KRONOS

PRODUCT OVERVIEW

PRECISION IN CRYSTAL GROWTH.

THE SYSTEM

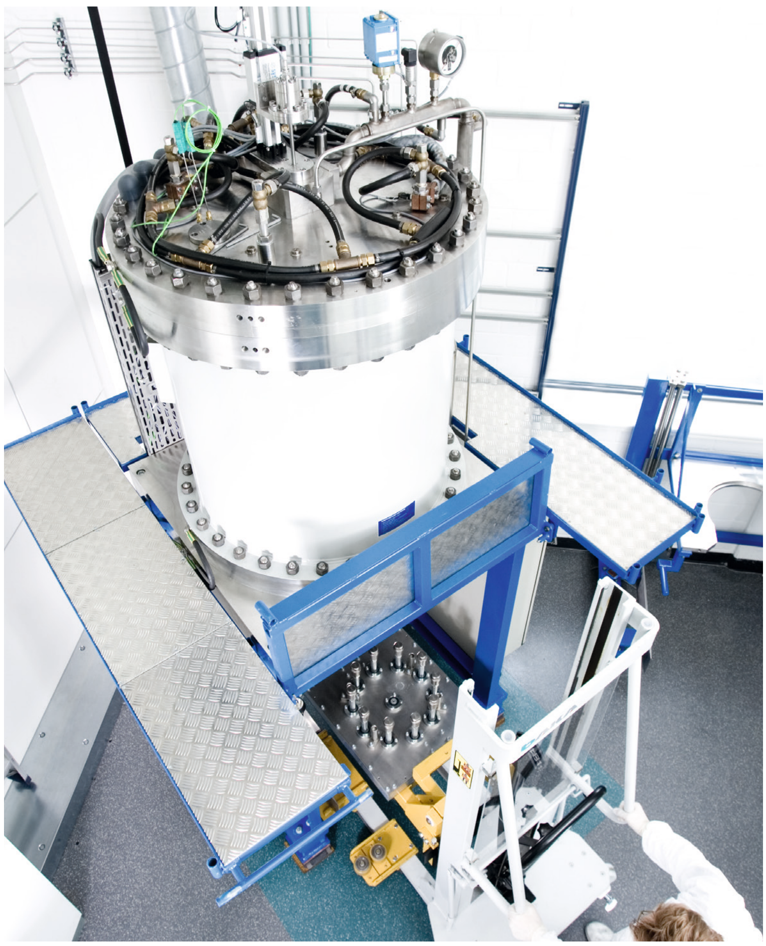
KRONOS CRYSTAL GROWTH FOR INP

VGF PRECISION, MADE IN GERMANY

Higher device yield starts with fewer dislocations – **KRONOS** moves only the gradient, growing low-defect InP crystals.

The PVA TePla Kronos is a high-performance VGF (Vertical Gradient Freeze) system for growing InP single crystals of the highest quality. In the VGF process, a polycrystalline charge is directionally solidified from bottom to top — guided by a precisely controlled temperature gradient and a seed crystal that defines the orientation of the single crystal. Without moving the crucible, the heating power of four independent resistance zones is slowly reduced under computer control, migrating the solidification front upward. The result: low-defect, highly homogeneous crystals with exceptionally low dislocation density – reproducible and ready for production. The Kronos combines decades of crystal growth expertise with state-of-the-art system engineering – delivering the substrate material on which tomorrow's communication technology is built.

- Temperature stability ≤ ± 0.5 K at operating pressures up to 40 bar
- Ingot diameters of 4“ and 6“, crystal weights up to 17 kg (6“)
- Optimized hot-zone design with 4 independent resistance heaters for minimal temperature fluctuations
- Automated temperature profile recording for full process transparency and control
- Technology from, and made in Germany produced at our manufacturing site in Jena, Germany



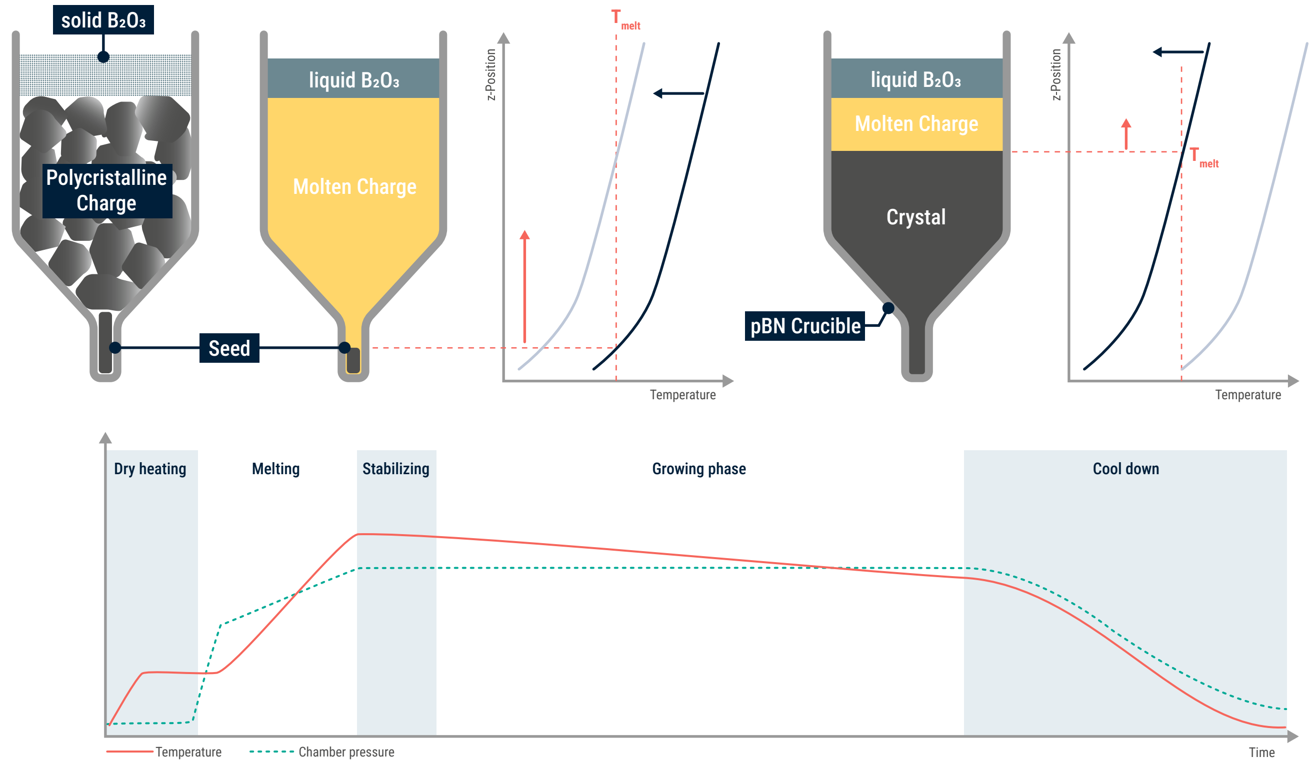
TECHNICAL PARAMETERS

SPECIFICATIONS	
Key Features	▪ minimized convection by optimized insulation design ▪ quick and easy loading/unloading via bayonet lock ▪ one system two ingot sizes (for 4” and 6” crystals) ▪ high temperature stability ($\Delta T \leq \pm 0.5$ K)
DIMENSIONS	
Height	approx. 3,800 mm (without optional temp. profiling unit)
Width	approx. 1,920 mm
Depth	approx. 3,000 mm
Weight	approx. 6,000 kg
Recommended ceiling height	min. 5,000 mm (for removal of top chamber lid)
CRYSTAL DIMENSIONS	
Crystal diameter	100 mm (4”) – 150 mm (6”)
Max. crystal weight	4” core module: approx. 6.5 kg InP 6” core module: approx. 17 kg InP
Max. ingot length	4“ core module: approx. 180 mm 6” core module: approx. 220 mm
HIGH PRESSURE CHAMBER	
Working pressure range	10^{-2} mbar–40 bar(g)
Design pressure	43 bar(g)
Design temperature	max. 150 °C
Inner diameter	900 mm
Total volume	600 l
Cooling method	double-walled, water-cooled
ELECTRICAL DATA	
Nominal voltage*	400 V AC ± 5 % | 3PH/PE
Nominal frequency*	50 Hz ±1 %
Rated power	approx. 90 kVA
Main fuse	160 A gG
Internal control voltage	DC 24 V

* Other on request.

THE PROCESS

HOW VERTICAL GRADIENT FREEZE WORKS
A PROCESS OVERVIEW



Setup & Seeding

The polycrystalline charge and a single-crystal seed are placed in a vertical crucible made of pyrolytic boron nitride (pBN). The material is then fully melted, preserving only the lower tip of the seed crystal as the crystalline nucleus – and the melt is thermally homogenized.

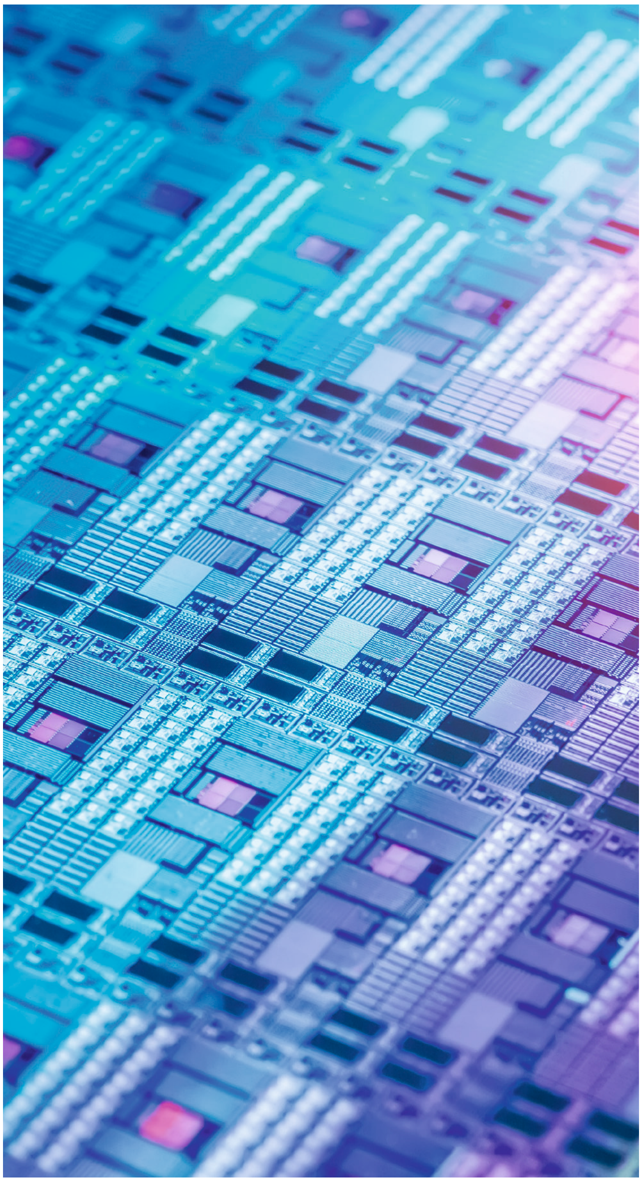
Crystallization (Gradient Freeze)

A vertical temperature gradient is established: the lower part of the crucible is cooler, the upper part hotter. Without any mechanical movement of the crucible, the heating power of the individual furnace zones is slowly reduced under computer control. The solidification front migrates upward through the melt, and the single crystal grows.

Controlled Cooling

After complete solidification, the crystal is slowly and precisely cooled. This step is critical to minimize thermomechanical stress in the crystal lattice, to ensure a low dislocation density and avoid generation of twins.

The result: low-defect, highly homogeneous InP single crystals – reproducible and ready for production.

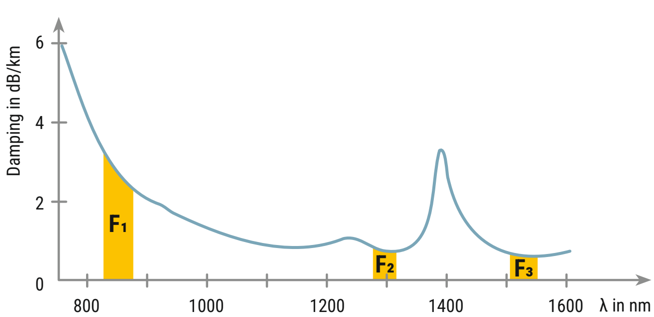


THE MATERIAL OF THE FUTURE

INDIUM PHOSPHIDE

THE PHOTONICS BACKBONE

Indium Phosphide (InP) is a III-V semiconductor material with outstanding properties: a direct bandgap of 1.34 eV (@ 300 K), an electron mobility of ~5,400 cm²/V·s (@ 300 K), and a refractive index of ~3.17 @ 1.55 µm are ideal prerequisites for high-speed data transmission and precision optics. InP is the key substrate material for lasers, photodetectors, and optical modulators in fiber-optic transceivers that today form the backbone of modern data centers, 5G networks, and AI infrastructure. In addition, InP is widely used in high-frequency devices (HEMTs, FETs) for microwave and millimeter wave systems, as well as in high-efficiency solar cells for space applications. With the rapidly growing demand for 800G and in future 1.6T optical modules in AI data centers, the need for high-quality InP substrate material is reaching an entirely new level. Furthermore, InP is increasingly gaining attention in the field of quantum computing: at cryogenic temperatures its electron mobility is exceptionally high, making InP a promising platform material for next-generation quantum devices and superconducting circuits.



Why InP?

Optical fibers transmit light at 1,550 nm with exceptionally low loss, as this is where the global attenuation minimum of the third optical window (F3) lies (see graphic). Thanks to their bandgap energy, InP-based devices such as lasers and transceivers emit precisely within this wavelength range, making them the heart of modern high-speed data connections.

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