PRODUCTION AND SPECIFICATIONS OF FUSED QUARTZ WAFERS

While quartz designates the crystalline form of SiO$_2$, fused quartz (also called “fused silica”) is the amorphous phase of quartz. The chemical formula is also SiO$_2$, but fused silica lacks the long-range crystalline order. While the optical transmission range and the maximum application temperature are somewhat lower than with crystalline quartz, the shape stability of fused silica is significantly better with temperature fluctuations due to its very low thermal expansion coefficient.

Production of Fused Silica Wafers

Manufacture of Fused Silica
A method for producing fused silica wafers is the melting and subsequent re-solidifying of ultra-pure quartz. Synthetic fused silica is made from gases such as SiCl$_4$ which is oxidized in a H$_2$ + O$_2$ atmosphere. The SiO$_2$ dust formed hereby is fused to silica on a substrate. This technique results in an improved optical transmission in the deep ultraviolet.

Production of Wafers
The fused silica blocks are cut into wafers, and the wafers finally polished. The technical procedures here correspond to the production of silicon or quartz wafers.

Specifications of Fused Silica Wafers

JGS1 (Ultraviolet Grade Fused Silica)
These wafers show a high transparency in the ultraviolet spectral range. The transmission in the VIS and UV (down to approx. 215 nm) is approx. 90 % (only reflection losses) and drops down to 0 % in the spectral range between 215 and 150 nm.

In the infrared range, the comparable high OH-concentration of typically 1000 ppm causes absorption bands for wavelengths >1.2 μm.

JGS2 (Optical Grade Fused Silica)
As compared with JGS1 wafers, the transmission range of significantly cheaper JGS2 wafers is shifted towards longer wavelengths: UV-absorption already starts below approx. 270 nm wavelength, while in the VIS and IR the transmission is approx. 90 % up to approx. 2 μm wavelength due to the lower OH-concentration (typ. <300 ppm).

JGS3 (Full Spectrum Fused Silica)
These wafers which are expensive even when compared with JGS1 show a very low OH-content (typ. < 10 ppm) with a high transparency of >80 % over a broad spectral range of approx. 200 nm - 3 μm, and approx. 90 % in the wavelength range 250 - 2.5 μm.

Surfaces
Usually, fused silica wafers are double-side polished. Single-side polishing possible on request. The roughness of the polished side(s) is typically <1 nm, a value of < 0.5 nm which almost corresponds to atomic smoothness is also technically feasible.
### Our Photoresists: Application Areas and Compatibilities

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<td>Improved adhesion for wet etching, no focus on steep resist sidewalls</td>
<td>AZ® 1500</td>
<td>AZ® 1505</td>
<td>= 0.5 µm</td>
<td>AZ® 351B, AZ® 326 MIF, AZ® 726 MIF, AZ® 626 MIF</td>
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<td>Spray coating</td>
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<td>AZ® P4110</td>
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<td>AZ® 4999</td>
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<td>1 - 15 µm</td>
<td>AZ® 400K, AZ® 326 MIF, AZ® 726 MIF, AZ® 826 MIF</td>
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<td>Positive (chem. amplified) Steep resist sidewalls, high resolution and aspect ratio for e.g. dry etching or plating</td>
<td>AZ® ECI 3000</td>
<td>AZ® ECI 3007</td>
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<td>AZ® 351B, AZ® 326 MIF, AZ® 726 MIF, AZ® 626 MIF Developer</td>
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<td>Elevated thermal softening point and high resolution for e.g. dry etching</td>
<td>AZ® 9200</td>
<td>AZ® 9245</td>
<td>3 - 6 µm</td>
<td>AZ® 400K, AZ® 326 MIF, AZ® 726 MIF</td>
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<td>AZ® 9260</td>
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<td>AZ® 971 MR (14 cPs)</td>
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<td>AZ® 971 MR (29 cPs)</td>
<td>AZ® 971 MR (29 cPs)</td>
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<td>Positive (chem. amplified) Steep resist sidewalls, high resolution and aspect ratio for e.g. dry etching or plating</td>
<td>AZ® XT</td>
<td>AZ® 12 XT-20PL-05</td>
<td>3 - 5 µm</td>
<td>AZ® 400K, AZ® 326 MIF, AZ® 726 MIF</td>
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<td>AZ® 40 XT</td>
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<td>AZ® IPS 6050</td>
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<td>20 - 100 µm</td>
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<tr>
<td>Image Reversal Elevated thermal softening point and undercut for lift-off applications</td>
<td>AZ® 5200</td>
<td>AZ® 5209</td>
<td>1 µm</td>
<td>AZ® 351B, AZ® 326 MIF, AZ® 726 MIF</td>
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<td>T1 35ESX</td>
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<td>T1 xLift-X</td>
<td>T1 xLift-X</td>
<td>4 - 8 µm</td>
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<td>Negative resist sidewalls in combination with no thermal softening for lift-off application</td>
<td>AZ® nLOF 2000</td>
<td>AZ® nLOF 2020</td>
<td>1.5 - 3 µm</td>
<td>AZ® 326 MIF, AZ® 726 MIF, AZ® 826 MIF</td>
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<td>AZ® nLOF 2070</td>
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<td></td>
<td>AZ® nLOF 5510</td>
<td>AZ® nLOF 5510</td>
<td>0.7 - 1.5 µm</td>
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<tr>
<td>Improved adhesion, steep resist sidewalls and high aspect ratios for e.g. dry etching or plating</td>
<td>AZ® nXT</td>
<td>AZ® 15 nXT (115 cPs)</td>
<td>2 - 3 µm</td>
<td>AZ® 326 MIF, AZ® 726 MIF, AZ® 826 MIF</td>
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<td>AZ® 15 nXT (450 cPs)</td>
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<td>AZ® 125 nXT</td>
<td>AZ® 125 nXT</td>
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</table>

### Our Developers: Application Areas and Compatibilities

#### Inorganic Developers

- **AZ® Developer** is based on sodium phosphate and –metasilicate, is optimized for minimal aluminum attack and is typically used diluted 1 : 1 in DI water for high contrast or undiluted for high development rates. The dark erosion of this developer is slightly higher compared to other developers.
- **AZ® 351B** is based on buffered NaOH and typically used diluted 1 : 4 with water, for thick resist up to 1 : 3 if a lower contrast can be tolerated.
- **AZ® 400K** is based on buffered KOH and typically used diluted 1 : 4 with water, for thick resist up to 1 : 3 if a lower contrast can be tolerated.
- **AZ® 303** specifically for the AZ® 111 XFS photoresist based on KOH / NaOH is typically diluted 1 : 3 - 1 : 7 with water, depending on whether a high development rate, or a high contrast is required.

#### Metal Ion Free (TMAH-based) Developers

- **AZ® 326 MIF** is 2.38 % TMAH- (TetraMethylAmmoniumHydroxide) in water.

### Note

1. In general, all resist developers can be used for almost any application. However, the special properties of each resist family can only be achieved or maintained with the designated developer under standard conditions. Some resists can be diluted for lower throughput and for lift-off applications.
2. Metal ion free (MIF) developers are significantly more expensive, and therefore recommended if metal ion free development is required.

### Developer Selection

- **TechniStrip® P1316**
- **TechniStrip® P1331**
- **TechniStrip® P100 Remover**
- **TechniStrip® P1316**

### Additional Resources

- **TechniStrip® Micro D2**
- **TechniStrip® NF52**
- **TechniStrip® MLO 07**
- **TechniStrip® N555**
- **TechniStrip® MLO 07**
- **TechniStrip® MLO 07**
Our frequently updated wafer stock list can be found here:

Our Silicon-, Quartz-, Fused Silica and Glass Wafers

Silicon wafers usually come as "Prime-grade" or "Test-grade", latter mainly have a slightly broader particle specification. "Dummy-Wafers" neither fulfill Prime- nor Test-grade for different possible reasons (e.g. very broad or missing Prime-, Test-, and Dummy Wafers). beside the crystal orientation (<100> or <111>) the doping (n- or p-type) as well as the resistivity (Ohm cm) are selection criteria.

Silicon-, Quartz-, Fused Silica and Glass Wafers

Our Wafers and their Specifications

Silicon-, Quartz-, Fused Silica and Glass Wafers

Silicon wafers are either produced via the Czochralski- (CZ-) or Float zone- (FZ-) method. The more expensive FZ wafers are primarily reasonable if very high-ohmic wafers (> 100 Ohm cm) are required. Quartz wafers are made of monocristalline SiO₂, main criterion is the crystal orientation (e. g. X-, Y-, Z-, AT- or ST-cut)

Fused silica wafers consist of amorphous SiO₂. The so-called JGS2 wafers have a high transmission in the range of ≈ 280 - 2000 nm wavelength, the more expensive JGS1 wafers at ≈ 220 - 1100 nm.

Our glass wafers, if not otherwise specified, are made of borosilicate glass.

Specifications

Common parameters for all wafers are diameter, thickness and surface (1- or 2-side polished). Fused silica wafers are made either of JGS1 or JGS2 material, for quartz wafers the crystal orientation needs to be defined. For silicon wafers, beside the crystal orientation (<100> or <111>) the doping (n- or p-type) as well as the resistivity (Ohm cm) are selection criteria.

Prime-, Test-, and Dummy Wafers

Silicon wafers usually come as „Prime-grade“ or „Test-grade“, latter mainly have a slightly broader particle specification. „Dummy-Wafers“ neither fulfill Prime- nor Test-grade for different possible reasons (e. g. very broad or missing specification of one or several parameters, reclaim wafers, no particle specification) but might be a cheap alternative for e. g. resist coating tests or equipment start-up.

Our Silicon-, Quartz-, Fused silica and Glass Wafers

Our frequently updated wafer stock list can be found here:

Further Products from our Portfolio

Plating

Plating solutions for e.g. gold, copper, nickel, tin or palladium:

Solvents (MOS, VLSI, ULSI)

Acetone, isopropyl alcohol, MEK, DMSO, cyclopentanone, butylacetate, ...

Acids and Bases (MOS, VLSI, ULSI)

Hydrochloric acid, sulphuric acid, nitric acid, KOH, TMAH, ...

Etching Mixtures

for e. g. chromium, gold, silicon, copper, titanium, ...

AZ® 726 MIF is 2.38 % TMAH- (TetraMethylAmmoniumHydroxide) in water, with additional surfactants for rapid and uniform wetting of the substrate (e. g. for puddle development)

AZ® 826 MIF is 2.38 % TMAH- (TetraMethylAmmoniumHydroxide) in water, with additional surfactants for rapid and uniform wetting of the substrate (e. g. for puddle development) and other additives for the removal of poorly soluble resist components (residues with specific resist families), however at the expense of a slightly higher dark erosion.

Our Removers: Application Areas and Compatibilities

AZ® 100 Remover is an amine solvent mixture and standard remover for AZ® and TI photoresists. To improve its performance, AZ® 100 remover can be heated to 60 - 80°C. Because the AZ® 100 Remover reacts highly alkaline with water, it is suitable for this with respect to sensitive substrate materials such as Cu, Al or ITO only if contamination with water can be ruled out.

TechniStrip® P1316 is a remover with very strong stripping power for Novolak-based resists (including all AZ® positive resists), epoxy-based coatings, polyimides and dry films. At typical application temperatures around 75°C, TechniStrip® P1316 may dissolve cross-linked resists without residue also, e.g. through dry etching or ion implantation. TechniStrip® P1316 can also be used in spraying processes. For alkaline sensitive materials, TechniStrip® P1313 would be an alternative to the P1316. Nicht kompatibel mit Au oder GaAs.

TechniStrip® P1331 can be an alternative for TechniStrip® P1316 in case of alkaline sensitive materials. TechniStrip® P1331 is not compatible with Au or GaAs.

TechniStrip® NIS55 is a stripper with very strong dissolving power for Novolak-based negative resists such as the AZ® 15 nXT and AZ® nLOF 2000 series and very thick positive resists such as the AZ® 40 XT. TechniStrip® NIS55 was developed not only to peel cross-linked resists, but also to dissolve them without residues. This prevents contamination of the basin and filter by resist particles and skins, as can occur with standard strippers. TechniStrip® NIS55 is not compatible with Au or GaAs.

TechniClean™ CA25 is a semi-aqueous proprietary blend formulated to address post etch residue (PER) removal for all interconnect and technology nodes. Extremely efficient at quickly and selectively removing organo-metal oxides from Al, Cu, Ti, TiN, W and Ni.

TechniStrip™ NFS2 is a highly effective remover for negative resists (liquid resists as well as dry films). The intrinsic nature of the additives and solvent make the blend totally compatible with metals used throughout the BEOL interconnects to WLP bumping applications.

TechniStrip™ Micro D2 is a versatile stripper dedicated to address resin lift-off and dissolution on negative and positive tone resist. The organic mixture blend has the particularity to offer high metal and material compatibility allowing to be used on all stacks and particularly on fragile III/V substrates for instance.

TechniStrip™ MLO 07 is a highly efficient positive and negative tone photoresist remover used for IR, III/V, MEMS, Photonic, TSV mask, solder bumping and hard disk stripping applications. Developed to address high dissolution performance and high material compatibility on Cu, Al, Sn/Ag, Alumina and common organic substrates.

AZ® 280 MIF is a 2.38% TMAH- (TetraMethylAmmoniumHydroxide) in water, with additional surfactants for rapid and uniform wetting of the substrate (e. g. for puddle development)
Further Information


Our Photolithography Book and -Posters

We see it as our main task to make you understand all aspects of microstructuring in an application-oriented way. At present, we have implemented this claim with our book *Photolithography* on over 200 pages, as well as attractively designed DIN A0 posters for your office or laboratory.

We will gladly send both of these to you free of charge as our customer (if applicable, we charge shipping costs for non-European deliveries):

www.microchemicals.com/downloads/brochures.html
www.microchemicals.com/downloads/posters.html

Thank you for your interest!

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The safe sequence of mixing components of a recipe usually does not correspond to the order of their listing. We do not warrant the full disclosure of any indications (among other things, health, work safety) of the risks associated with the preparation and use of the recipes and processes. The information in this book is based on our current knowledge and experience. Due to the abundance of possible influences in the processing and application of our products, they do not exempt the user from their own tests and trials. A guarantee of certain properties or suitability for a specific application cannot be derived from our data. As a matter of principle, each employee is required to provide sufficient information in advance in the appropriate cases in order to prevent damage to persons and equipment. All descriptions, illustrations, data, conditions, weights, etc. can be changed without prior notice and do not constitute a contractually agreed product characteristics. The user of our products is responsible for any proprietary rights and existing laws.

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