

## PRODUCTION AND SPECIFICATIONS OF FUSED QUARTZ WAFERS

While quartz designates the crystalline form of  $\text{SiO}_2$ , fused quartz (also called "fused silica") is the amorphous phase of quartz. The chemical formula is also  $\text{SiO}_2$ , 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  $\text{SiCl}_4$  which is oxidized in a  $\text{H}_2 + \text{O}_2$  atmosphere. The  $\text{SiO}_2$  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  $> 1.2 \mu\text{m}$ .

#### 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.  $2 \mu\text{m}$  wavelength due to the lower OH-concentration (typ.  $< 300 \text{ ppm}$ ).

#### JGS3 (Full Spectrum Fused Silica)

These wafers which are expensive even when compared with JGS1 show a very low OH-content (typ.  $< 10 \text{ ppm}$ ) with a high transparency of  $> 80 \%$  over a broad spectral range of approx. 200 nm -  $3 \mu\text{m}$ , and approx. 90 % in the wavelength range 250 -  $2.5 \mu\text{m}$ .

#### Surfaces

Usually, fused silica wafers are double-side polished. Single-side polishing possible on request. The roughness of the polished side(s) is typically  $< 1 \text{ nm}$ , a value of  $< 0.5 \text{ nm}$  which almost corresponds to atomic smoothness is also technically feasible.

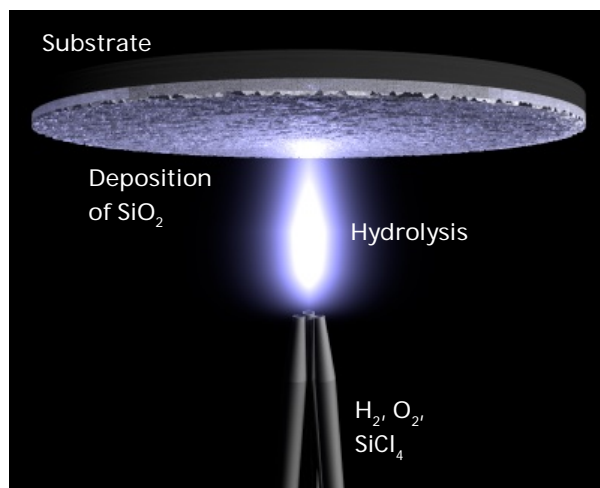


Fig. 36: Diagram of the separation of quartz from the gases  $\text{H}_2\text{O}_2$  and  $\text{SiCl}_4$

## Our Photoresists: Application Areas and Compatibilities

Recommended Applications <sup>1</sup>		Resist Family	Photoresists	Resist Film Thickness <sup>2</sup>	Recommended Developers <sup>3</sup>	Recommended Removers <sup>4</sup>
Positive	Improved adhesion for wet etching, no focus on steep resist sidewalls	AZ <sup>®</sup> 1500	AZ <sup>®</sup> 1505 AZ <sup>®</sup> 1512 HS AZ <sup>®</sup> 1514 H AZ <sup>®</sup> 1518	≈ 0.5 µm ≈ 1.0 - 1.5 µm ≈ 1.2 - 2.0 µm ≈ 1.5 - 2.5 µm	AZ <sup>®</sup> 351B, AZ <sup>®</sup> 326 MIF, AZ <sup>®</sup> 726 MIF, AZ <sup>®</sup> Developer	AZ <sup>®</sup> 100 Remover, TechniStrip <sup>®</sup> P1316 TechniStrip <sup>®</sup> P1331
			AZ <sup>®</sup> 4533 AZ <sup>®</sup> 4562	≈ 3 - 5 µm ≈ 5 - 10 µm	AZ <sup>®</sup> 400K, AZ <sup>®</sup> 326 MIF, AZ <sup>®</sup> 726 MIF, AZ <sup>®</sup> 826 MIF	
			AZ <sup>®</sup> P4110 AZ <sup>®</sup> P4330 AZ <sup>®</sup> P4620 AZ <sup>®</sup> P4903	≈ 1 - 2 µm ≈ 3 - 5 µm ≈ 6 - 20 µm ≈ 10 - 30 µm	AZ <sup>®</sup> 400K, AZ <sup>®</sup> 326 MIF, AZ <sup>®</sup> 726 MIF, AZ <sup>®</sup> 826 MIF	
			AZ <sup>®</sup> PL 177	AZ <sup>®</sup> PL 177	≈ 3 - 8 µm	
	Spray coating	AZ <sup>®</sup> 4999		≈ 1 - 15 µm	AZ <sup>®</sup> 400K, AZ <sup>®</sup> 326 MIF, AZ <sup>®</sup> 726 MIF, AZ <sup>®</sup> 826 MIF	
	Dip coating	MC Dip Coating Resist		≈ 2 - 15 µm	AZ <sup>®</sup> 351B, AZ <sup>®</sup> 400K, AZ <sup>®</sup> 326 MIF, AZ <sup>®</sup> 726 MIF, AZ <sup>®</sup> 826 MIF	
	Steep resist sidewalls, high resolution and aspect ratio for e. g. dry etching or plating	AZ <sup>®</sup> ECI 3000	AZ <sup>®</sup> ECI 3007 AZ <sup>®</sup> ECI 3012 AZ <sup>®</sup> ECI 3027	≈ 0.7 µm ≈ 1.0 - 1.5 µm ≈ 2 - 4 µm	AZ <sup>®</sup> 351B, AZ <sup>®</sup> 326 MIF, AZ <sup>®</sup> 726 MIF, AZ <sup>®</sup> Developer	
			AZ <sup>®</sup> 9245 AZ <sup>®</sup> 9260	≈ 3 - 6 µm ≈ 5 - 20 µm	AZ <sup>®</sup> 400K, AZ <sup>®</sup> 326 MIF, AZ <sup>®</sup> 726 MIF	
Positive (chem. amplified)	Steep resist sidewalls, high resolution and aspect ratio for e. g. dry etching or plating	AZ <sup>®</sup> XT	AZ <sup>®</sup> 701 MiR (14 cPs) AZ <sup>®</sup> 701 MiR (29 cPs)	≈ 0.8 µm ≈ 2 - 3 µm	AZ <sup>®</sup> 351B, AZ <sup>®</sup> 326 MIF, AZ <sup>®</sup> 726 MIF, AZ <sup>®</sup> Developer	AZ <sup>®</sup> 100 Remover, TechniStrip <sup>®</sup> P1316 TechniStrip <sup>®</sup> P1331
			AZ <sup>®</sup> 12 XT-20PL-05 AZ <sup>®</sup> 12 XT-20PL-10 AZ <sup>®</sup> 12 XT-20PL-20 AZ <sup>®</sup> 40 XT	≈ 3 - 5 µm ≈ 6 - 10 µm ≈ 10 - 30 µm ≈ 15 - 50 µm	AZ <sup>®</sup> 400K, AZ <sup>®</sup> 326 MIF, AZ <sup>®</sup> 726 MIF	
Image Re-verseal	Elevated thermal softening point and undercut for lift-off applications	AZ <sup>®</sup> 5200	AZ <sup>®</sup> 5209 AZ <sup>®</sup> 5214	≈ 1 µm ≈ 1 - 2 µm	AZ <sup>®</sup> 351B, AZ <sup>®</sup> 326 MIF, AZ <sup>®</sup> 726 MIF	TechniStrip <sup>®</sup> Micro D2 TechniStrip <sup>®</sup> P1316 TechniStrip <sup>®</sup> P1331
		TI	TI 35ESX TI xLift-X	≈ 3 - 4 µm ≈ 4 - 8 µm		
Negative (Cross-linking)	Negative resist sidewalls in combination with no thermal softening for lift-off application	AZ <sup>®</sup> nLOF 2000	AZ <sup>®</sup> nLOF 2020 AZ <sup>®</sup> nLOF 2035 AZ <sup>®</sup> nLOF 2070	≈ 1.5 - 3 µm ≈ 3 - 5 µm ≈ 6 - 15 µm	AZ <sup>®</sup> 326 MIF, AZ <sup>®</sup> 726 MIF, AZ <sup>®</sup> 826 MIF	TechniStrip <sup>®</sup> NI555 TechniStrip <sup>®</sup> NF52 TechniStrip <sup>®</sup> MLO 07
		AZ <sup>®</sup> nLOF 5500	AZ <sup>®</sup> nLOF 5510	≈ 0.7 - 1.5 µm		
	Improved adhesion, steep resist sidewalls and high aspect ratios for e. g. dry etching or plating	AZ <sup>®</sup> nXT	AZ <sup>®</sup> 15 nXT (115 cPs) AZ <sup>®</sup> 15 nXT (450 cPs)	≈ 2 - 3 µm ≈ 5 - 20 µm	AZ <sup>®</sup> 326 MIF, AZ <sup>®</sup> 726 MIF, AZ <sup>®</sup> 826 MIF	TechniStrip <sup>®</sup> P1316 TechniStrip <sup>®</sup> P1331 TechniStrip <sup>®</sup> NF52 TechniStrip <sup>®</sup> MLO 07
			AZ <sup>®</sup> 125 nXT	≈ 20 - 100 µm	AZ <sup>®</sup> 326 MIF, AZ <sup>®</sup> 726 MIF, AZ <sup>®</sup> 826 MIF	

<sup>1</sup> In general, almost all resists can be used for almost any application. However, the special properties of each resist family makes them specially suited for certain fields of application.

<sup>2</sup> Resist film thickness achievable and processable with standard equipment under standard conditions. Some resists can be diluted for lower film thicknesses; with additional effort also thicker resist films can be achieved and processed.

<sup>3</sup> Metal ion free (MIF) developers are significantly more expensive, and reasonable if metal ion free development is required.

## Our Developers: Application Areas and Compatibilities

### Inorganic Developers

(typical demand under standard conditions approx. 20 L developer per L photoresist)

**AZ<sup>®</sup> 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<sup>®</sup> 351B** is based on buffered NaOH and typically used diluted 1 : 4 with water, for thick resists up to 1 : 3 if a lower contrast can be tolerated.

**AZ<sup>®</sup> 400K** is based on buffered KOH and typically used diluted 1 : 4 with water, for thick resists up to 1 : 3 if a lower contrast can be tolerated.

**AZ<sup>®</sup> 303** specifically for the AZ<sup>®</sup> 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

(typical demand under standard conditions approx. 5 - 10 L developer concentrate per L photoresist)

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

**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 T1 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® P1331 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® NI555** 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® NI555 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® NI555 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™ NF52** 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.

## 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 monocrystalline SiO<sub>2</sub>, main criterion is the crystal orientation (e. g. X-, Y-, Z-, AT- or ST-cut)

Fused silica wafers consist of amorphous SiO<sub>2</sub>. 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: [⇒ www.microchemicals.com/products/wafers/waferlist.html](http://www.microchemicals.com/products/wafers/waferlist.html)

## Further Products from our Portfolio

### Plating

Plating solutions for e. g. gold, copper, nickel, tin or palladium: [⇒ www.microchemicals.com/products/electroplating.html](http://www.microchemicals.com/products/electroplating.html)

### Solvents (MOS, VLSI, ULSI)

Acetone, isopropyl alcohol, MEK, DMSO, cyclopentanone, butylacetate, ... [⇒ www.microchemicals.com/products/solvents.html](http://www.microchemicals.com/products/solvents.html)

### Acids and Bases (MOS, VLSI, ULSI)

Hydrochloric acid, sulphuric acid, nitric acid, KOH, TMAH, ... [⇒ www.microchemicals.com/products/etchants.html](http://www.microchemicals.com/products/etchants.html)

### Etching Mixtures

for e. g. chromium, gold, silicon, copper, titanium, ... [⇒ www.microchemicals.com/products/etching\\_mixtures.html](http://www.microchemicals.com/products/etching_mixtures.html)

## Further Information

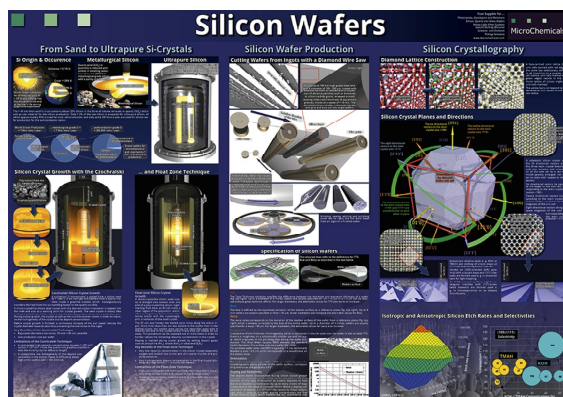
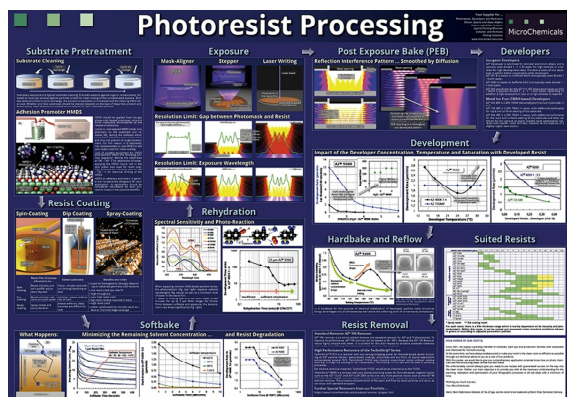
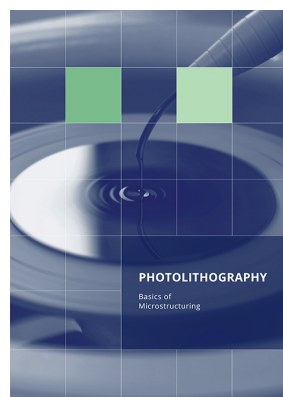
Technical Data Sheets:

[www.microchemicals.com/downloads/product\\_data\\_sheets/photosresists.html](http://www.microchemicals.com/downloads/product_data_sheets/photosresists.html)

Material Safety Data Sheets (MSDS):

[www.microchemicals.com/downloads/safety\\_data\\_sheets/msds\\_links.html](http://www.microchemicals.com/downloads/safety_data_sheets/msds_links.html)

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