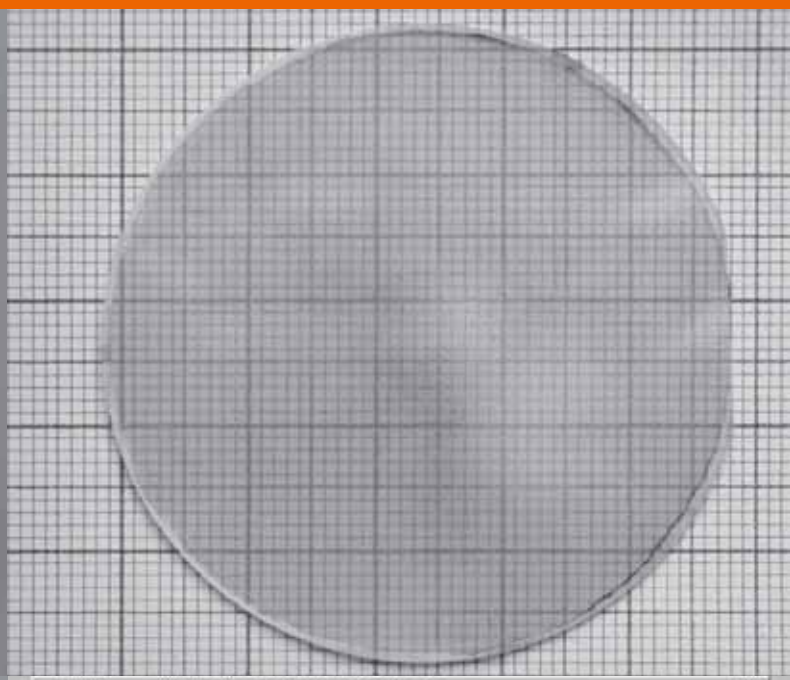
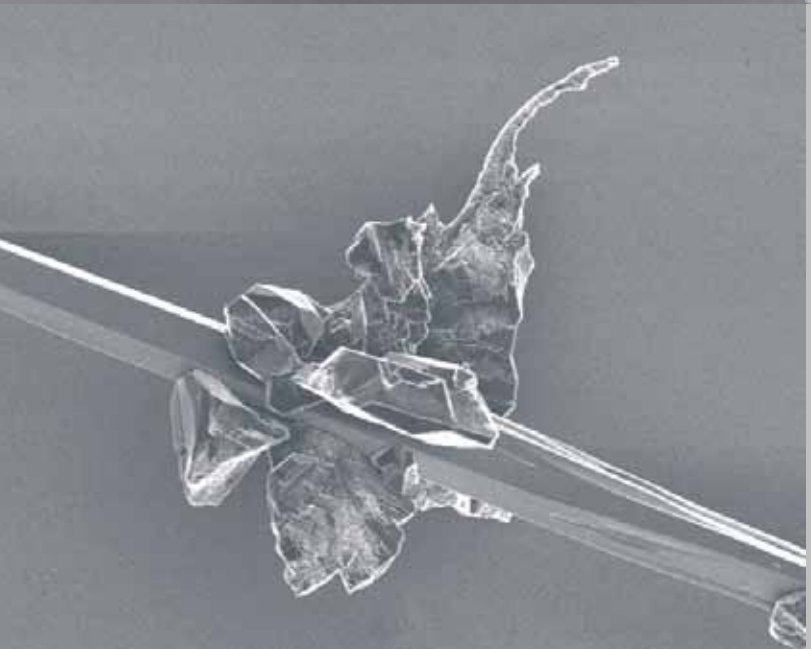
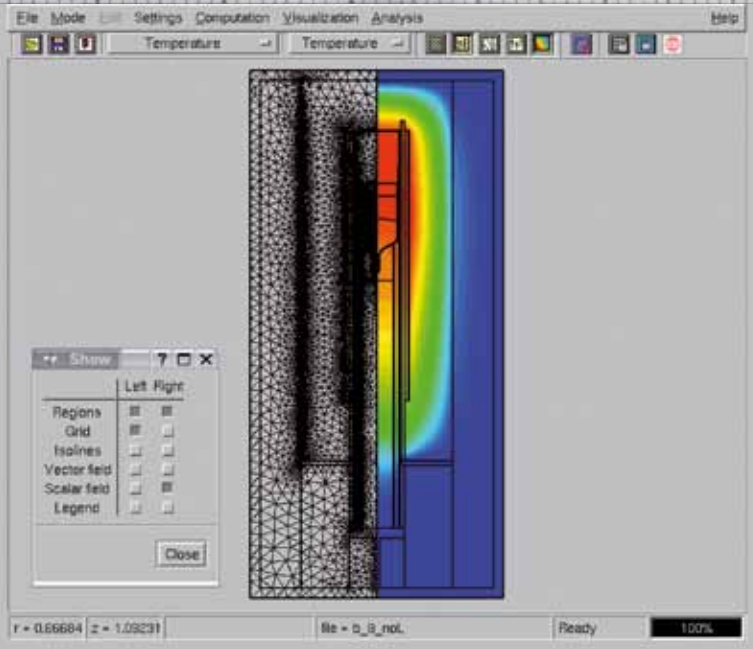
Fraunhofer
IISB

FRAUNHOFER-INSTITUT FÜR INTEGRIERTE SYSTEME UND BAUELEMENTETECHNOLOGIE IISB

CRYSTAL GROWTH







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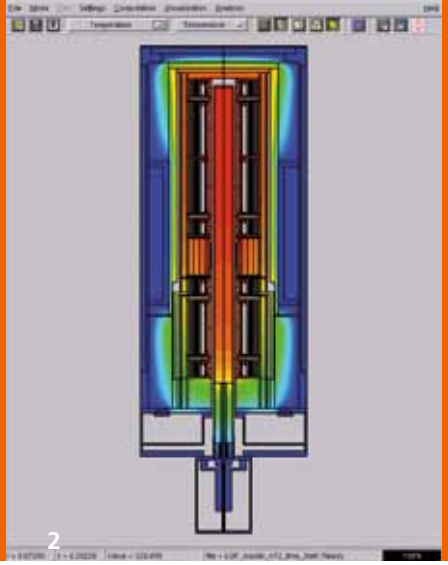

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Mission

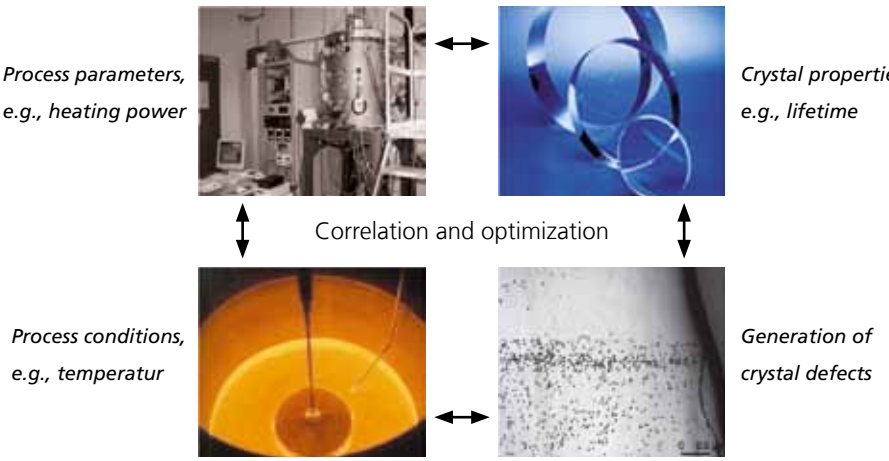
Our research focus is to clarify – in close collaboration with our industrial partners - how material properties of bulk crystals as well as those of thin epitaxial or other functional layers correlate with their respective production conditions. This basic understanding between material quality and growth conditions is of utmost importance for an improvement of bulk growth and layer deposition techniques used in industry with respect to larger crystal dimensions, less harmful crystal defects, more uniform electrical and structural properties, and new materials.

Strategy

Our strategy is the optimization of crystal growth processes through a combination of thorough experimental process analysis, tailored characterization techniques, and numerical modeling. For that purpose, IISB is equipped with a well suite d infrastructure consisting of R&D type furnaces and reactors, state-of-the-art metrology tools, as well as powerful and user-friendly simulation programs. These programs are especially suitable for heat and mass transport calculations in high temperature equipment with complex geometry.

Competences

Fraunhofer IISB has a profound experience in a variety of growth techniques and materials to be used in microelectronics, photovoltaics and optical technologies. IISB has significantly contributed to the development of the VGF technique for production of GaAs, InP and CaF_2 as well as to the upscaling of the Czochralski process from 200mm to 300mm silicon. Fundamental results have been achieved on the role of melt convection during directional solidification of photovoltaic silicon and on the dislocation dynamics during epitaxial growth of GaN and SiC epitaxial layers.



1 *Silicon Czochralski crystal with 300 mm diameter*

2 *CrysMAS model of furnace to be used onboard the International Space Station*

COVER PAGE

Structure of the Department of Crystal Growth:

Melt growth

- *Solar silicon*
- *Low-defect compound semiconductors*
- *Perfect CaF_2 crystals*
- *Sapphire ribbons*

Epitaxy / Layer deposition

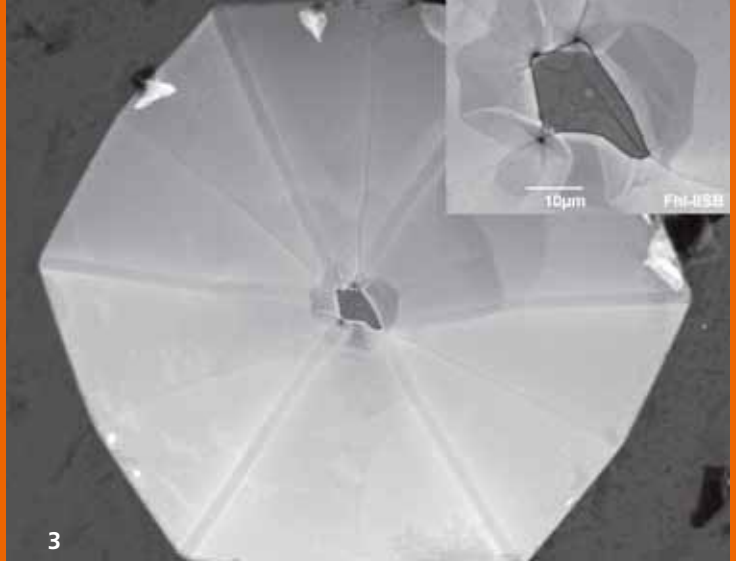
- *Liquid phase epitaxy of GaN*
- *Chemical vapor deposition of SiC*
- *Silicon solar cells*

Defect engineering

- *Dislocations and other extended defects in multi-crystalline silicon, GaN, SiC, ...*

Modeling

- *Process and defect models*
- *3D simulation*
- *Bulk growth processes*
- *Licensing of software*



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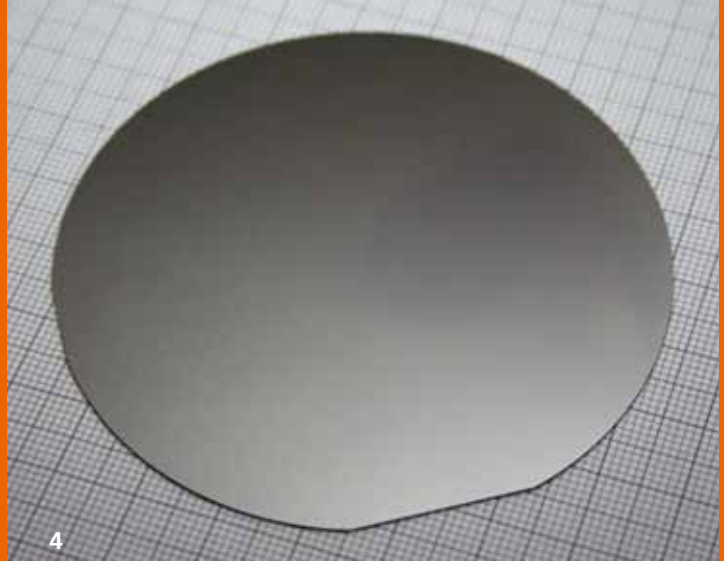

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Structure

The IISB Department of Crystal Growth currently consists of 30 crystal growth experts organized in four topical teams focusing on bulk crystal growth techniques, epitaxial processes, defect engineering, and modeling of crystal growth processes. The close collaboration with the Department of Material Science of the University of Erlangen–Nuremberg makes Fraunhofer IISB also attractive for students.

3 *V pit in HVPE-CaN*

4 *Low-defect GaN template*

References

Several awards for the Department of Crystal Growth document its world-wide leading position in the field of crystal growth. These awards were granted for the outstanding scientific achievements of our institute as well as for its excellent contributions to the education of students and engineers. The members of the department are engaged on national and international level in several associations and conferences in order to promote crystal growth.

History

Research and development in crystal growth has been carried out in Erlangen since the 1950ies, when the Siemens process, the Floating Zone process, and compound semiconductors were invented. For more than 40 years research is conducted at the university and since the mid 1990ies at Fraunhofer IISB. Since 2005, the department has extended its activities to Freiberg/Saxony, where it is engaged in the Fraunhofer Technology Center for Semiconductors (THM), which is a joint institution of Fraunhofer IISB and ISE.

Process	Material
Czochralski technique and its variants (LEC/VCZ)	Si, Ge, III-V semiconductors, oxides, fluorides
Bridgman and gradient freeze techniques	III-V and II-VI semiconductors, fluorides, oxides
Growth of shaped crystals (EFG, string ribbon)	Solar silicon, oxides
Growth from solution and vapor phase	SiC, GaN, AlN
Directional solidification, ingot casting	Solar silicon, metallic alloys
Surface treatment and defect characterization	GaN, SiC, solar silicon

Table
Overview of the experience in methods and materials of the Department of Crystal Growth

CONTACT

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