ALN SINGLE CRYSTALS AS SUBSTRATES FOR DEEP-UV OPTOELECTRONICS

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In recent years, single-crystalline aluminum nitride (AlN) became a candidate as substrate material for AlGaN epilayers with high Al content. AlN substrates have recently been successfully employed for solid-state deep-UV optoelectronic emission, lasing, and sensor devices. The preferred method to grow AlN bulk single crystals is the sublimation–recondensation method at temperatures well above 2000°C. As AlN does not occur in nature, three strategies for obtaining seeds for bulk crystal growth have been investigated: Grain selection, spontaneous nucleation, and growth on SiC as a foreign substrate. While spontaneous nucleation yields crystals of highest structural perfection but limited size, seeding on SiC seemed especially promising to quickly reach AlN crystals of industrial relevant size and diameter. However, lattice and thermal expansion mismatch as well as defects present in the SiC seed or generated at the SiC/AlN interface lead to formation of grain boundaries and tilted domains, which persists when using such crystals as seeds for subsequent homoepitaxial growth. While as AlN is still commercially available only in small quantities and sizes, both routes discussed above are actively researched.

In this presentation, the two routes to AlN bulk growth will be contrasted and evaluated in respect to their potentials and consequences for AlN substrate preparation and application. Furthermore, we will show in detail how the choice of growth strategy not only influences the available size and quality of the AlN crystals, but also their optical properties. Due to materials compatibility issues, the two routes are followed using different crucible materials and growth parameters. The resulting differences in impurity and intrinsic defect concentrations have a decisive impact on deep-UV absorption in bulk AlN. Thus, controlling contamination as well as faceting and orientation-dependent segregation effects will be a key prerequisite for further commercialisation of AlN substrates.