With ever increasing demand for clean energy, the fabrication of low cost and high efficiency photovoltaic devices has attracted considerable attention in recent years. Among different types of photovoltaic devices, inorganic photovoltaic cells have exhibited the highest solar energy conversion efficiency, but at the expense of high fabrication cost. In particular, $A^{\text{III}}B^{\text{II}}X^{2-}$ semiconductors of the I-III-VI$_2$ family, such as CuIn$_{1-x}$Ga$_x$S$_2$, are of considerable interest for use as light-emitting diodes, photovoltaic cells, and nonlinear optical devices. Colloidal suspensions of the nanocrystals are attractive for use as inks for low-cost fabrication of thin film solar cells by spin or spray coating. We are synthesizing nanocrystals of the I-III-VI$_2$ family using solution-based methods and using them for the fabrication of solar cells. As an example, we have synthesized monodisperse wurtzite CuIn$_{1-x}$Ga$_x$S$_2$ nanocrystals over the entire composition range by thermal decomposition of simple chemical precursors dissolved in solution. Depending on the chemical composition and synthesis conditions, the morphology of the nanocrystals can be controlled in the form of bullet-like, rod-like, and tadpole-like shapes as seen in the Transmission Electron Microscopy (TEM) images (Fig. 1). The band gap of the nanocrystals increases linearly with increasing Ga concentration, as directly observed from changes in the color of the suspension (Fig. 2), resulting in efficient absorption of solar radiation over a wide wavelength range.

This project will expose the REU student to the synthesis of nanocrystals using solution-based methods and studying their structural and optical properties. Additionally, thin film solar cells will be fabricated from colloidal suspensions of the nanocrystals and characterized.