

## PRODUCTION AND SPECIFICATIONS OF GLASS WAFERS

*For applications where neither the high dielectric strength of quartz nor the high transparency in the ultraviolet, visible or infrared spectral range or the thermal stability of quartz or quartz glass is required, borosilicate glass wafers are an inexpensive alternative.*

### Borosilicate Glass and Ordinary Glass in Comparison

#### Composition

Borosilicate glass consists of approximately 80% of silicon dioxide ( $\text{SiO}_2$ ) and approximately 5-15% boron trioxide ( $\text{B}_2\text{O}_3$ ). Other additives are alkaline oxide ( $\text{Na}_2\text{O}$ ,  $\text{K}_2\text{O}$ ), aluminium oxide ( $\text{Al}_2\text{O}_3$ ) and alkaline potassium oxide ( $\text{CaO}$ ,  $\text{MgO}$ ). Borosilicate glasses typically have a very low iron content, which causes the typical green colour of window glass in order to increase the transparency.

#### Properties

Due to its boron content, borosilicate glass exhibits a higher chemical stability against water, many chemicals and pharmaceutical products compared to window glass.

In addition, borosilicate glass exhibits significantly higher thermal stability against temperature fluctuations due to its thermal expansion coefficients, which are less than half as large as compared to window glass.

### Production of Glass Wafers

For the further processing into glass wafers, specific borosilicate glass is produced using the "float process" (Fig. 37). Hereby the molten glass on melted tin forms a floating both-side smooth ribbon with a homogeneous thickness.

On its way on the tin bath, the temperature is gradually reduced from 1100 down to 600°C until the sheet can be lifted onto rollers.



Fig. 37: The production of glass panes in the "float process" technique

After further cooling down the glass gradually to room temperature, so that it anneals without strain, the sheets are cut into the desired dimensions.

### Glass Wafer Specifications

#### Diameter and Dimensions

Available diameters are 2, 3, 4, 5, 6 and 8 inch, other diameters as well as rectangular wafer pieces on request.

#### Wafer Thicknesses and Surface

Standard thickness are 500, 700 and 1100  $\mu\text{m}$ . Other thickness on request. The surfaces can be one or double-side polished. The roughness of the polished side(s) is usually at  $< 1.5 \text{ nm}$ .

## Material Properties of Quartz, Fused Silica and Borosilicate Glass

	Quartz	Fused silica	Borosilicate glass
Composition	SiO <sub>2</sub> (100 %)	SiO <sub>2</sub> (100 %)	SiO <sub>2</sub> (approx. 80 %), B <sub>2</sub> O <sub>3</sub>
Density (g/cm <sup>3</sup> )	2.65	2.2	2.2
Mohs hardness	7	5.3 - 6.5	6.5
Melting point (quartz) or maximum working temperature (°C)	1670 / 1713*	1400	400 - 500
Refractive index (600 nm)	1.54	1.46	1.47
Spectral transmission range (µm)	0.15 - 4	0.17 - 3**	0.35 - 2
Thermal expansion coefficient (10 <sup>-6</sup> / K)	8 - 13***	0.54	3
Heat conductivity (W/mK)	6 - 12****	1.38	1.2
Dielectric strength (kV/mm)	> 1000	40	30

Table 2: Several Material Properties of Quartz, Fused Silica and Borosilicate Glass

\* At these temperatures, quartz has already transformed in (1670°C) tridymite or cristobalite (1713°C)

\*\* Transmission range for JGS1, JGS2 and JGS3 material

\*\*\* Anisotropic, depending on the direction of crystal

\*\*\* Anisotropic, depending on the direction of crystal

## 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 Re-movers <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 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® 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 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

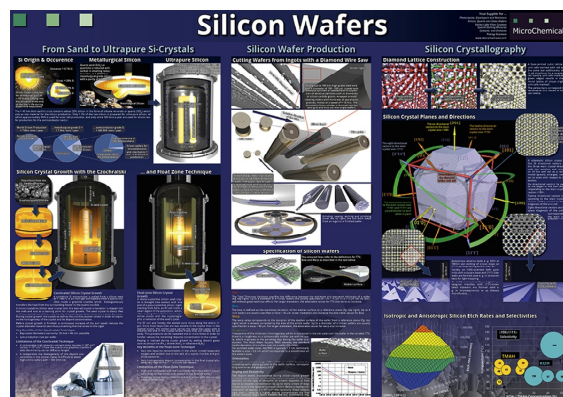
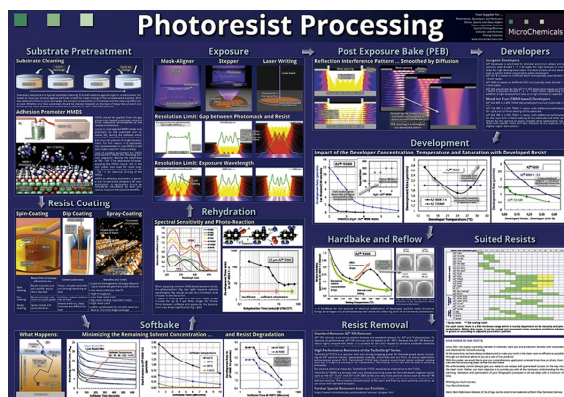
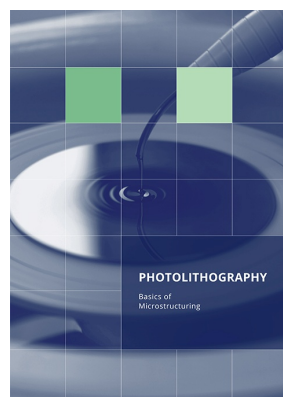
Technical Data Sheets:

[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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