The micromechanics of shear thickening fluids and their application as protective materials for medical professionals, first responders, protective materials for atheletes, astronauts and spacecraft

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Shear thickening colloidal and/or nanoparticle suspensions are commonly encountered in chemical and materials processing, and are also the basis of a technology platform for advanced, field responsive nanocomposites. In this presentation, I will review some of the experimental methods and key results concerning the micromechanics of colloidal suspension rheology. Micromechanics is the ability to predict the properties of complex systems from a colloidal or microscopic level description of the structure and forces. A fundamental understanding of colloidal suspension rheology and in particular, shear thickening, has been achieved through a combination of model system synthesis, rheological, rheo-optical and rheo-small angle neutron scattering (SANS) measurements, as well as simulation and theory (Colloidal Suspension Rheology Mewis and Wagner, Cambridge Univ. Press, 2012).

Shear thickening fluids (STFs) are novel field-responsive materials that can be engineered to be useful nanocomposites for enhanced ballistic and impact protection, puncture resistant medical gloves, energy absorbing materials for mitigating impacts and concussions, as well as in systems for mitigating micrometeoroid and orbital debris threats in space applications. The development of commercial applications of STFs will be discussed. The rheological investigations and micromechanical modeling serve as a framework for the rational design of STF-based materials to meet specific performance requirements not easily achieved with more conventional materials. (Phys. Today, Oct. 2009, p. 27-32) I will illustrate some technological applications of STFs under commercial development, including use in astronaut protection and application in the manned missions to the Moon and Mars.