Electrical Properties and Crystallization Study of Indium Oxide Thin Films Via Grazing-Incidence Wide-Angle X-Ray Scattering

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Grazing-incidence, wide-angle x-ray scattering (GI-WAXS) measurements were conducted at the Advanced Photon Source on indium oxide thin films grown via pulsed laser deposition. Growth temperatures ranged from -50 °C to 600 °C in order to investigate thermal effects on the films' structure and spatial homogeneity. Films grown below room temperature were amorphous. Crystalline samples were obtained at and above room temperature. The measured electrical properties of the crystalline films were correlated to their structure and microstructure. Lattice parameters, strain, texture, degree of crystallinity, and peak broadening were obtained from analyzing the GI-WAXS data. Depth uniformity of the films was assessed from data measured at two different incident angles, while lateral homogeneity was studied by collecting data along the in-plane and out-of-plane directions. High electron mobility was measured in samples that exhibited high depth and lateral isotropy. These results suggest that both depth and lateral uniformity in the crystalline films affect their electrical properties. These investigations provide valuable insight that can help to improve the desirable properties of indium oxide, as well as other transparent conducting oxides.