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James C. McGroddy Prize for New Materials Talk: From discovery to design of new materials

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The design and discovery of new materials and their crystal growth is critical for continued scientific and technological progress far into the future. It is also a fundamental goal of condense matter science. We have been developing the chemistry of novel chalcogenide and intermetallic materials which define a remarkably broad set of structurally diverse compounds, associated with a wide range of physical properties and impacting a variety of physics and materials science issues. In contrast to solid-state methods, materials syntheses in liquid fluxes permit crystallization at lower temperatures due to facile diffusion and possible chemical reactions with the flux itself. These reactions can produce a wide range of materials, often metastable such as oxides, chalcogenides and intermetallics, but typically the formation paths are obscure or poorly understood. In this talk I will describe how we observe, understand, and engineer the formation of compounds from inorganic melts and an approach we call panoramic synthesis. I will also highlight some of our recent results on the discovery of remarkable materials and crystal structures and how they can be leveraged for achieving unusual or enhanced properties of interest in a variety of fields such as thermoelectrics, γ ray detection, superconductivity, topological properties, nonlinear optics, etc.