Infrared Absorption of α-Sn

J. R. Love,[1] **C. A. Armenta,**[1] **A. K. Moses,**[1] **S. Zollner,**[1] **A. N. Engel,**[2] **C. J. Palmstrom**[2]

[1] New Mexico State University, Las Cruces, NM 88003

[2] University of California, Santa Barbara, CA 93106

Alpha-tin (α-Sn) is a zero-bandgap semiconductor with an inverted s-antibonding electron band. We discuss the presence of a strong E_0 peak in the extinction coefficient appearing at 0.41 eV in infrared spectroscopic ellipsometry measurements. We also discuss the changes seen in the dielectric function at low temperatures. The E_0 peak is attributed to allowed interband transitions from the Γ_7^- VB ("electron") to the Γ_8^{+v} heavy hole VB or the Γ_8^{+c} light "hole" CB [1].

Previous mid-IR ellipsometry measurements of α-Sn grown pseudomorphically by molecular beam epitaxy on InSb or CdTe have a room temperature dielectric function with an E_0 peak at 0.41 eV. The strength of the E_0 peak is affected by hole doping of the α-Sn layer. Unintentional doping with In from the substrate layers were influenced by variations in substrate surface preparation or by growing on a different substrate (CdTe). The effects are noticeable at low temperatures. The E_0 peak for α-Sn grown on InSb demonstrated temperature invariance for both the amplitude and energy while the E_0 peak amplitude for α-Sn grown on CdTe diminishes with decreasing temperature [1].

An MBE was used to grow new 30 nm α-Sn layers on InSb (001) substrate terminated with Sb [2]. By terminating the surface with Sb the amount of background In doping is reduced, therefore limiting the allowed transitions between bands. This limitation leads to a reduction in the peak amplitude at low temperatures. Temperature dependent ellipsometry spectra were taken from 5K – 295K and show that the E_0 peak is larger at high temperatures for α-Sn layers with reduced doping.

This work was supported in part by: AFOSR (FA9550-24-1-0061), ARO (W911NF-22-2-0130), NSF (DMR-2423992), and SCALE-RH (W52P1J-22-9-3009).

[1] R. A. Carrasco, Appl. Phys. Lett. 113, 232104 (2018).
[2] A. N. Engel, Phys. Rev. Materials 8, 044202 (2024).