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Urbach Analysis of Band-Edge in ZnO and MgZnO Thin Films
AMRAH CANUL, JESSE HUSO, DINESH THAPA, LEAH BERGMAN, Univ of Idaho — ZnO has gained popularity as a material of choice for UV applications. It has a benign chemical nature, a deep excitonic energy level, and a direct bandgap of about 3.4 eV. The latter two properties make ZnO a highly efficient light-emitter at and above room temperature. Alloying ZnO with magnesium creates the MgxZn1-xO alloy system which can tune the bandgap by design and add new optical and electronic functionalities to ZnO. The goal of this study is to investigate the nature of defect states at the band-edge introduced by alloying in ZnO and $Mg_{0.07}Zn_{0.93}O$ thin films. To investigate the band-edge dynamics, we study in-gap states via temperature dependent absorption spectroscopy in the range 150-500K. The in-gap states at the band-edge were analyzed via the Urbach Energy model, where the Urbach Energy is a measure of the extent of defect states in the bandgap. In parallel, we also analyze the absorption spectra via the Wasim model, which gives the interaction between defect states and phonons. The Wasim model of the Urbach Energy allows deconvolution of the relative contributions of static defect states and temperature dependent phonon modes to the in-gap states. It was found that the defect contribution to in-gap states at the band-edge was significantly higher for $Mg_{0.07}Zn_{0.93}O$ than in ZnO. Additionally, the phonon contribution to in-gap states was also higher in $Mg_{0.07}Zn_{0.93}O$ than in ZnO. These effects will be discussed in terms of the distortion of the periodicity in the $Mg_{0.07}Zn_{0.93}O$ lattice. The authors gratefully acknowledge the National Science Foundation under grant No. DMR-1202532.

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