Michigan State University
Science at the Edge
Engineering Seminar

January 24th, 2014
11:30 a.m.
Room1400 Biomedical and Physical Sciences Building
Refreshments served at 11:15 a.m.

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Shear thickening fluids and their applications

Abstract

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. Measurements of the microstructure commensurate with the viscosity and normal stress differences in shearing colloidal suspensions provides an understanding of how to control the viscosity, shear thinning, and shear thickening rheological behavior typical of concentrated dispersions. 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 are novel field-responsive materials that can be engineered to be useful nanocomposites for enhanced ballistic and impact protection, as well as for space applications. I will discuss the scientific basis of shear thickening and their applications. http://www.ccm.udel.edu/STF/ Although many applications of concentrated suspensions are hindered by shear thickening behavior, novel materials have been developed around shear thickening fluids (STFs). Ballistic, stab and impact resistant flexible composite materials are synthesized from colloidal & nanoparticle shear thickening fluids for applications as protective materials. 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, as will be discussed. (Phys. Today, Oct. 2009, p. 27-32)

Bio

Norman J. Wagner is the Alvin B. and Julia O. Stiles Professor in the Department of Chemical & Biomolecular Engineering at the University of Delaware. He served as Chair of the Department from 2007-2012, and also the director of the Center for Neutron Science

(www.cns.che.udel.edu). He leads an active research group in the fields of rheology, complex fluids, polymers, applied statistical mechanics, nanotechnology and particle technology. His research focus areas include the effects of applied flow on the microstructure and material properties of colloidal suspensions, polymers, self-assembled surfactant solutions, and combinations thereof. Prof. He earned his Bachelors degree from Carnegie Mellon and Doctorate from Princeton University, was an NSF/NATO Postdoctoral Fellow in Germany, and a Director' s Postdoctoral Fellow at Los Alamos National Lab prior to joining the University of Delaware in 1991. He was named a Senior Fulbright Scholar (Konstanz, Germany) and served as a guest Professor at the ETH, Zurich (1997) and the University of Rome (2004). He was awarded the Siple Award in 2002 by the US Army for his development of shear thickening fluids for novel energy absorbing materials. This collaborative research with the Army Research Lab is a major research and development effort toward creating novel, protective materials (www.ccm.udel.edu/STF/). Prof. Wagner has authored or coauthored over 180 scientific publications and patents and is on the editorial boards of five international journals. He has co-authored a textbook (2008) on Mass and Heat Transfer for the Chemical Engineering series of Cambridge University Press, as well as Colloidal Suspension Rheology (2011), also Cambridge University Press. He has developed commercial rheo-optic instruments as well as novel rheo-SANS instruments for investigating nanoscale and microscale structure in flowing systems. More about Professor Wagner and his research can be found at www.che.udel.edu/wagner.

For further information please contact Prof. Christina Chan, Department of Chemical Engineering and Materials Science at krischan@egr.msu.edu

Persons with disabilities have the right to request and receive reasonable accommodation. Please call the Department of Chemical Engineering and Materials Science at 355-5135 at least one day prior to the seminar; requests received after this date will be met when possible.