

## TSC Material Grades

### Applications

Semiconductor, solar, LED and flat panel display applications.

### Characteristics

High purity quartz solid and hollow material with low bubble content.

### TSC Grades

TSC ingots are made with the highest quality natural quartz powders that have been purified using Heraeus' proprietary refining process.

These purified powders are then fused using Heraeus' continuous flame fusion process resulting in a consistent, high purity material that has very few bubbles and inclusions.

Specializing in "near-net-shape", TSC ingots are available in rectangular, round and hollow shapes to help reduce cost in volume applications. Furthermore, TSC is now available in extra large geometries and is ideally suited for the fabrication of large parts as found in flat panel display and atomic layer deposition systems.



**TSC-3®** is the standard semiconductor grade material, ideal for use in single wafer processing applications such as plasma etch and deposition systems.

**TSC-4** further reduces the risk of contamination by providing a lower Al and alkali metal content. TSC-4 has been designed for the most demanding semiconductor applications.

### Available dimensions

The TSC Series is readily available in large sizes of up to 570 mm x 2200 mm.

Extra large ingots, in sizes from 600 mm to 1300 mm square, are available on request, please check for availability.

#### Rectangular Ingots (Length up to 2200 mm)

Thickness (mm)	200			
	160			
	120			
Width (mm)	450	540	1300	

#### Hollow Ingots

	mm
OD	Up to 670
OD tolerance	+4 / -0
Wall thickness	≥ 20

#### Round Ingots

Length (mm)	2100				
	1600				
	210				
	160				
	120				
Diameter (mm)	310	350	420	540	670

### Chemical purity – typical trace elements and OH content in quartz glass (ppm by weight oxide)

Elements	Al	Ca	Cr	Cu	Fe	K	Li	Mg	Mn	Na	Ti	Zr	OH
TSC-3®	15	0.4	< 0.01	< 0.01	0.05	0.2	0.2	< 0.01	< 0.01	0.3	1.1	0.8	170
TSC-4	8	0.7	< 0.01	< 0.01	0.1	0.08	0.04	< 0.01	< 0.01	0.2	1.3	0.7	170

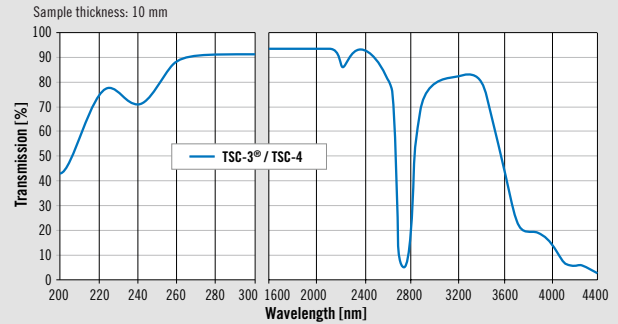
### Bubbles and inclusions

Heraeus' flame fusion process has been developed to ensure TSC materials have the lowest amount of bubbles and inclusion available in fused quartz materials.

Table showing typical combined bubble and inclusion counts per ft<sup>3</sup>

Grade	Bubble & Inclusion Diameter (mm)			
	< 0.3	0.3 ~ 0.5	0.5 ~ 1.0	> 1.0
TSC-3® & TSC-4	Not Specified	7	0	0

### Typical transmission spectrum (including Fresnel reflection losses)



### Technical properties TSC-3® / TSC-4

#### Mechanical data

Density (g/cm <sup>3</sup> )	2.2
Mohs hardness	5.5 ... 6.5
Micro hardness (N/mm <sup>2</sup> )	8600 ... 9800
Knoop hardness (N/mm <sup>2</sup> )	5800 ... 6100
Modulus of elasticity at 20 °C (N/mm <sup>2</sup> )	7.3 x 10 <sup>4</sup>
Modulus of torsion (N/mm <sup>2</sup> )	3.0 x 10 <sup>4</sup>
Poisson's ratio	0.16
Compressive strength (approx.) (N/mm <sup>2</sup> )	1110
Tensile strength (approx.) (N/mm <sup>2</sup> )	50
Bending strength (approx.) (N/mm <sup>2</sup> )	65
Torsional strength (approx.) (N/mm <sup>2</sup> )	30
Sound velocity (m/s)	5700

#### Thermal data

Softening temperature (°C)	1730
Annealing temperature (°C)	1200
Strain temperature (°C)	1080
Max. working temperature – continuous (°C)	1050
Max. working temperature – short term (°C)	1350

#### Mean specific heat (J/kg\*K)

0 ... 100 °C	772
0 ... 500 °C	964
0 ... 900 °C	1052

#### Heat conductivity (W/m\*K)

20 °C	1.38
100 °C	1.47
200 °C	1.55
300 °C	1.67
400 °C	1.84
950 °C	2.68

#### Mean expansion coefficient (K<sup>-1</sup>)

0 ... 100 °C	5.1 x 10 <sup>-7</sup>
0 ... 200 °C	5.8 x 10 <sup>-7</sup>
0 ... 300 °C	5.9 x 10 <sup>-7</sup>
0 ... 600 °C	5.4 x 10 <sup>-7</sup>
0 ... 900 °C	4.8 x 10 <sup>-7</sup>
-50 ... 0 °C	2.7 x 10 <sup>-7</sup>

### Electrical data TSC-3® / TSC-4

#### Electrical resistivity (Ω\*m)

20 °C	10 <sup>16</sup>
400 °C	10 <sup>10</sup>
800 °C	6.3 x 10 <sup>6</sup>
1200 °C	1.3 x 10 <sup>3</sup>

#### Dielectric strength (kV/mm) [sample thickness ≥ 5 mm]

20 °C	25 ... 40
500 °C	4 ... 5

#### Dielectric loss angle (tg δ)

1 kHz	5.0 x 10 <sup>-4</sup>
1 MHz	1.0 x 10 <sup>-4</sup>
3 x 10 <sup>10</sup> Hz	4.0 x 10 <sup>-4</sup>

#### Dielectric constant (ε)

20 °C	0 ... 10 <sup>6</sup> Hz	3.70
23 °C	9 ... 10 <sup>6</sup> Hz	3.77
23 °C	3 ... 10 <sup>10</sup> Hz	3.81

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