



We are committed to the supply of all types of substrate wafers to the microelectronics industry

Single Quartz Materials

Hydrothermal Growth of Quartz:

1. The autoclave is filled to some predetermined factor with water plus mineralizer (NaOH or Na₂CO₃)
2. The baffle localizes the temperature gradient so that each zone is nearly isothermal.
3. The seeds are thin slices of (usually) Z-cut single crystals.
4. The nutrient consists of small (~2½ to 4 cm) pieces of single-crystal quartz ("lascas").
5. The temperatures and pressures are typically about 3500C and 800 to 2,000 atmospheres; T₂ - T₁ is typically 40C to 100C.
6. The nutrient dissolves slowly (30 to 260 days per run), diffuses to the growth zone, and deposits onto the seeds.



1. Physical properties of synthetic crystal quartz

Density, g/cm ³	2.65
Melting point, °C	1467
Thermal conductivity, W/(m x K) (T = 25°C)	10.7 (parallel to axis Z) 6.2 (perpendicular to axis Z)
Thermal coefficient of linear expansion at temperature range 0-25°N, °C ⁻¹	7.1 ÷ 10 ⁻⁶ (parallel to axis Z) 13.2 ÷ 10 ⁻⁶ (perpendicular to axis Z)
Hardness (Mohs)	7
Specific heat capacity, J/(kg x K) (T = 25°C)	710
Dielectric constant at 30 MHz	4.34 (parallel to axis Z) 4.27 (perpendicular to axis Z)
Young's modulus (E), GPa	97.2 (parallel to axis Z) 76.5 (perpendicular to axis Z)
Shear modulus (G), GPa	31.14
Bulk modulus (K), GPa	36.4
Chemical stability	insoluble in water
Elastic coefficients	C11=87 C12=7 C44=58 C13=13 C14=18 C33=106

2. Synthetic crystal quartz refractive index vs wavelength

l, mm	n _o	n _e	l, mm	n _o	n _e	l, mm	n _o	n _e
0.185	1.676	1.69	0.243	1.605	1.617	0.589	1.544	1.553
0.194	1.66	1.673	0.263	1.593	1.604	1.083	1.534	1.543
0.204	1.643	1.656	0.291	1.581	1.591	1.8	1.524	1.532
0.219	1.625	1.637	0.34	1.567	1.577	2.5	1.512	1.52
0.231	1.614	1.626	0.405	1.557	1.567	3	1.5	1.507

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3. Quality evaluation of synthetic quartz crystal

- The amount of crystal defect and impurity in synthetic quartz crystal depends on growth rate, mineralizer and raw material. The growth rate affects greatly to the important properties such as infra-red absorption coefficient α which correlates to Q value, and frequency-temperature characteristics. The larger growth rate causes increase in α , decrease in Q value, and dispersion in frequency-temperature characteristics.
- The quality index of synthetic quartz crystal was originally a Q value, and a 5 MHz quartz crystal unit operated in 5th overtone mode was used to obtain the Q value. But it required laborious work to fabricate the 5 MHz crystal unit, so the index had been changed to the coefficient α instead of the Q value.

4. Standard specification for synthetic quartz crystal

- Twinning: There shall be no electrical or optical twinning in the usable region.
- Strain: There shall be no strain contained both inside and surface of seed crystal as well as in a grown quartz crystal.
- Cracks and fractures: There shall be no cracks, chippings or fractures in the usable region.
- Inclusion density: The specification is in accordance with the IEC 60758.

Size range	Qty per cm ³			
	10 to 30	30 to 70	70 to 100	>100
Grade (μm)				
Ia	2	1	0	0
Ib	3	2	1	1
I	6	4	2	2
II	9	5	4	3
III	12	8	6	4

- Infra-red quality indication: The specification is in accordance with the IEC 60758.

Grade	Max. α_{3585}	Estimated Q values (x 10 ⁶)
A	0.015	3.8
A	0.024	3
B	0.05	2.4
C	0.069	1.8
D	0.1	1.4

- Etch channel density: The specification is in accordance with the IEC 60758.

Grade	Max. number per cm ³
1	10
2	30
3	100
4	300
5	600

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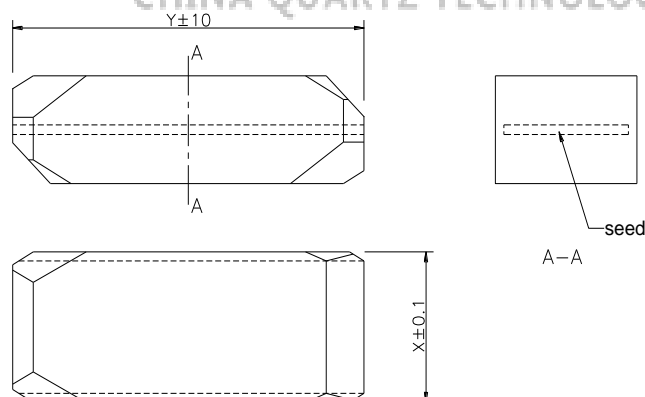


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5. Specification for lapped quartz crystal

- a) Angles:
 - i. Rotation angle of X-surface around Y-axis: $00^{\circ}00' \pm 15'$
 - ii. Rotation angle of X-surface around Z-axis: $00^{\circ}00' \pm 15'$
- b) Dimensional tolerance:
 - i. Along X or Z axis: ± 0.1 mm
 - ii. Along Y axis: ± 10 mm
- c) Surface roughness: as customized, lapped and polished are both available.



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