Richard F. Josey III and Julie L. Fenton
Penn State Materials Day 2023
09/22/2023

Title: **Variable mechanical response in crystalline hybrid solids based on organic composition**

Abstract: Hybrid organic-inorganic solids have emerged as a robust class of materials which possess exceptional chemical tunability and ability to incorporate a wide variety of molecular organic species which electrostatically stabilize the inorganic material lattice. Synthetically, the formation of hybrid metal halide materials is well understood, and the introduction of organic spacers of differing size and chemical functionality has resulted in numerous phases of inorganic-halide structures. However, these organic species are generally regarded as only a convenient template to form the inorganic framework and relatively little is known about their contribution to bulk material properties. Previous reports have suggested that the identity of the organic species does play a considerable role in determining material stability and photovoltaic performance in 2D lead halide hybrid phases, but these studies have generally focused on basic organic species, and comprehensive studies of their impact on other material properties remains limited. To this end, a series of hybrid organic-inorganic materials was synthesized utilizing molecular organic spacers with varying chain lengths and intermolecular interactions (Van der Waals forces, covalent bonding, π-π stacking) within 2D $CuBr_4$ layers to investigate how these discrete interactions contribute to bulk mechanical material properties. Nanoindentation experiments on individual crystal products revealed that the hardness and elasticity of each material change alongside variations to the organic spacer, where alkyl chain length and the presence of different intermolecular interactions both play significant roles. This indicates that there is indeed a clear connection between bulk material response and the identity of the organic constituents. Ultimately, such synthesis provides deeper insight into the structure-property relationships of hybrid materials and offers greater fundamental understanding for the generation of a diverse array of responsive materials with tunable properties.