

Growth of Metal Sulfides/Selenides from Metal Flux Reactions to Synthesize Semiconductors

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Metal flux reactions use a low-melting metal present in excess as a solvent to allow reactions to occur at low enough temperatures to obtain kinetic and metastable products as well as production of crystals due to the liquid medium. It was of interest to use metal flux to synthesize sulfides or selenides that were semiconductors with a band gap between 1-2 eV. In this project, bismuth or an equimolar mixture of indium and bismuth were used as fluxes for the synthesis of Cu_3BiS_3 and InSe respectively. Production of these compounds was confirmed with powder X-ray diffraction (PXRD) and scanning electron microscopy-energy dispersive spectroscopy (SEM-EDS). Cu_3BiS_3 has an indirect band gap of about 1.7 eV. The attempt to adjust the bandgap of this product by substitution of sulfur with selenium simply lead to the production of Cu_2S . InSe has a direct band gap of about 1.3 eV. This was adjusted with the replacement of selenium with either sulfur or tellurium, which was confirmed with PXRD, but further optical spectroscopy must be done to determine the altered band gap. Sulfur could be incorporated up to a ratio of $\text{InSe}_{0.8}\text{S}_{0.2}$; higher amounts led to phase segregation. SEM-EDS on the substituted indium selenide products will also be used to quantify the amount of sulfur or tellurium incorporated into the final product.