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Oxide and Nitride Single Crystals for Novel Optical and Electronic Applications

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Single crystals are an ideal benchmark for ceramic and composite materials, as they lack grain boundaries and sintering aids. Typically, single crystals consist of a nearly perfect atomic lattice with highest chemical purity thereby providing superior properties (e.g. transparency, anisotropy, electrical and thermal conductivity) for the intended application. However, their preparation is much more challenging compared to ceramic fabrication. Thus, they are generally smaller and more expensive, and some compounds are even unavailable as bulk crystals.

This talk aims to introduce single crystal growth for optical and electronic applications, focusing in particular on suitable growth technologies as well as on challenges in tailoring the properties of these crystals required for the application. In particular, two materials are examined. First, Ti-doped sapphire (Ti:Sa) for laser applications is grown from the melt at about 2050°C by the Czochralski method. Self-absorption by Ti^{4+} formation can be prevented by properly adjusting the oxygen partial pressure during growth. In addition, Ti segregation must be mitigated to obtain homogeneous properties in the crystals. Second, langasite-type compounds (e.g. $La_3Ga_5SiO_{14}$) enable high-temperature (800°C) piezoelectric pressure sensors. Here, tailoring composition and elements in the structure (e.g. $Ca_3TaGa_3Si_2O_{14}$) yield a strongly enhanced sensitivity. Finally, we give a general view on crystal growth research at the Leibniz-Institut für Kristallzüchtung (IKZ) Berlin including further oxides, nitrides, and fluorides.