



ADVANCED XTAL PRODUCTS

Capabilities for Advanced Crystal Products LGS, LGT and CTGS

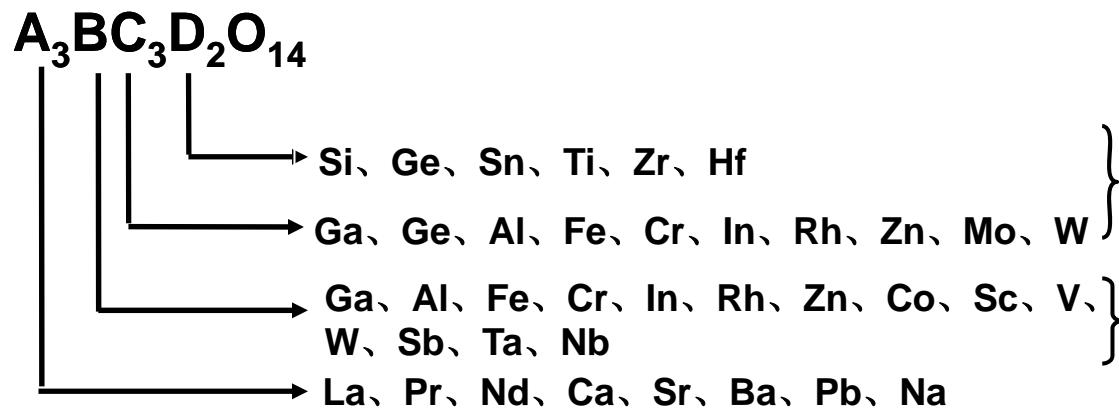
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Dipl.-Phys. Dipl.-Ing.



“Langasite Family”



- ✗ more than 100 isomorpheous variants with trigonal „32“ symmetry



- ✗ Examples:

- Langasite LGS ($\text{La}_3\text{Ga}_5\text{SiO}_{14}$)
- Langatate LGT ($\text{La}_3\text{Ga}_{5.5}\text{Ta}_{0.5}\text{O}_{14}$)
- Langanite LGN ($\text{La}_3\text{Ga}_{5.5}\text{Nb}_{0.5}\text{O}_{14}$)
- CTGS ($\text{Ca}_3\text{TaGa}_3\text{Si}_2\text{O}_{14}$)
- and ... BTGS, BSGS, SSAS, SNAS, STAS, CTAS, SNGS, STGS, CNGS



Target Markets & Applications



✖ Target Markets

- Process Control (Chemical Industry)
- Combustion Engines
- Aerospace (Turbines)
- Down hole (off-shore and terrestrial)

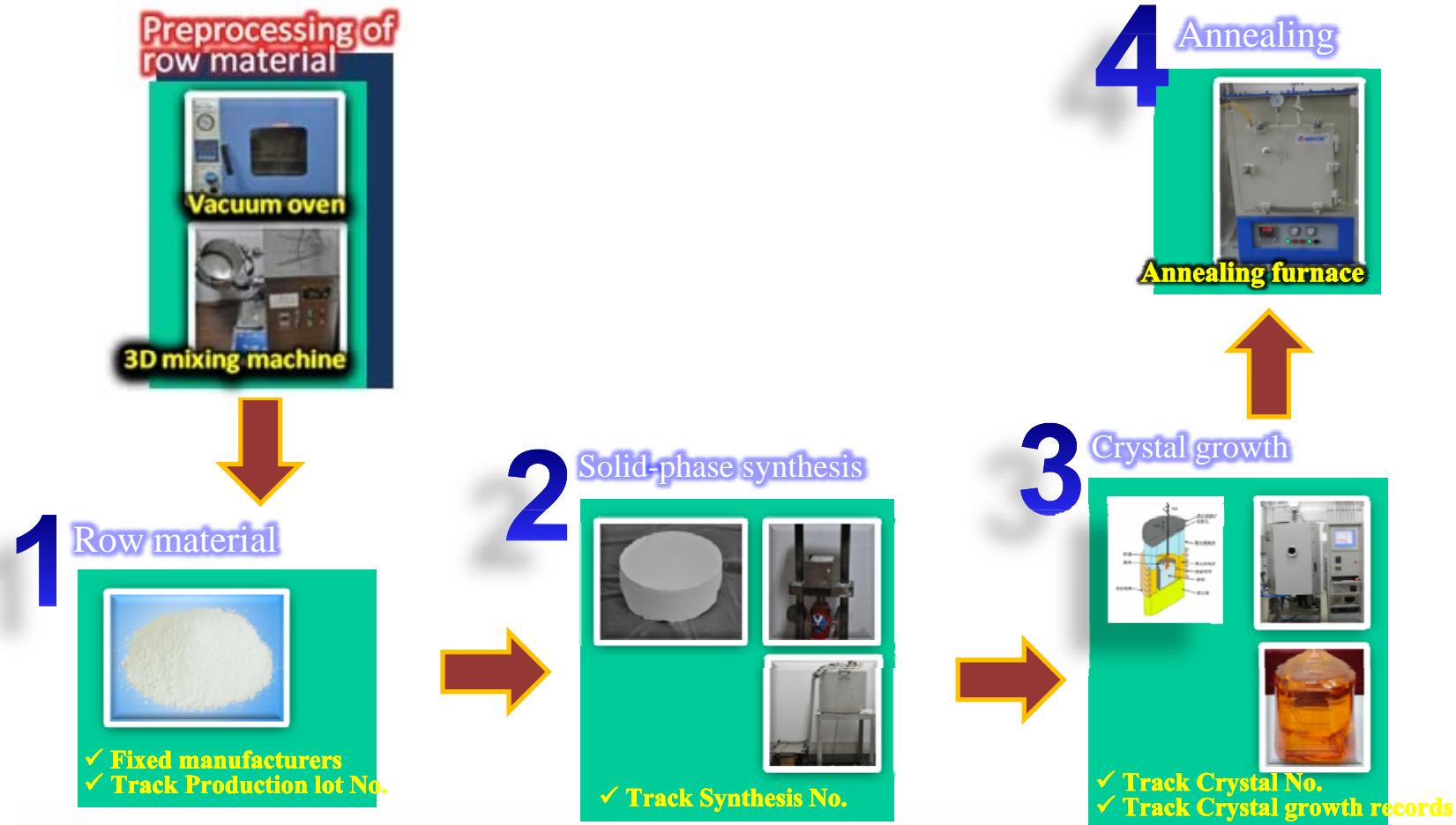
✖ Sensors for high temperatures (up to 900°C)

- Pressure
- Force
- Acceleration
- Mass („Q“CM)

✖ Frequency Control

- Wide-pull crystal oscillators
- Wideband Crystal Filters

Manufacturing Process



Pre-Processing



Compound mixing



Synthesis station



Crystal Growth

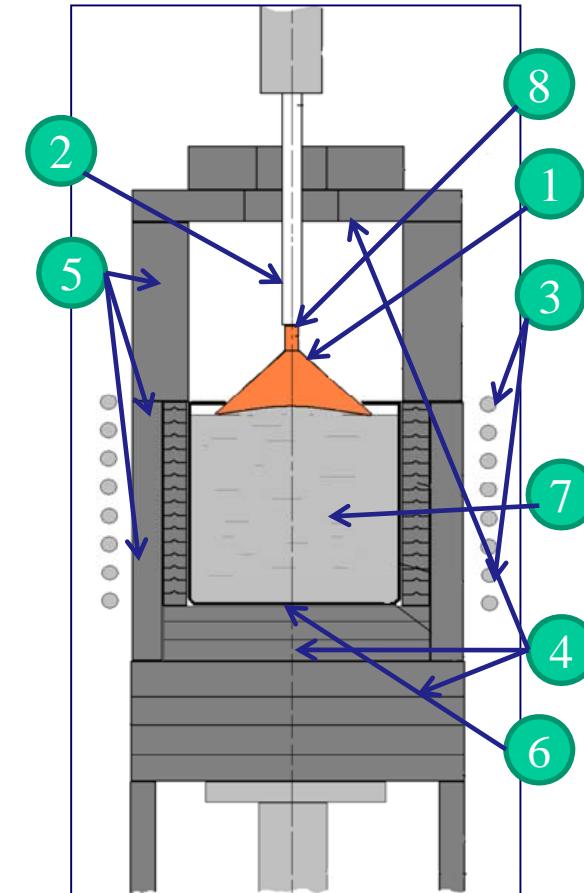


✗ Czochralsky method

- 1- crystal
- 2- seed holder
- 3- induction coil (RF heating, 8 kHz, 60 kW)
- 4- ceramic plates
- 5- ceramic tubes
- 6- crucible (diameter up to 200 mm)
- 7- melt
- 8- seed



- temperature up to 2100°C
- vacuum down to 10^{-5} Pa
- mass of grown crystal up to 16 kg

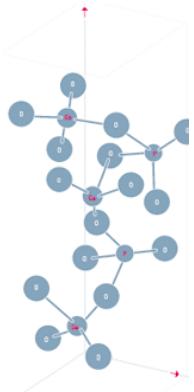


Czochralsky Furnaces



Czochralsky Furnaces



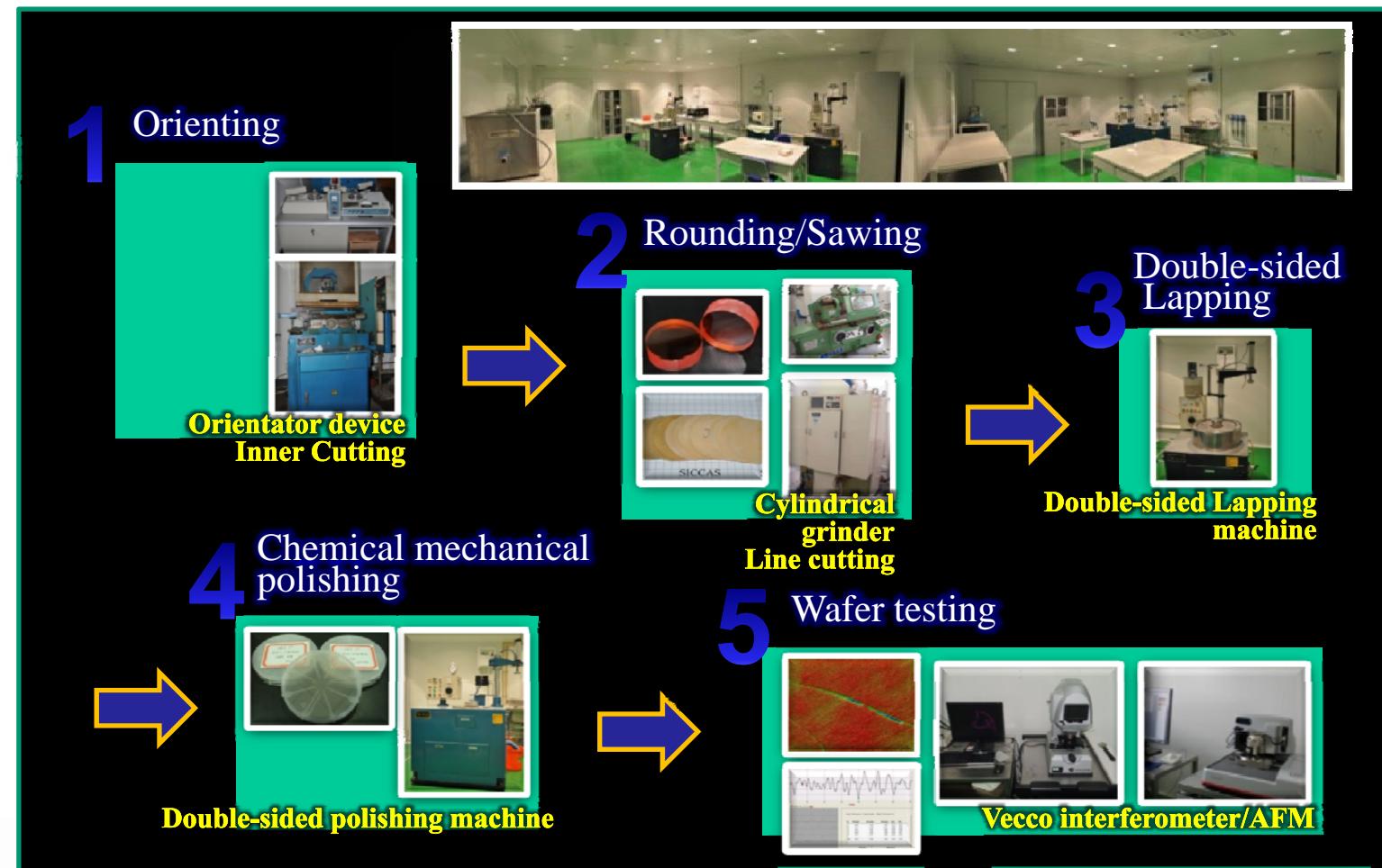


Growth of GaPO₄

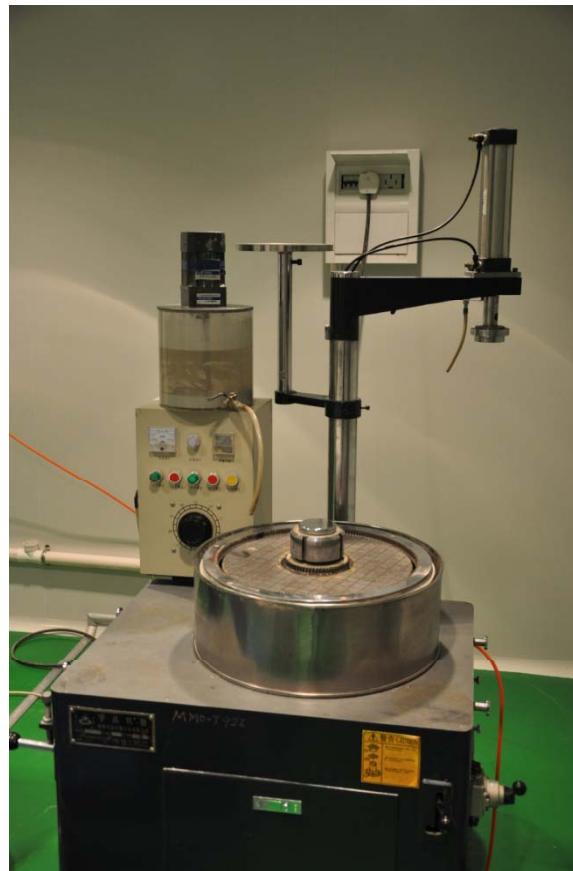
- ✗ growth: hydro- thermal epitaxy
 - pressure up to 20 MPa
 - temperature <250°C
 - very low growth rate
 - low yield
 - ◆ twinning
 - ◆ max. wafer size 20x20 mm
 - ◆ very expensive
 - Single source



Processing



Annealing, Lapping & Polishing



Principles of Piezo Sensors



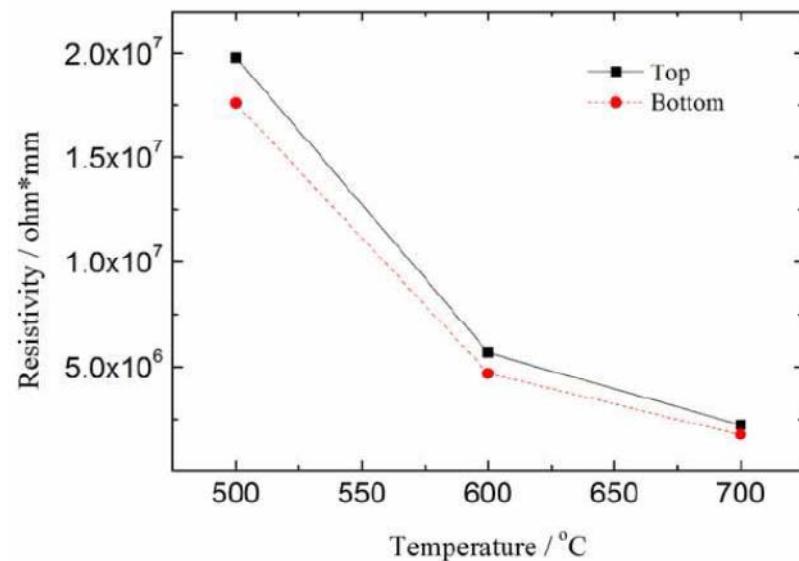
- ✖ Direct piezo-electric effect („piezo-static“)
 - Generation of electrical charge Q by pressure p : $Q = d_{ij} * p$
 - ◆ Most important parameters: d_{11} or d_{33} , R_{isol} = f (temperature)
 - ◆ Longitudinal, transversal or shear
 - ◆ Applications: pressure sensors, force sensors
- ✖ Resonant piezo sensors
 - Bulk-acoustic wave resonators (BAW)
 - ◆ Most important parameters: piezo-electric coupling factor k , s_{11} , resonance frequency f_r and resonance resistance R_r = f (temperature)
 - Surface-acoustic wave (SAW-) devices (resonators, filters, delay lines)
 - ◆ Most important parameters: piezo-electric coupling factor k , SAW velocity v_{ef} , (frequency f_r , and resistance R_r) = f (temperature)

“Piezo-Static” Sensors



✖ Isolation resistance

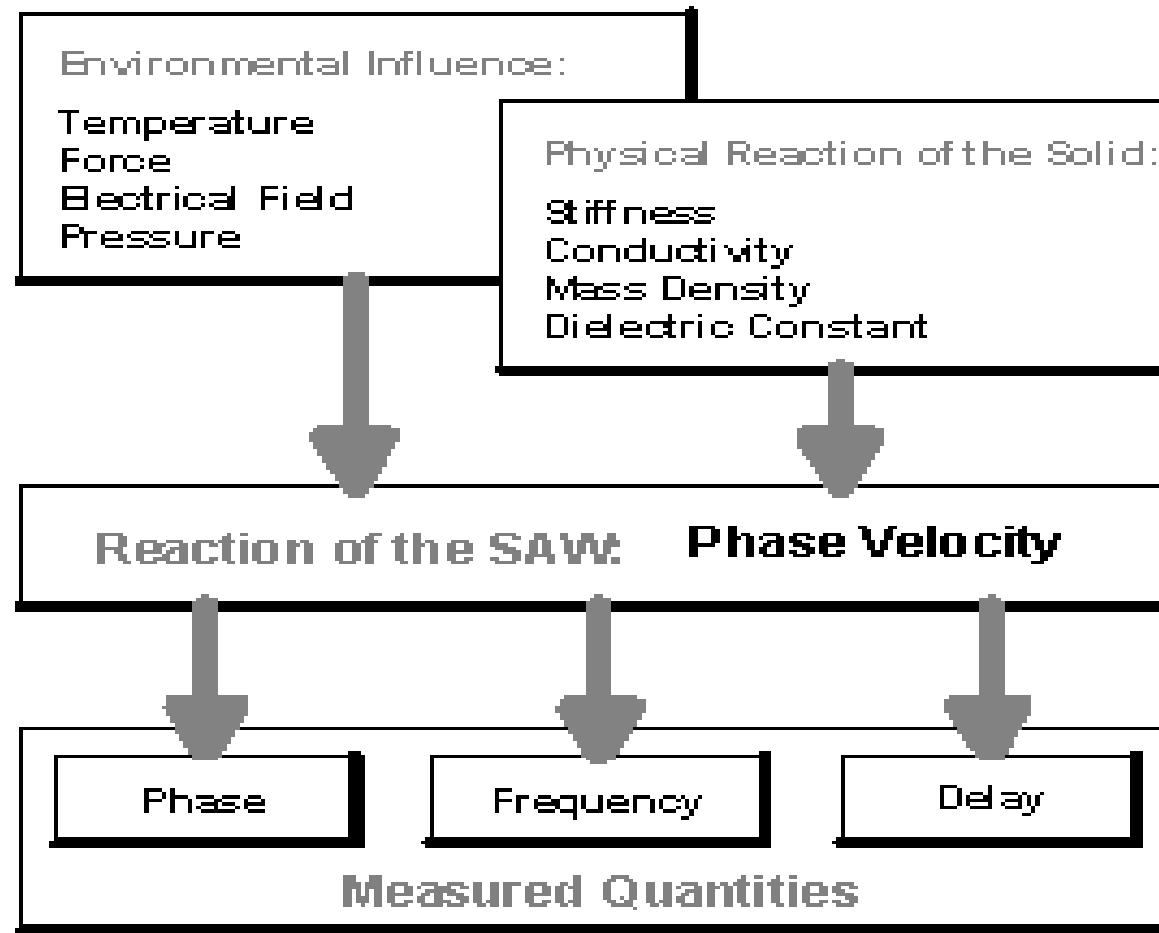
Langatate (LGT)



	CTGS	STGS	CTAS
600°C	4.10×10 ⁷	4.13×10 ⁷	1.72×10 ⁷
500°C	3.45×10 ⁸	2.79×10 ⁸	9.9×10 ⁷
400°C	5.54×10 ⁹	3.86×10 ⁹	1.0×10 ⁹
200°C	9.05×10 ¹¹	>1.5×10 ¹¹	1.6×10 ¹¹



Principles of SAW Sensors



Available Shapes



- ✗ Boules or Segments thereof
- ✗ Blocks
- ✗ Wafers
- ✗ Blanks & Plates (round and rectangular)
- ✗ Rings

Boules & Segments



✖ Langasite/Langatate

- Orientations
 - LGS: $<00.1>$, $<01.1>$ or $<11.0>$
 - LGT: $<01.1>$ or $<11.0>$
- Diameter
 - up 3" (LGT) or 4 " (LGS)
- Length
 - up to 100 mm ... 150 mm
- Weight: up to 10 kg/month

Langasite Crystals



Langasite crystals, grown along (00.1); (11.0) and (01.1) axis



(00.1) Ø 130 mm
7.5 kg



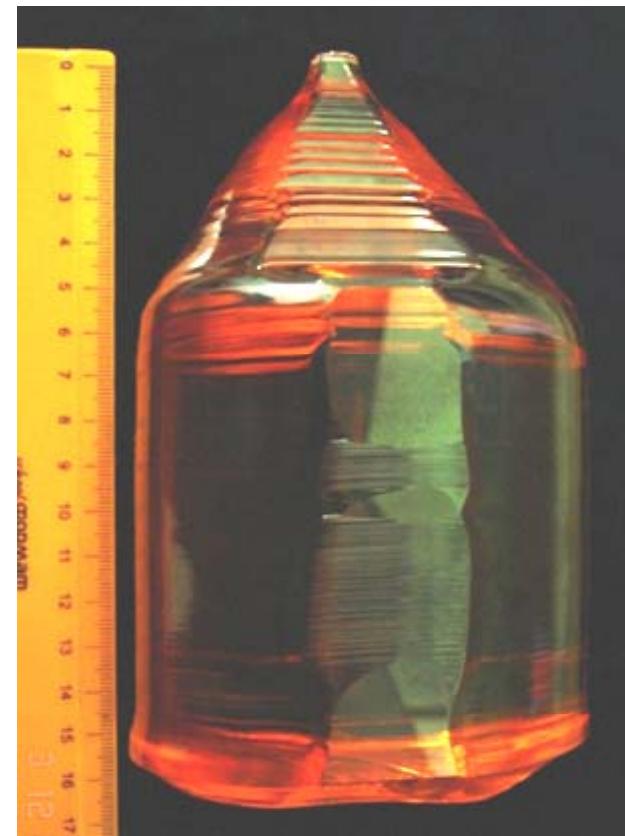
(11.0) 150 x 65 mm
6 kg



(01.1) Ø 130 mm
8.5 kg



As-grown Langatate crystal



- ✗ Along $<01.1>$, $<11.0>$ axis
- ✗ Diameter – up to 77(100) mm
- ✗ Length – up to 100 mm
- ✗ Mass – up to 5 kg

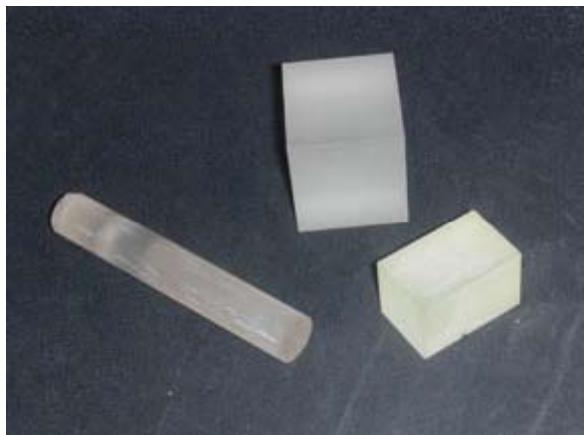
Boules & Segments



✗ CTGS

- Orientations
 $<00.1>$, $<01.1>$ or $<11.0>$
- Diameter
2" (3 " ~ 4" from 2014)
- Size of segments: 320 cm³
(4 slices of 40x50x40 mm)
- Weight: up to 2 kg/month

LGS & LGT Blocks

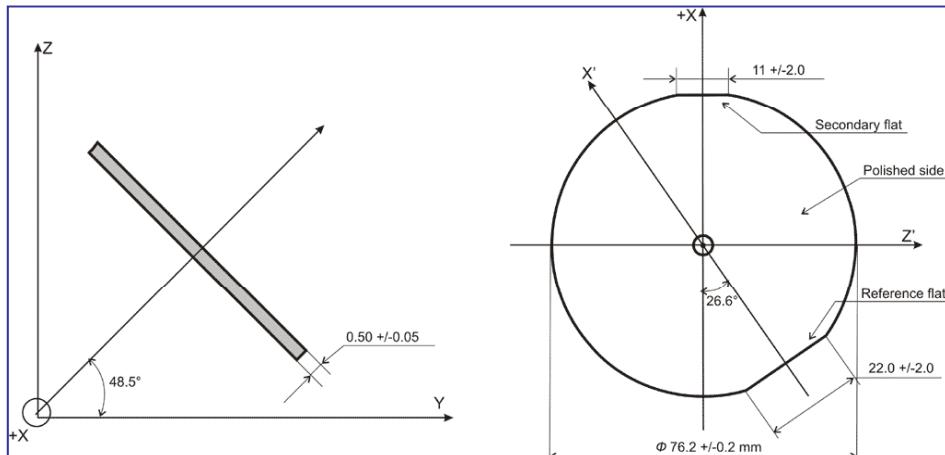
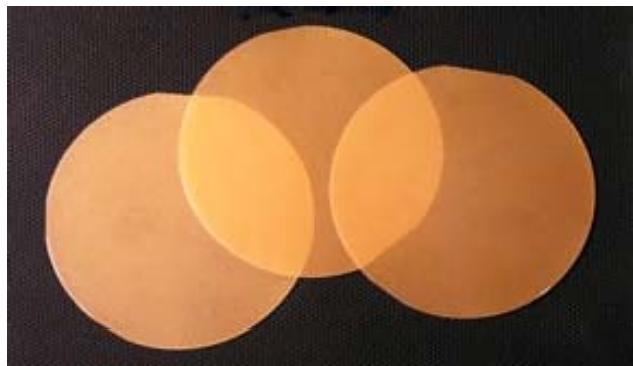


✖ Dimensions

l_x = 5 mm to 40 mm
 l_y = 5 mm to 40 mm
 l_z up to 90 mm



Wafers



X Diameter

- 2" (50.8 mm) - CTGS
- 3" (76.2 mm) – LGS, LGT*
- 4" (100 mm) – only LGS*

X Thickness

0.35 mm to 0.5 mm

X Orientations

X-cut

- Y-cut, $Y^{+1.5^\circ}$, Y^{+3°
- $YX_{lt} 48.5^\circ/26.6^\circ (0^\circ, 138.5^\circ, 26.6^\circ)$
- $YX_{lt} 50.1^\circ/25.5^\circ$ (LGS SAW)
($0^\circ, 22^\circ, 90^\circ$) and many others

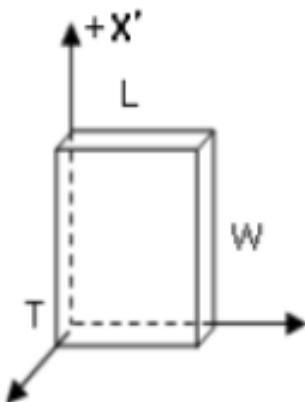
X Surface Finish:

DSL, SSP, DSP

*depending on orientation



Blanks & Plates



✖ Sizes

$l_x, l_y = 10 \sim 40 \text{ (50) mm}$ and bigger
 $l_z = 0.25 \text{ mm to } 1.0 \text{ mm}$

✖ Diameter

3 mm to 60 mm*

✖ Thickness

0.25 mm to 1.0 mm

✖ Orientation

X-cut

Y-cut, Y+1.5°, Y+3°

YXIt 48.5°/26.6°

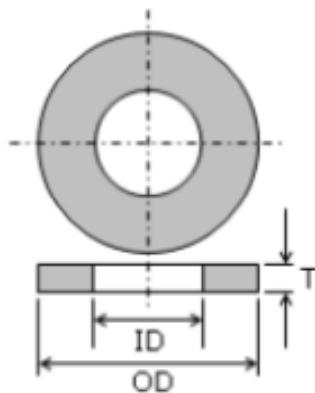
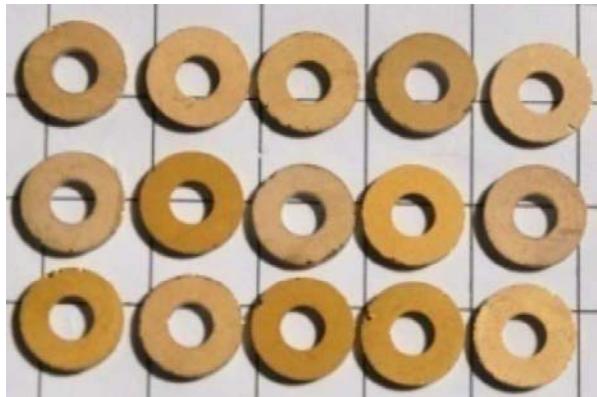
YXIt 50.1°/25.5°

✖ Surface Finish:

DSL, SSP

*depending on orientation

Rings



- ✖ Outer diameter
6 mm to 20 mm
- ✖ Inner diameter
1.5 mm to 10 mm
- ✖ Thickness
0.15 mm to 1.0 mm
- ✖ Orientation
 - X-cut (Standard)
 - Y-cut
 - Rotated cuts on request
- ✖ Surface Finish:
DSL, SSP, Cr-Au optional

Available Surfaces



- ✗ as grown
- ✗ sawed
- ✗ lapped (double-sided lapped = DSL)
 - Surface roughness: $R_a < 0.6 \mu\text{m}$ or TBD
- ✗ polished: single-sided (SSP) or double-sided (DSP)
 - Surface quality: $R_a < 0.001 \mu\text{m}$ or TBD

Metallization



- ✗ Cr-Ag (evaporation)
- ✗ Cr-Au (evaporation)
- ✗ Pt (sputtered)
- ✗ other materials on request

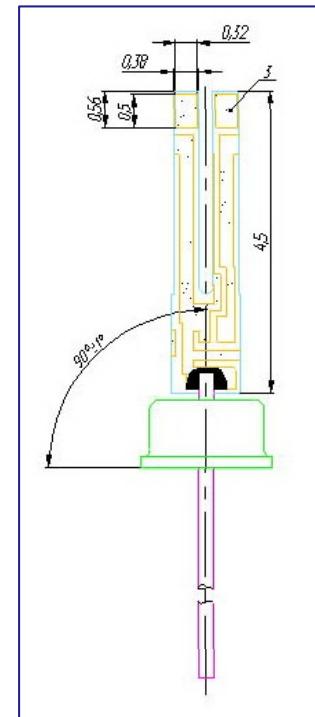
Finished and semi-finished units



✗ Micro balances („Q“CM, LCM)



✗ Resonators



✗ Tuning Fork Elements

Contact



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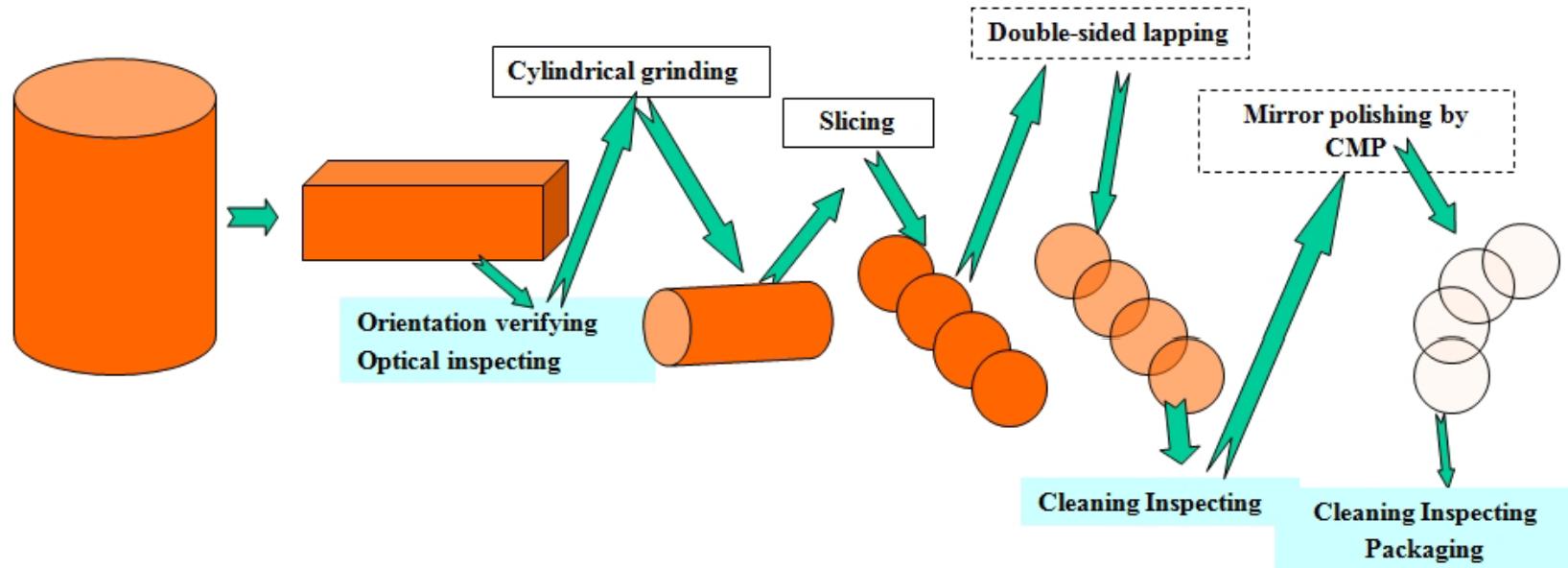
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Manufacturing processes



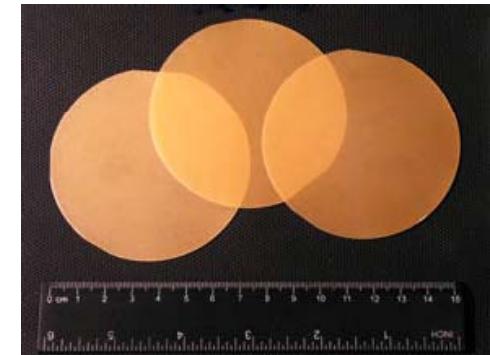
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AXTAL Products



Crystal Wafers and Blanks

- Langasite (LGS) Wafers
 - 3" (76.2 mm) diameter and 4" (100 mm) diameter, SSP or DSP
 - Thickness 0.35 mm or 0.5 mm, one-side or two sides polished
 - X-cut, Y-cut or special cuts like YXlt/48.5°/26.6°
- Langatate (LGT) Wafers
 - 3" (76.2 mm) diameter and 4" (100 mm) diameter, SSP or DSP
 - Thickness 0.35 mm or 0.5 mm, one-side or two sides polished
 - X-cut, Y-cut or special cuts like YXlt/48.5°/26.6°
- LGS, LGT and CTGS blanks
 - various sizes, round, or rectangular or special
- LGT and CTGS rings
 - 6 mm ~ 16 mm diameter, 3 mm ~ 6 mm bore
 - with double-sided Gold (Cr-Au) plating
- Other crystals from Langasite family
 - Wafers, blanks, or other shapes
- Quartz crystal wafers & rings
 - 3" (76.2 mm) & 4" (100 mm) diameter, AT-cut, ST-cut, X-cut, Y-cut etc.
 - Quartz rings for force sensor moduls



AXTAL Website



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For latest updates:
Visit our Website
www.axtal.com*

*New website in preparation

AXTAL ADVANCED XTAL PRODUCTS

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