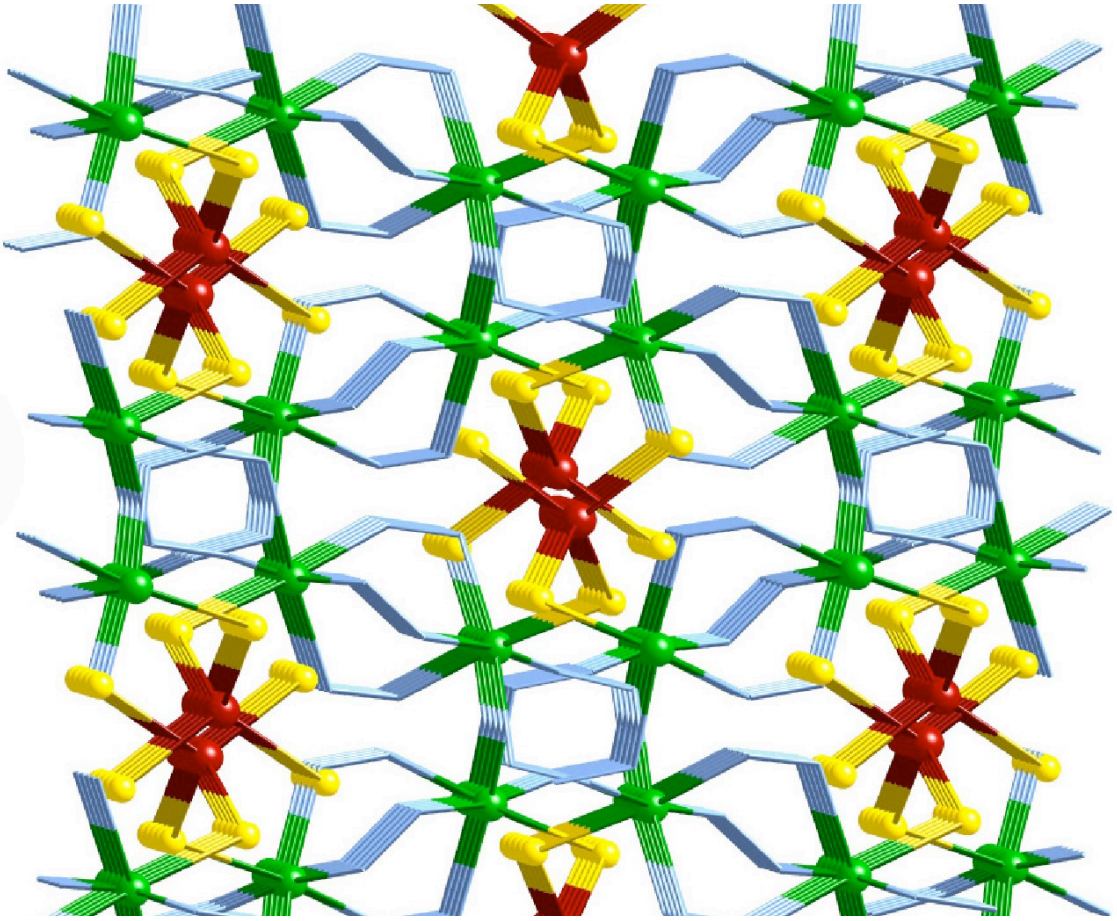
METACRYSTALS

Penn State MRSEC



An array of $SnSe_4Mn_2$ clusters linked by (blue) hydrazine molecules in three dimensions.

Networks of molecular building blocks
clusters and linkers

SEED

Regular crystalline lattices, whether of salt, silicon or sand, are composed of atoms interlinked by chemical bonds. Penn State researchers are taking this "atom plus bond" scenario one stage higher. Carefully selected stable clusters of atoms take on the role of meta-atoms, while other molecules bind these clusters tightly to each other, acting as meta-bonds. Together, these clusters and linkers form a new class of meta-crystals. MRSEC researchers have developed a techniques to link together chalcogenide clusters into one, two and three dimensional crystal structures like that shown above. If the linker molecules enable electrons to hop between the clusters, then these assemblies will act as a new class of solids in which the properties of the clusters, not the constituent atoms, determine the properties of the crystal. With new meta-atoms and new meta-bonds, we can expand beyond the conceptual confines of the periodic table and design new crystals with novel electronic properties. For example, since the clusters are larger than single atoms, they can hold a variable number of electrons. Successful implementation of these concepts, in particular realization of meta-material energy bands, could allow for a profound new paradigm in the design of materials.

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