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Diffraction Imaging Analysis of Crystal Defects in AlN Substrates from Different Vendors

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Aluminum nitride (AlN) is a key substrate material for (Al,Ga)N-based UV photonics, ultra-high-power electronics, and RF devices. The realization of these applications critically depends on the availability of high-quality bulk AlN substrates with excellent structural perfection. Currently, bulk AlN crystals for substrate fabrication are predominantly grown by physical vapor transport (PVT), which remains the most established method for producing large, high-purity crystals.

To evaluate the structural quality of such materials, non-destructive and high-resolution characterization techniques are required. This seminar presents a comparative analysis of PVT-grown AlN substrates from different commercial vendors or research institutions using Lang X-ray topography (L-XRT) for large-area defect mapping and synchrotron-based monochromatic rocking curve imaging (RCI) for quantitative defect analysis. All investigated crystals exhibited high to exceptionally high structural quality. RCI enabled visualization of individual dislocations with submicrometer spatial resolution, allowing for a full quantitative analysis of local lattice distortions.

The combined application of L-XRT and RCI demonstrates a powerful approach for comprehensive defect characterization in bulk AlN. A key result of this study is that, despite all substrates being grown by the same fundamental PVT technique, distinct differences in the observed dislocation types and defect distributions are evident among substrates from different vendors, indicating significant variations in growth conditions and crystal optimization strategies.

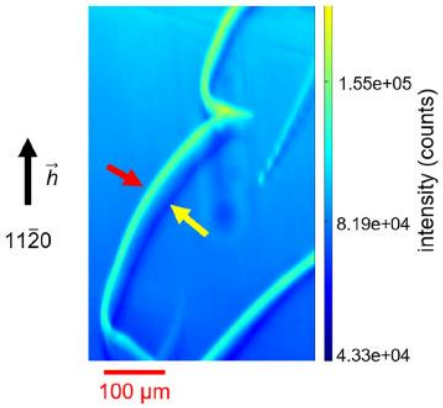

Fig. 1. RCI integrated intensity map of a basal-plane dislocation showing the direct (red arrow) and dynamic image (yellow arrow) indicating high AlN crystal quality of the matrix.

Location: Seminar room on II floor, IHPP PAS New Technologies building
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