

# Structure Property Relationships in Wide-Gap Gallium Oxide Thin Films

## Scientific Achievement

Successfully determined the synthesis space (substrate temperature, oxygen partial pressure, substrate selection) for the targeted growth of  $\beta$ -Ga<sub>2</sub>O<sub>3</sub> thin films through theory-guided experiments. Grew high-quality, oriented  $\beta$ -Ga<sub>2</sub>O<sub>3</sub> films.

## Significance and Impact

Gallium oxide is of current interest as a wide-bandgap semiconductor for power electronics. Identifying the processing conditions necessary for high-quality film synthesis is a critical step toward developing this technology.

## Research Details

**Film Synthesis:** Temperature-gradient combinatorial pulsed laser deposition was used to broadly map the synthesis space. Additional uniform samples were grown for detailed structural studies.

**Structural Properties:** The films crystallized into  $\beta$ -Ga<sub>2</sub>O<sub>3</sub> above 250 °C, with the onset of exclusive 201 textured orientation at 450 °C. Epitaxial growth was achieved on Ga<sub>2</sub>O<sub>3</sub>, but twinned domains were observed for films on 0001 sapphire.

**Optical and Electronic Properties:** Substrate temperature and pO<sub>2</sub> had a large effect on electrical conductivity and visible transmission.

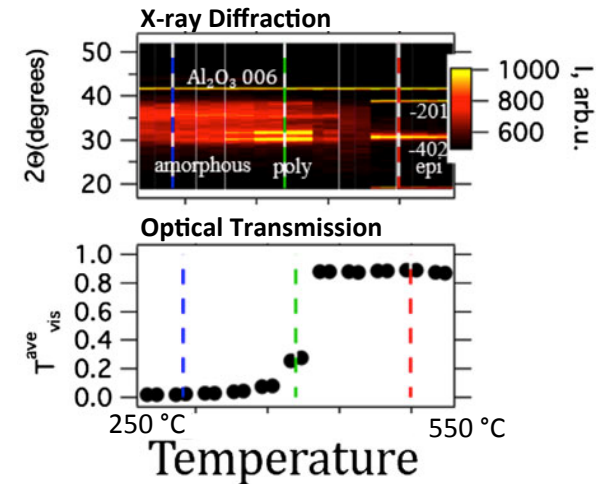


Fig. 1: X-ray diffraction and optical transmission of Sn-doped Ga<sub>2</sub>O<sub>3</sub> films as a function of temperature.

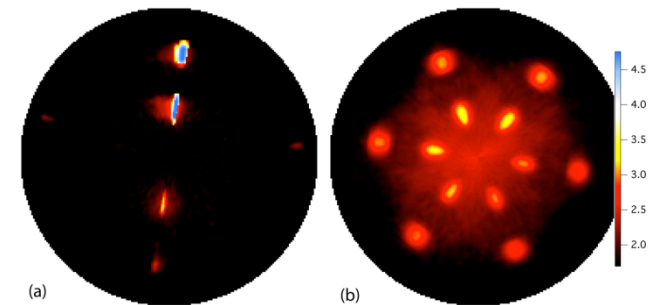


Fig. 2 (002) XRD pole figure of a 2% Sn: Ga<sub>2</sub>O<sub>3</sub> films: a) Epitaxial growth on Ga<sub>2</sub>O<sub>3</sub> single crystal; b) Bi-axially textured growth on sapphire single crystal.

L.M. Garten *et al.*, *MRS Comm.*, 2016 <https://doi.org/10.1557/mrc.2016.50>