Leibniz-Institut für Kristallzüchtung

Seminar of the Institute "Quantum Phenomena in Novel Materials" at HZB

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Current Topics in Oxide Substrate Crystal Growth at IKZ

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Crystals are the hidden pillars in the world of modern technology. Bulk single crystals used as substrates enable production of micro- and optoelectronics devices. They founded and continue to shape the basis of virtually all of the technology we constantly use today. However, getting new crystalline materials to commercial production is extremely challenging as industry demands mature and scalable processes while academia typically cannot provide decade-long development. It is IKZ's mission to bridge this gap by service and prototyping of crystalline materials, including bulk single crystals, in their pre-industrial validation phase. After a short general introduction to the topic and to the IKZ in Berlin-Adlershof, I will highlight the current activities in the Oxide and Fluoride Section, which addresses preparation of bulk single crystals for photonics (optics, lasers, sensors, scintillators) and electronics (semiconductors, piezo- and ferroelectrics, spintronics, magnonics).

Then, two current research topics in bulk crystal growth of oxides for substrate applications are presented in more detail. First, compositionally tailored single-crystal substrates enable the growth of lattice mis-matched (strained) epitaxial films exhibiting unusual, novel, and interesting chemical and physical properties. I will show how e.g. ferroelectric behavior of thin films can be controlled by the substrate composition, with rare-earth scandium oxides of perovskite structure as an example. The second topic is on substrates and materials for next-generation efficient power switching devices. As current SiC and GaN power electronics become more mature and commercialized, their limitations come into focus. Ultra-wide band-gap (UWBG) semiconductors such as beta-Ga2O3 or GeO2 have promising properties, but as a clear additional advantage, they can be again grown as bulk crystals by the Czochralski method. However, the technology route to obtain proper substrates is still under research. The underlying issues and implications of crystal growth technology will be discussed. Finally, I will show how IKZ activities address the needs of researchers in academia and industry to provide crystalline materials for the application.

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