NASA/Delaware Space Grant Consortium

Novel nanomaterial aimed to improve space suit safety

A. Kate Gurnon,
University of Delaware

Photo courtesy of Evan Krape, University of Delaware Photography

Astronauts are exposed to many dangers in space, particularly debris encountered while working outside the spacecraft. Micrometeoroid and orbital debris (MMOD) are sub-centimeter sized particles that can travel up to 19 kilometers per second and have the potential to penetrate space suits [Christiansen, E.L. Handbook for Designing MMOD Protection. *Johnson Space Center Report* (2009)], placing astronauts at risk and sometimes forcing them to abort their mission. During the past two years as a NASA Delaware Space Grant Fellow, I have studied Shear Thickening Fluids (STFs), a novel nanotechnology comprised of nanoparticles in a carrier fluid that has the potential to dissipate energy upon an impact and improving the material's resistance to the imposed stress. This unique material can be incorporated into fabrics and shows promise to improve MMOD resistance in the next generation space suits while remaining flexible and durable.

Under the supervision of my advisors, Dr. Norman J. Wagner and Dr. John W. Gillespie, I have developed a new test method by combining large amplitude oscillatory shear (LAOS) rheometry and small angle neutron scattering (SANS) methods to understand the shear response and corresponding microstructure of STFs during a dynamic deformation, [A. K. Gurnon, *et al.* 'Measuring Material Microstructure under Flow Using 1-2 plane flow-Small Angle Neutron Scattering'. Journal of Visual Experiments (In-Press)]. This knowledge is relevant for understanding the response of STF-fabric nanocomposites during hypervelocity impact and can help engineer STFs tailored to meet the challenges of operating in the environment of low earth orbit.

I am honored to be a NASA DESGC fellow, and I attribute the significant progress I have made in my research to the added financial flexibility the award afforded me. My first, first-author paper [A. K. Gurnon and N. J. Wagner. J. Rheol. 56, 333 (2012)] focuses on the development of constitutive models to predict the dynamic response of non-Newtonian materials undergoing LAOS. I have also presented my Space Grant-supported research annually at the national Society of Rheology (SoR) meeting as well as the International Congress on Rheology (ICR). As the Fraser and Shirley Russell teaching Fellow, I co-instructed the Introduction to Chemical Engineering course this past spring. Further, I am involved in K-12 and women's STEM outreach programs at UDel, during which I use my DESGC sponsored research for laboratory demonstrations.

Finally, this summer I am advising an undergraduate student in the Chemical and Biomolecular Engineering Department. We will focus on the dynamic material properties of STFs undergoing shear for composite material applications as I complete my doctoral dissertation. I am fortunate to have received the DESGC fellowship; it has given me opportunities to develop novel experiments, flexibility to attend conferences directly related to my research and the platform to communicate my work to other researchers and students who match my enthusiasm for research.