td>
<td></td>
</tr>
<tr>
<td></td>
<td>90 °C, 30 min convection oven</td>
<td></td>
</tr>
<tr>
<td>Development</td>
<td>AR 300-47, 1 : 1</td>
<td>AR 300-47, 1 : 1</td>
</tr>
<tr>
<td></td>
<td>50 s</td>
<td>35 s</td>
</tr>
<tr>
<td></td>
<td>DI-H2O, 30 s</td>
<td></td>
</tr>
<tr>
<td>Selective removal of the photoresist film (optional)</td>
<td>AR 600-70</td>
<td>AR 600-70</td>
</tr>
<tr>
<td></td>
<td>10 s</td>
<td>10 s</td>
</tr>
<tr>
<td>Post-bake (optional)</td>
<td>Not required</td>
<td>Not required</td>
</tr>
<tr>
<td>Customer-specific technologies</td>
<td>Evaporation/sputtering of metal onto lift-off structures</td>
<td>Evaporation/sputtering of metal onto lift-off structures</td>
</tr>
<tr>
<td>Lifting / Removal</td>
<td>AR 300-73 or AR 300-76</td>
<td>AR 300-73 or AR 300-76</td>
</tr>
</tbody>
</table>

**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 first coated with the copolymer 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 photore sist should not be left for more than 10 s 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 photore sist 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 cross-linking bake in the negative mode.

AR-P 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 photore sist 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-P 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 photore sist 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 photore sist layer (optional)**: For transparent and temperature-stable films, the copolymer layer is used alone. For this undiluted, the residual photore sist 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. Ultra sound 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 patterning 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 dimerazine, crosslinking agent, adhesion promoter; safer solvent PGMEA

**Properties I**
- Parameter / AR-P
- 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

**Spin curve**

**Properties II**
- Glass transition temperature 108
- Dielectric constant 3.1
- Cauchy coefficients
  - $N_0$: 16.23
  - $N_1$: 166.8
  - $N_2$: 10
- Plasma etching rates (nm/min)
  - (5 Pa, 240-250 V Bias)
  - Ar-sputtering: 7
  - O$_2$: 161
  - CF$_4$: 38
  - 80 CF$_4$ + 16 O$_2$: 89

**Structure resolution**

**Resist structures**

**Process parameters**
- Substrate: Si 4” wafer
- Tempering: 90 °C, 2 min, hot plate
- Develop: 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

**HF-stable Positive Photoresist AR-P 5900**

**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, 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”.

1. **Pre-coating with AR 300-80**
   - Adhesive bonding, resulting film thickness 15 nm
2. **Tempering**
   - 180 °C, 2 min hot plate or 180 °C, 25 min convection oven
3. **Coating**
   - AR-P 5910
     - 4000 rpm, 60 s, 5.0 µm
4. **2. Tempering (± 1 °C)**
   - 90 °C, 2 min hot plate or 85 °C, 25 min convection oven
5. **UV exposure**
   - Broadband UV, 365 nm, 405 nm, 436 nm
   - Exposure dose ($E_0$, broadband UV stepper): 380 ml/cm², 5.0 µm
6. **Development**
   - AR 300-26
     - 60 s
     - DI-H$_2$O, 30 s
7. **Post-bake**
   - 110 °C, 2 min hot plate or 105 °C, 25 min convection oven
8. **Removal**
   - AR 300-76 or O$_2$ 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 ammoniu fluoride (5% HF, 5% NH$_4$F) 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% NH$_4$F: conc. HF) are used, etching is possible for an even longer period of time.

**Development recommendations**
- Resist / Developer: AR 300-26
- AR-P 5910: undil.
**Negative Photoresist AR-N 4200**

**AR-N 4240 Negative Photoresist for the mid and deep UV range**

Sensible negative resist for the production of integrated circuits

### Characterisation
- Deep UV, i-line
- High sensitivity, high resolution
- Good adhesion, wide process range
- Undercut profiles (lift-offs) are possible
- Not chemically enhanced
- Plasma etching resistant, temperature-stable
- Novolac with photoactive crosslinking agent
- Safer solvent PGMEA

### Properties I

<table>
<thead>
<tr>
<th>Parameter / AR-N</th>
<th>4240</th>
</tr>
</thead>
<tbody>
<tr>
<td>Solids content (%)</td>
<td>30</td>
</tr>
<tr>
<td>Viscosity 25°C (mPas)</td>
<td>10</td>
</tr>
<tr>
<td>Film thickness/4000 rpm (µm)</td>
<td>1.4</td>
</tr>
<tr>
<td>Resolution (µm)</td>
<td>0.6</td>
</tr>
<tr>
<td>Contrast</td>
<td>2.8</td>
</tr>
<tr>
<td>Flash point (°C)</td>
<td>42</td>
</tr>
<tr>
<td>Storage 6 month (°C)</td>
<td>14 - 20</td>
</tr>
</tbody>
</table>

### Properties II

| Glass transition temperature | 102 |
| Diellectric constant | 3.1 |
| Cauchy coefficients unexposed / exposed |
| | N0 | 1.610 |
| | N1 | 82.4 |
| | N2 | 88.0 |
| | N3 | 93.0 |
| | 85.8 |
| Plasma etching rates (nm/min) (5 Pa, 240-250 V Bias) |
| Ar-sputtering | 7 |
| O2 | 170 |
| CF4 | 39 |
| 80 CF4 | 91 |
| + 16 O2 |

### Structure resolution

AR-N 4240 0.8 µm trenches at a film thickness of 1.1 µm

### Resist structures

AR-N 4240 Test structures on 2.0 µm-thick film

### Process parameters

- Substrate: Si 4" wafer
- Tempering: 85 °C, 60 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

### Process conditions

**AR-N 4240**

- Coating: AR-N 4240 4000 rpm, 60 s 1.4 µm
- Tempering: (± 1 °C) 90 °C, 1 min hot plate or 85 °C, 25 min convection oven
- UV exposure: i-line stepper (broadband UV, 365 nm) Exposure dose (E0, i-line stepper): 340 mJ/cm², 1.4 µm
- Crosslinking bake: (±1°C) 85 °C, 2 min hot plate or 80 °C, 25 min convection oven to increase the sensitivity slightly
- Development (21-23 °C ± 0.5 °C) puddle
  - Note: By extending the development time, an undercut (lift-off) of the resist structure can be obtained at minimum possible exposure dose AR 300-47, 90 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 e.g. semiconductor properties or lift-off
- Removal: AR 300-76 or O2 plasma ashing

**Development recommendations**

- Resist / Developer: AR 300-26 AR 300-47
- AR-N 4240 1 : 1 undil.
### Negative Photoresist AR-N 4200

#### Sensitivity vs. soft bake

In a range between 85 to 110 °C, the sensitivity remains more or less constant which indicates a stable process for this resist. Above temperatures of 105 °C, the crosslinking agent slowly begins to disintegrate (i-line stepper, thickness 1.4 µm).

#### Development rate vs. soft bake

The development rate more or less decreases constantly up to 110 °C. The stronger developer AR 300-46 increases the development rate again, despite the higher temperature.

#### Time for complete development

At a recommended soft bake temperature of 85 °C, the time for complete development is approx. 70 s. A faster development requires the stronger developer AR 300-46.

#### Absorption curve

Absorption up to 280 nm is mainly due to the novolac. The bisazide absorbs up to 380 nm and the resist is thus optimally suited for i-line.

#### Crosslinking reaction, no CAR

Novolac molecules are connected via bisazide molecules.
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>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/4000 rpm (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 | N₂ | 1.593 | 1.599 |
| unexposed/exposed | N₁ | 75.4 | 81.4 |
| Plasma etching rates (mV/min) (5 Pa, 240-250 V Bias) | Ar-sputtering | 8 |
| | O₂ | 173 |
| | CF₂ | 33 |
| | 80 CF₄ + 16 O₂ | 93 |

Structure resolution
AR-N 4340 Film thickness 1.4 µm Resist structure 0.7 µm L/S

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 parameters
Adhesion promoter AR 300-80
Developer AR 300-475
Thinner AR 300-12
Remover AR 300-76, AR 300-72
**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. (parameter see graphic Focus variation).

**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**

- Hardened resist bar structures after tempering at 200 °C. 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.
**Negative Photoresists AR-N 4400 (CAR 44)**

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

This photoresist series provides thick negative resists for electroplating, microsystems technology and LIGA ≤ 20 µm.

#### 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 (250 rpm)
- 4450-10 for film thicknesses up to 20 µm and lift-off
- novolac, crosslinking agent, amine-based acid generator
- safer solvent PGMEA

#### Properties I

<table>
<thead>
<tr>
<th>Parameter / AR-N</th>
<th>4400-05</th>
<th>4400-10</th>
<th>4450-10</th>
</tr>
</thead>
<tbody>
<tr>
<td>Solids content (%)</td>
<td>33</td>
<td>45</td>
<td>45</td>
</tr>
<tr>
<td>Film thickness/1000 rpm (µm)</td>
<td>5</td>
<td>10</td>
<td>10</td>
</tr>
<tr>
<td>Resolution (µm)</td>
<td>1.0</td>
<td>2.0</td>
<td>3.5</td>
</tr>
<tr>
<td>Contrast</td>
<td>4.0</td>
<td>4.0</td>
<td>10</td>
</tr>
<tr>
<td>Flash point (°C)</td>
<td>42</td>
<td>42</td>
<td>42</td>
</tr>
<tr>
<td>Storage 6 month (°C)</td>
<td>10 - 18</td>
<td>10 - 18</td>
<td>10 - 18</td>
</tr>
</tbody>
</table>

#### Properties II

- Glass transition temperature: 102
- Dielectric constant: 3.1
- Cauchy coefficients: N0 = 1.615, N1 = 77.6, N2 = 64.1
- Plasma etching rates (nm/min) (5 Pa, 240-250 V Bias):
  - Ar-sputtering: 3
  - O2: 122
  - CF4: 31
  - 80 CF4 + 16 O2: 81

#### 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

#### Resist structures
- AR-N 4400-10: 3 µm resolution at a film thickness of 15 µm

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

This photoresist series provides thick negative resists for electroplating, microsystems technology and LIGA ≥ 50 µm.

#### 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 I

<table>
<thead>
<tr>
<th>Parameter / AR-N</th>
<th>4400-25</th>
<th>4400-50</th>
</tr>
</thead>
<tbody>
<tr>
<td>Solids content (%)</td>
<td>52</td>
<td>58</td>
</tr>
<tr>
<td>Film thickness/1000 rpm (µm)</td>
<td>25</td>
<td>50</td>
</tr>
<tr>
<td>Resolution (µm)</td>
<td>3.5</td>
<td>5.0</td>
</tr>
<tr>
<td>Contrast</td>
<td>5.0</td>
<td>6.0</td>
</tr>
<tr>
<td>Flash point (°C)</td>
<td>42</td>
<td>42</td>
</tr>
<tr>
<td>Storage 6 month (°C)</td>
<td>10 - 18</td>
<td>10 - 18</td>
</tr>
</tbody>
</table>

#### Properties II

- Glass transition temperature: 102
- Dielectric constant: 3.1
- Cauchy coefficients: N0 = 1.615, N1 = 77.6, N2 = 64.1
- Plasma etching rates (nm/min) (5 Pa, 240-250 V Bias):
  - Ar-sputtering: 3
  - O2: 122
  - CF4: 31
  - 80 CF4 + 16 O2: 81

#### Process parameters
- Substrate: Si 4” wafer
- Tempering: 95 °C, 10 min, hot plate
- Exposure: Maskaligner 150
- Development: AR 300-44, undil., 90 min, 22 °C

#### Resist structures
- Siemens star produced with AR-N 4400-25 (30 µm thickness)
### 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 "Detailed 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>
</tr>
</thead>
<tbody>
<tr>
<td>4400-05</td>
</tr>
<tr>
<td>1000 rpm</td>
</tr>
<tr>
<td>5 µm</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Tempering (± 1 °C)</th>
</tr>
</thead>
<tbody>
<tr>
<td>H* = Hot plate or C* = Convection oven</td>
</tr>
<tr>
<td>H* 90 °C 4 min</td>
</tr>
<tr>
<td>C* 85 °C 30 min</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>UV exposure</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maskaligner, broadband UV</td>
</tr>
<tr>
<td>Exposure dose (E₀, broadband UV): 22 mJ/cm² 26/90 mJ/cm² 33 mJ/cm² 52 mJ/cm²</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Crosslinking bake (+/- 1 °C)</th>
</tr>
</thead>
<tbody>
<tr>
<td>H* = Hot plate or C* = Convection oven</td>
</tr>
<tr>
<td>H* 100 °C 5 min</td>
</tr>
<tr>
<td>C* 95 °C 30 min</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Development (21-23 °C ± 0,5 °C) puddle</th>
</tr>
</thead>
<tbody>
<tr>
<td>300-47, 3 : 2</td>
</tr>
<tr>
<td>2 min</td>
</tr>
<tr>
<td>DH-H₂O₂ 30 s and dry with caution</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Rinse</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flood exposure 100 mJ/cm²; bake 120 °C, 5 min hot plate</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Hardening of structures up to 300 °C (optional)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flood exposure 100 mJ/cm²; bake 120 °C, 5 min hot plate</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Customer-specific technologies</th>
</tr>
</thead>
<tbody>
<tr>
<td>Generation of e.g. semiconductor properties or lift-off (4450-10) and galvanic, MEMS</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Removal</th>
</tr>
</thead>
<tbody>
<tr>
<td>AR 300-76 for low crosslink density, AR 600-71 for high crosslink density, O₂ plasma ashing is also possible for high film thicknesses.</td>
</tr>
</tbody>
</table>

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

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

#### Sensitivity of AR-N 4400-05

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

#### Gradiation curve of AR-N 4400-05

The gradation (contrast) is 3.5, the sensitivity was determined to 21.5 mJ/cm² for a structure buildup of 90 % (H₀90).

#### Thermal stability and shrinking up to 300 °C

At a film thickness of 5 µm, 1.0 µm bars 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.

#### Resolution of AR-N 4400-05

At a film thickness of 5 µm, 1.0 µm bars were produced.

#### Picture of Albert Einstein

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

#### Lift-off structures

Undercuts produced with low exposure dose (AR-N 4450-10)
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/1h; 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 4450-10, 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>SU-8</th>
</tr>
</thead>
<tbody>
<tr>
<td>✓ thick films</td>
<td>✓ ✓</td>
</tr>
<tr>
<td>✓ high resolution</td>
<td>✓</td>
</tr>
<tr>
<td>✓ excellent aspect ratio</td>
<td>✓</td>
</tr>
<tr>
<td>✓ high sensitivity at i-line, deep UV, e-beam, X-ray</td>
<td>✓ ✓</td>
</tr>
<tr>
<td>✓ good sensitivity at g-line</td>
<td>✗</td>
</tr>
<tr>
<td>✓ low-stress tempering – easy handling</td>
<td>✗</td>
</tr>
<tr>
<td>✓ aqueous-alkaline development</td>
<td>✗</td>
</tr>
<tr>
<td>✓ easy removal</td>
<td>✗</td>
</tr>
</tbody>
</table>

As of January 2014
As of January 2016

Photoresists

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

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

Characterisation
- 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 cleaning 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>
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<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>
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<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>
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<td>Water content max. (%)</td>
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<tr>
<td>Non-volatiles max. (%)</td>
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<td>Flash point (°C)</td>
<td>42</td>
<td>28</td>
<td>44</td>
<td>38</td>
<td>46</td>
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<td>Filtration (µm)</td>
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<tr>
<td>Suitable for dilution of AR photoresists</td>
<td>3000, 4000, 5000</td>
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<tr>
<td>Suitable for dilution of AR e-beam resists</td>
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<tr>
<td>Storage 6 month (°C)</td>
<td>10-22</td>
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</tr>
</tbody>
</table>

Application properties

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. 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.

Formula for dilutions

Example: Starting with a resist with 35 % solids content (AR-P 3510), a solids content of 31 % is desired. Requested is the amount of thinner AR 300-12 in g which has to be added to 100 g resist with 35 % solids content (mass m in g, solids content c /100).

\[
m \text{ thinner} = m \text{ resist} \cdot c_{\text{resist}} = c_{\text{desired}} = 1000 \cdot (0.35 - 0.31) = 12.9 \text{ g thinner}
\]

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

Characterisation
- 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

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>
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<td>1.02</td>
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<tr>
<td>Filtration (µm)</td>
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<tr>
<td>Storage 6 month (°C)</td>
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Development recommendations

<table>
<thead>
<tr>
<th>AR-resists / main component(s)</th>
<th>AR 300-26</th>
<th>AR 300-35</th>
</tr>
</thead>
<tbody>
<tr>
<td>AR-P 3110 ; 3120 ; 3170</td>
<td>immersion, puddle and spray development</td>
<td></td>
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<tr>
<td>AR-P 3210</td>
<td>1 : 3</td>
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<tr>
<td>AR-P 3220 ; 3250</td>
<td>2 : 1 to 3 : 2</td>
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<tr>
<td>AR-P 3510, 3540 ; 3510 T, 3540 T</td>
<td>1 : 5 ; 1 : 2</td>
<td></td>
</tr>
<tr>
<td>AR-P 3740, 3840</td>
<td>1 : 3</td>
<td></td>
</tr>
<tr>
<td>AR-U 4030, 4040, 4060</td>
<td>1 : 1</td>
<td></td>
</tr>
<tr>
<td>AR-P 5320 ; 5350</td>
<td>2 : 1 to 3 : 2 ; 1 : 7</td>
<td></td>
</tr>
<tr>
<td>AR-BR 5460, 5480</td>
<td>1 : 4</td>
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</tr>
<tr>
<td>AR-P 5910 (formerly X-AR-P 310010)</td>
<td>undil.</td>
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<tr>
<td>AR-N 4240 ; AR-N 4340</td>
<td>1 : 1</td>
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<tr>
<td>AR-P 7400</td>
<td>1 : 6</td>
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</tr>
<tr>
<td>AR-N 7500.18 ; 7500.08</td>
<td>1 : 4 ; 1 : 7</td>
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<tr>
<td>AR-N 7520.17 ; 7520.11 , 07 new</td>
<td>3 : 1 ; 1 : 1</td>
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<tr>
<td>AR-N 7520.18 ; 7520.073</td>
<td>2 : 1</td>
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<tr>
<td>AR-N 7700.18 ; 7700.08</td>
<td>2 : 1 ; 1 : 3</td>
<td></td>
</tr>
<tr>
<td>AR-N 7720.30 ; 7720.13</td>
<td>undil. to 3 : 1</td>
<td></td>
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</tbody>
</table>

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, longer development times. This particularly selective working method ensures a high degree of detail reproduction, longer development times. This particularly selective working method ensures a high degree of detail reproduction, longer development times. This particularly selective working method ensures a high degree of detail reproduction, longer development times. This particularly selective working method ensures a high degree of detail reproduction, longer development times. This particularly selective working method ensures a high degree of detail reproduction, longer development times. This particularly selective working method ensures a high degree of detail reproduction, longer development times. This particularly selective working method ensures a high degree of detail reproduction, longer development times. This particularly selective working method ensures a high degree of detail reproduction, longer development times. This particularly selective working method ensures a high degree of detail reproduction, longer development times. This particularly selective working method ensures a high degree of detail reproduction, longer development times. This particularly selective working method ensures a high degree of detail reproduction, longer development times. This particularly selective working method ensures a high degree of detail reproduction, longer development times. This particularly selective working method ensures a high degree of detail reproduction, longer development times. This particularly selective working method ensures a high degree of detail reproduction, longer development times. This particularly selective working method ensures a high degree of detail reproduction, longer development times. This particularly selective working method ensures a high degree of detail reproduction, longer development times. This particularly selective working method ensures a high degree of detail reproduction, longer development times. This particularly selective working method ensures a high degree of detail reproduction, longer development times. This particularly selective working method ensures a high degree of detail reproduction, longer development times. This particularly selective working method ensures a high degree of detail reproduction, longer development times. This particularly selective working method ensures a high degree of detail reproduction, longer development times. This particularly selective working method ensures a high degree of detail reproduction, longer development times. This particularly selective working method ensures a high degree of detail reproduction, longer development times. This particularly selective working method ensures a high degree of detail reproduction, longer development times. This particularly selective working method ensures a high degree of detail reproduction, longer development times. This particularly selective working method ensures a high degree of detail reproduction, longer development times. This particularly selective working method ensures a high degree of detail reproduction, longer development times. This particularly selective working method ensures a high degree of detail reproduction, longer development times. This particularly selective working method ensures a high degree of detail reproduction, longer development times. This particularly selective working method ensures a high degree of detail reproduction, longer development times. This particularly selective working method ensures a high degree of detail reproduction, longer development times. This particularly selective working method ensures a high degree of detail reproduction, longer development times. This particularly selective working method ensures a high degree of detail reproduction, longer development times.
### 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**
- 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

**Remover 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>AR-P 1200, AR-N 2200</td>
<td>2 : 1 to 3 : 1</td>
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<tr>
<td>AR-P 3110, 3120, 3170</td>
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<td>-</td>
<td>1,5 : 1 to 1 : 1,5</td>
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<tr>
<td>AR-P 3510, 3540 ; 3510T, 3540T</td>
<td>-</td>
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<td>AR-P 3740, 3840</td>
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<td>1 : 0</td>
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<td>AR-P 5320, AR-P 5350</td>
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<td>AR-B 5460, 5480</td>
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<td>AR-P 5910 (formerly X AR-P 3100/10)</td>
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<td>AR-N 4400-10</td>
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<td>AR-N 4400-25</td>
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<td>AR-P 7400, 23</td>
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<tr>
<td>AR-N 7500,18 ; 7500.08</td>
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<tr>
<td>AR-N 7520,17 ; 7520.11,07 new</td>
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<td>AR-N 7520,18 ; 7520.073</td>
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<td>AR-N 7700,18 ; 7700.08</td>
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<tr>
<td>AR-N 7720,30 ; 7720.13</td>
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</tbody>
</table>

*Information on developer processing (→ see also information on developers AR 300-26 and 300-35)*

If metal ion-free developers are diluted, it is recommended to adjust the desired normality immediately prior to use by 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 photoresists and e-beam resist films

**Characterisation**
- aqueous-alcoholic 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 200 °C: AR 600-71, 300-76
- novolac e-beam resists 150 °C: AR 300-73, 300-76

**Properties**
- Main component acetone dioxolane DMG NEP TMAH
- Non-volatiles max. (%) 0.002
- Flash point (°C) -17 3 103 98 -
- Filtration (µm) 0.2
- Storage up to 6 month (°C) 10-22 10-18 15-25 10-22 10-22

**Processing instructions for removers**

Substrates coated with resist are exposed to the effect of the remover by immersion (puddle 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 to 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>Temperature (°C)</th>
<th>Recomm.</th>
<th>Film thickness (µm)</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>AR-P 300</strong></td>
<td>1.5</td>
<td>95 - 120</td>
<td>60-70</td>
<td>60-71</td>
<td>300-76</td>
<td>300-70, 300-72, 300-73</td>
</tr>
<tr>
<td></td>
<td><strong>Example 3110</strong></td>
<td></td>
<td></td>
<td>21 °C</td>
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### Remover for AR Resists

<table>
<thead>
<tr>
<th>Remover recommendations</th>
<th>Temperature (°C)</th>
<th>Recomm.</th>
<th>Film thickness (µm)</th>
<th>optimally suitable</th>
<th>suitable</th>
<th>limited suitability</th>
<th>unsuitable</th>
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<tbody>
<tr>
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<td><strong>AR-N 4400</strong></td>
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<td>300-76</td>
<td>300-70</td>
<td>600-71</td>
<td>600-70, 600-72, 600-73</td>
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<td><strong>Example 4340</strong></td>
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<td>&lt; 20 s</td>
<td>&lt; 20 s</td>
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<td>&lt; 60 s</td>
</tr>
</tbody>
</table>

The average times required for removal as listed under “properties” are divided into time clusters (< 20 s, < 60 s, ...) for better orientation. In the column for remover recommendations, the first entry applies to low-baked and the second entry (or, if applicable, the third) to resist films baked at higher temperatures. 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 All Resist. As replacement, we recommend the equivalent removers AR 300-76 and 600-71.
Adhesion Promoter for AR Resists

AR 300-80 and HMDS adhesion promoter

For improving the adhesive strength of photo and e-beam resists

**Characterisation**
- Improvement of the adhesive strength of photo and e-beam resist films
- Especially for surfaces with low adhesion properties, e.g. metal, SiO₂, GaAs
- AR 300-80: spin coating of a diphenylsilanediol solution = improved adhesion properties and simple, cheaper alternative to HDMS
- HMDS: evaporation of HMDS on the substrate surface (equipment required)

**Properties**

<table>
<thead>
<tr>
<th>Parameter / AR</th>
<th>300-80</th>
<th>HMDS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Density at 20 °C (g/cm³)</td>
<td>0.971</td>
<td>0.774</td>
</tr>
<tr>
<td>Flash point (°C)</td>
<td>7</td>
<td>14</td>
</tr>
<tr>
<td>Filtration (µm)</td>
<td>0.2</td>
<td>0.2</td>
</tr>
<tr>
<td>Storage 6 month (°C)</td>
<td>10-22</td>
<td></td>
</tr>
</tbody>
</table>

**Processing information AR 300-80**

AR 300-80 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 to perform the subsequent tempering on a hot plate for 2 min or in a convection oven for 25 min at 180 °C. 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.

As of January 2017
**Product Portfolio Photoresists**

<table>
<thead>
<tr>
<th>Resist system</th>
<th>Product</th>
<th>DoI µm rpm</th>
<th>Type</th>
<th>Characteristic Properties</th>
<th>Application</th>
<th>Resolution [µm]</th>
<th>Contrast</th>
<th>Expos. Sure</th>
<th>Thinner</th>
<th>Develo-</th>
<th>Remover</th>
</tr>
</thead>
<tbody>
<tr>
<td>AR-P 1200</td>
<td>1210, 1220, 1230</td>
<td>[0.5 - 10]</td>
<td>spray resist, var. applications</td>
<td>MEMS</td>
<td>1</td>
<td>3</td>
<td>300-12</td>
<td>300-44</td>
<td>600-71</td>
<td>300-73</td>
<td></td>
</tr>
<tr>
<td>AR-P 3100</td>
<td>3110, 3120, 3170</td>
<td>1.0; 0.6; 0.1</td>
<td>high resolution, adhesion-enhanced</td>
<td>masks, etch-stop</td>
<td>0.5; 0.4</td>
<td>3.0</td>
<td>300-12</td>
<td>300-35</td>
<td>600-71</td>
<td>300-76</td>
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</tr>
<tr>
<td>AR-P 3200</td>
<td>3210, 3220, 3250</td>
<td>10; 10.5</td>
<td>high resist with high resolution, accuracy up to 100 µm</td>
<td>electroplating, MST</td>
<td>4; 3; 1.2</td>
<td>2.0; 0.25</td>
<td>300-12</td>
<td>300-26</td>
<td>600-71</td>
<td>300-76</td>
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</tr>
<tr>
<td>AR-P 3510</td>
<td>3510, 3540</td>
<td>2.0</td>
<td>wide process range, high resolution</td>
<td>ICS</td>
<td>0.8; 0.7</td>
<td>4.0; 4.5</td>
<td>-</td>
<td>300-12</td>
<td>300-35</td>
<td>600-71</td>
<td>300-76</td>
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<tr>
<td>AR-P 3550</td>
<td>3510 T, 3540 T</td>
<td>2.0; 1.4</td>
<td>wide process range, high resolution, developable in 0.2 µm TMAH</td>
<td>ICS</td>
<td>0.6; 3</td>
<td>4.5; 5.0</td>
<td>-</td>
<td>300-12</td>
<td>300-35</td>
<td>600-71</td>
<td>300-76</td>
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<tr>
<td>AR-P 3700, 3800</td>
<td>3740, 3840</td>
<td>1.4; 1.4</td>
<td>highest resolution, sub-µm, high contrast, 3840 dyed</td>
<td>VLSIC</td>
<td>0.4</td>
<td>6.0; 6.0</td>
<td>300-12</td>
<td>300-47</td>
<td>600-71</td>
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<tr>
<td>AR-P 5320, 5350</td>
<td>5320, 5350</td>
<td>5.0</td>
<td>understructs (single layer lift-off)</td>
<td>evaporation structures</td>
<td>2.0; 0.1</td>
<td>5.5</td>
<td>300-12</td>
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<td>600-71</td>
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<tr>
<td>AR-P 5900</td>
<td>5910</td>
<td>5.0</td>
<td>complicated pattern, up to 5% HIF BOE</td>
<td>MEMS</td>
<td>2</td>
<td>2.0; 1.5</td>
<td>-</td>
<td>300-12</td>
<td>300-26</td>
<td>600-71</td>
<td>300-76</td>
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<tr>
<td>AR-N 2220, 2220, 2220</td>
<td>2210, 2220, 2230</td>
<td>[0.5 - 10]</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>300-73</td>
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<tr>
<td>AR-N 4200</td>
<td>4240</td>
<td>1.4</td>
<td>highly sensitive, high resolution</td>
<td>ICS</td>
<td>0.6</td>
<td>2.8</td>
<td>300-12</td>
<td>300-26</td>
<td>600-71</td>
<td>300-73</td>
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<tr>
<td>AR-N 4300</td>
<td>4314</td>
<td>1.4</td>
<td>highest sensitivity, high resolution, CAR</td>
<td>ICS</td>
<td>0.5</td>
<td>2.5</td>
<td>300-12</td>
<td>300-26</td>
<td>600-71</td>
<td>300-73</td>
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<tr>
<td>AR-N 4400-50, 4400-70</td>
<td>4400-50, 4400-70</td>
<td>1000 rpm</td>
<td>thick films up to 100, 50, 25, 10 µm, easy removal</td>
<td>electroplating, MST, LIGA</td>
<td>2.0; 6.5; 0.1; 1.0</td>
<td>300-12</td>
<td>300-44</td>
<td>600-71</td>
<td>300-70</td>
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<tr>
<td>AR-N 4450-10</td>
<td>4450-10</td>
<td>1000 rpm</td>
<td>thick films up to 20 µm, lift-off</td>
<td>-</td>
<td>2.0</td>
<td>10</td>
<td>300-12</td>
<td>300-47</td>
<td>600-71</td>
<td>300-70</td>
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</table>

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

**Product Portfolio E-Beam Resists**

<table>
<thead>
<tr>
<th>Resist system</th>
<th>Product</th>
<th>DoI µm rpm</th>
<th>Type</th>
<th>Characteristic Properties</th>
<th>Application</th>
<th>Resolution [µm]</th>
<th>Contrast</th>
<th>Expos. Sure</th>
<th>Thinner</th>
<th>Develo-</th>
<th>Remover</th>
</tr>
</thead>
<tbody>
<tr>
<td>AR-P 617</td>
<td>copolymer PMMA/MMA 33%</td>
<td>0.09-1.75</td>
<td>highest resolution, 2x more sensitive than PMMA, IR off</td>
<td>ICS, masks</td>
<td>10 / 100</td>
<td>6.0</td>
<td>600-71</td>
<td>300-76</td>
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<tr>
<td>AR-P 631- 671</td>
<td>PMMA 50K, 200K, 600K, 950K</td>
<td>0.02-1.70</td>
<td>chlorobenzene</td>
<td>ICS, masks</td>
<td>6 / 100</td>
<td>7.0</td>
<td>600-71</td>
<td>300-76</td>
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<td>AR-P 632- 672</td>
<td>PMMA 50K, 200K, 600K, 950K</td>
<td>0.01-1.87</td>
<td>anisole</td>
<td>ICS, masks</td>
<td>6 / 100</td>
<td>7.0</td>
<td>e-beam, deep UV</td>
<td>600-71</td>
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<td>AR-P 639- 679</td>
<td>PMMA 50K, 200K, 600K, 950K</td>
<td>0.02-0.74</td>
<td>ethyl lactate</td>
<td>ICS, masks</td>
<td>6 / 100</td>
<td>7.0</td>
<td>e-beam, deep UV</td>
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<td>AR-P 6200</td>
<td>CSAR 62</td>
<td>0.08-0.4</td>
<td>positive</td>
<td>ICS, sensors, masks</td>
<td>6</td>
<td>15</td>
<td>600-71</td>
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<tr>
<td>AR-P 6500</td>
<td>6510, 11, 18, 19 styrene acryl</td>
<td>350 rpm</td>
<td>positive</td>
<td>micro components</td>
<td>1 µm (x-ray)</td>
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<td>e-beam</td>
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<td>300-76</td>
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<td>AR-P 7400</td>
<td>7400.23 novolac</td>
<td>0.6</td>
<td>positive</td>
<td>novolac</td>
<td>40 / 150</td>
<td>4.0</td>
<td>e-beam, deep UV, g-line, l-line</td>
<td>600-71</td>
<td>300-76</td>
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<tr>
<td>AR-N 7500</td>
<td>7500.08, 7500.18 novolac</td>
<td>0.1</td>
<td>novolac</td>
<td>ICS, masks</td>
<td>40 / 100</td>
<td>5.0</td>
<td>e-beam, deep UV, g-line, l-line</td>
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<td>AR-N 7520</td>
<td>7520.07, 7520.18 novolac</td>
<td>0.1</td>
<td>novolac</td>
<td>ICS, masks</td>
<td>30 / 8.0</td>
<td>2.0</td>
<td>e-beam, deep UV, g-line, l-line</td>
<td>600-71</td>
<td>300-76</td>
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<tr>
<td>AR-N 7700</td>
<td>7700.08, 7700.18 novolac</td>
<td>0.1</td>
<td>novolac</td>
<td>ICS, masks</td>
<td>28 / 10.0</td>
<td>2.0</td>
<td>e-beam, deep UV, g-line, l-line</td>
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<td>AR-N 7720</td>
<td>7720.13, 7720.30 novolac</td>
<td>0.25</td>
<td>novolac</td>
<td>ICS, masks</td>
<td>80 / 200</td>
<td>1.0</td>
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<td>300-76</td>
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<td>AR-P 5000</td>
<td>polyaniline 5090, 5091, 5092</td>
<td>0.04</td>
<td>novolac</td>
<td>ICS, masks</td>
<td>-</td>
<td>-</td>
<td>water</td>
<td>600-71</td>
<td>300-76</td>
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</tr>
</tbody>
</table>

All resist systems show optimal adhesion features with adhesion promoter AR-300-80 which is applied prior to resist deposition.
# Product Portfolio Experimental Samples

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 \( \frac{1}{4} \ell, 0.5 \ell, 1 \ell, 2.5 \ell \), \( 6 \times 1 \ell, 4 \times 2.5 \ell \) and corresponding process chemicals in package sizes of \( 1 \ell, 2.5 \ell, 5 \ell, 4 \times 2.5 \ell, 4 \times 5 \ell \). Test samples/smallest quantities of 30 ml and 100 ml are possible. Please request our price lists.

## Special product

<table>
<thead>
<tr>
<th>Special product</th>
<th>Do/μm</th>
<th>Type</th>
<th>Characteristic properties / Application</th>
<th>Resolution [μm]</th>
<th>Contrast</th>
<th>Exposure</th>
<th>Thinner</th>
<th>Developer</th>
<th>Remover</th>
</tr>
</thead>
<tbody>
<tr>
<td>X AR-P 3220/7</td>
<td>6.0</td>
<td>post</td>
<td>positive, temperature-/ plasma etching stable thick resist</td>
<td>2</td>
<td>2</td>
<td>i-line, g-line, BB-UV</td>
<td>300-12</td>
<td>300-26</td>
<td>300-76</td>
</tr>
<tr>
<td>X AR-P 5900/4</td>
<td>1.4</td>
<td>post</td>
<td>positive photosresist, alkaline-stable up to pH 13</td>
<td>1</td>
<td>2</td>
<td>i-line, g-line</td>
<td>300-12</td>
<td>300-26</td>
<td>600-70</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>
<td>600-70</td>
</tr>
</tbody>
</table>

## Market-ready experimental samples

### SX AR-P 3500/6

| SX AR-P 3500/6 | 2.0   | post | positive photosresist for holography (488 nm) | 1              | 3       | i-line, g-line, BB-UV | 300-12 | 300-47    | 600-70  | 300-76  |

### SX AR-P 3500/8

| SX AR-P 3500/8 | 1.4   | post | positive photosresist up to 300 °C | 1              | 3       | i-line, g-line, BB-UV | 300-12 | 300-47    | 600-70  | 300-76  |

### SX AR-P 3740/4

| SX AR-P 3740/4 | 1.4   | post | positive photosresist, highly process-stable, high contrast | 0.6            | 5       | i-line, g-line, BB-UV | 300-12 | 300-475   | 600-70  | 300-76  |

### SX AR-N 4340/7

| SX AR-N 4340/7 | 1.4   | neg  | temperature stable negative resist up to 270 °C (1/-2L-system) | 0.5            | 5       | i-line, g-line | 300-12 | 300-47    | 300-76  | 600-71  |

### SX AR-PC 5000/40

| SX AR-PC 5000/40 | 5.0   | -    | protective coating 40% KOH- and 50% HF-resistant | 1 L: -          | 1 L: -  | i-line, g-line, BB-UV | 300-74/1 | 300-26    | 300-74/1 | 300-76 |

### SX AR-PC 5000/80.2

| SX AR-PC 5000/80.2 | 0.4   | -    | polyimide photosresist, protective coating for 2 L-patterning | 1 L: -          | 1 L: -  | i-line, g-line, BB-UV | 300-12/3 | -        | 600-70  | 300-76  |

### SX AR-PC 5000/82.7

| SX AR-PC 5000/82.7 | 0.8   | -    | polyimide photosresist, structurable and temperature-stable | 1.5            | 2       | i-line | 300-12/3 | 300-26    | 300-47    | 300-76  | 300-72  |

### SX AR-N 7530 new

| SX AR-N 7530 new | 0.1   | neg  | white light e-beam resist like AR-N 7520 | 0.03           | 8       | e-beam, deep UV | 300-12 | 300-47    | 600-71  |        |

### SX AR-N 7730 new

| SX AR-N 7730 new | 0.8   | neg  | white light e-beam resist like AR-N 7700 | 0.08           | < 1.0   | e-beam, deep UV | 300-12 | 300-47    | 300-76  |        |

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

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Authors: Matthias and Brigitte Schirmer
assisted by Dr. Christian Kaiser
Layout: Ulrike Dorothea Schirmer
Translation: S.K. Hemschemeier

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