Keynote Address
Room Davis Hall 101 - Session KEY-TuM

Keynote Address II

Moderators: Uttam Singisetti, University of Buffalo, SUNY, **Joel Varley**, Lawrence Livermore National Laboratory

8:30am **KEY-TuM-1 Welcome and Opening Remarks***,*

8:45am **KEY-TuM-2 Bulk Single Crystals and Physical Properties of β-$(Al_xGa_{1-x})_2O_3$ Grown by the Czochralski Method***, Zbigniew Galazka,* LEIBNIZ-INSTITUT FÜR KRISTALLZÜCHTUNG, Germany **INVITED**

β-Ga_2O_3 is a transparent semiconducting oxide that attracted a particular attention in the research community with potential applications especially in high power electronics and UV opto-electronics. This is the result of a wide bandgap of 4.85 eV, good electrical properties enabling a wide doping range, high theoretical breakdown field of 8 MV/cm, and a capability of growing large bulk single crystals and thin films of high structural quality [1].

A yet higher critical breakdown field of β-Ga_2O_3 can be achieved by enlarging its bandgap through heavy doping with Al. For homoepitaxial growth of β-$(Al_xGa_{1-x})_2O_3$ films and subsequent device fabrication, wafers from bulk single crystals of similar composition would be highly beneficial. We have already demonstrated the capability of growing bulk β-$(Al_xGa_{1-x})_2O_3$ single crystals by the Czochralski method with x = 0 – 0.35, and provided basic structural, optical, and electrical properties [2].

The present study provides an overview of the growth of bulk β-$(Al_xGa_{1-x})_2O_3$ single crystals by the Czochralski method, including thermodynamics and limits of Al incorporation in the monoclinic β-Ga_2O_3 crystal lattice, as well as limits of Ga incorporation in the trigonal a-Al_2O_3 crystal lattice. In addition to Al doping, the crystals were co-doped either with Si or Mg. The study is accompanied with extended characterization of physical properties of β-$(Al_xGa_{1-x})_2O_3$ as a function of [Al]. It covers structural (lattice constants), electrical (free electron concentration, electron mobility, BOFM), optical (absorption edge, bandgap, static dielectric constants, refractive index), and thermal (thermal conductivity) properties. A high doping level of bulk β-Ga_2O_3 single crystals with [Al] ≤ 35 mol.%, their high structural quality, and a wide spectrum of physical properties might facilitate homoepitaxial growth of β-$(Al_xGa_{1-x})_2O_3$ films and novel device fabrication.

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[1] Eds. M. Higashiwaki and S. Fujita; "Gallium Oxide: Crystal Growth, Materials Properties, and Devices"; Springer Nature Switzerland AG (2020).

[2] Z. Galazka, A. Fiedler, A. Popp, S. Ganschow, A. Kwasniewski, P. Seyidov, M. Pietsch, A. Dittmar, S. Bin Anooz, K. Irmscher, M Suendermann, D. Klimm, T.-S. Chou, J. Rehm, T. Schroeder, M. Bickermann; J. Appl. Phys. 133 (2023) 035702.

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