

2026 HBCU CHIPS Network Conference

Contribution ID: 60

Type: ORAL

Growth of Scandium Diboride Semimetallic Single Crystals by Laser Floating Zone Method

Thursday, April 2, 2026 12:45 PM (20 minutes)

Scandium diboride (ScB₂) is a refractory semi-metallic ultrahard ceramic crystal that is lattice matched to ultra-wide bandgap (UWBG) AlGa_{0.55}N. The lattice match of ScB₂/Al_{0.55}Ga_{0.45}N would reduce the strain and crystal defects of epitaxial layers enabling thicker pseudomorphic drift layers >5μm for high voltage vertical power devices >5kV on these semi-metallic substrates, while eliminating the substrate series resistance parasitic.

We demonstrate the growth of ScB₂ crystals by the laser-diode floating zone (LDFZ) method. Poly-crystalline ScB₂ rods were used as our feed and seed rods, and Sc as flux, with a starting resistivity of ~400μΩcm. Our growth rate is ~2mm/hr giving a typical total growth of >20mm long. X-Ray Diffraction (XRD) data shows clear signatures of (001) ScB₂. Laue measurements on cut/polished samples show six-fold symmetry over mm length scales, with room temperature bulk resistivity ~20μΩ-cm, ~20x lower than the starting feed material. Heat-capacity measurements were performed at temperatures 2K<T<300 K and were analyzed to quantify the contributions of phonons and electrons. The Debye temperature (θ_D~710K) and the electronic coefficient (γ ~ 3.8 mj.mol⁻¹.K⁻²) of heat capacity Determined. These samples had thermal conductivity ~100 W/m-K at the level of Si and GaN, showing the potential for substrates from an electrothermal co-design perspective.

Academic or Professional Status

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Session Classification: Technical Session 3

Track Classification: Materials & Devices: Materials & Devices - (c)