**Department of Chemical Engineering**

**Seminar Schedule**

**Understanding and Design of Glass Formation and Dynamics in Nanostructured Materials**

Dr. David S. Simmons

The University of Akron

**Abstract**

From longer-lasting and safer batteries to strong and lightweight composites for use in airplanes and auto bodies, many of the materials that could open the door to tomorrow’s technologies incorporate nanoscale compositional or structural heterogeneity. A central drive behind these materials’ adoption is their potential to exhibit combinations of properties that are largely inaccessible in homogenous materials, such as high modulus combined with high permeability or light weight with high rigidity. Indeed, the properties of these materials can exhibit extraordinary deviations from those of their bulk constituents – a consequence of a dominance of interface over bulk. One of the central effects is an alteration in their glass transition – a precipitous dynamic arrest phenomenon the origin of which comprises a grand open question of materials science and condensed matter physics. This ubiquitous phenomenon can drive solid-like behavior in materials as diverse as polymers, bulk metallic glasses, small organic molecules, and inorganic solids. Glass formation behavior in nanostructured materials from all of these classes can be a central determinant of performance properties, with alterations in this behavior impacting mechanical response, permeability, and aging behavior. For this reason, fundamental understanding and rational control of the glass transition in nanostructured materials would enable transformational advances in material technologies, with applications ranging from energy storage to flexible electronics to robust structural materials.

Here, we present an emerging unified understanding of alterations in glass formation and dynamics in interfacially rich materials as diverse as thin films, nanocomposites, ionomers, and block polymeric ionic liquids. This new picture casts all of these systems as specific instances of a general tendency toward broad dynamic interphases in glass forming materials – a natural consequence of an emergent length scale of cooperative dynamics. We further show how these and other insights into dynamics in supercooled liquids can be employed to guide the design of ionic-liquid containing nanostructured ion conductors for next generation battery applications. Ultimately, we describe how these insights, combined with design tools including evolutionary algorithms, machine learning, and high-throughput experiments, enable rational design of materials with targeted glass formation behavior for next-generation material technologies.

**Bio**

Dr. David S. Simmons, an assistant professor in the Department of Polymer Engineering at The University of Akron, has been awarded a prestigious National Science Foundation CAREER Award for research in computer simulations and theoretical approaches to understanding the glass transition in strongly interacting polymers.

**Seminar**

**Monday, December, 11**

**3:00 pm**

**Livermore 101**