Shear History Extensional Rheology Experiment II (SHERE II)
Microgravity Rheology with Non-Newtonian Polymeric Fluids

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Introduction
• The primary objective of SHERE II is to study the effect of torsional preshear on the subsequent extensional behavior of filled viscoelastic suspensions.
• Microgravity environment eliminates gravitational sagging that makes Earth-based experiments of extensional rheology challenging.
• Experiments may serve as an idealized model system to study the properties of lunar regolith-polymeric binder based construction materials.
• Filled polymeric suspensions are ubiquitous in foods, cosmetics, detergents, biomedical materials, etc.

Model Fluid and Experimental Hardware
• The SHERE II test fluid consists of a dilute solution (0.025 wt.%) of 2.25 × 104 g/mol polystyrene (narrow polydispersity) in oligomeric styrene mixed with 6 µm poly (methyl methacrylate) microspheres. 6 micron PMMA beads (left) were used to simulate the lunar regolith (right).
• Test fluid preparation and its ground-based rheological characterization was performed at Massachusetts Institute of Technology (MIT) using a TA Instruments strain-controlled ARES rheometer. The onboard extensional rheometer and other allied hardware was manufactured by ZIN Technologies.

Results
Shear Rheology
• The shear viscosity of the filled suspension is higher than that of the pure Boger fluid alone and is Newtonian over two decades of shear rate.
• The shear thickening seen at higher shear rates is possibly due to improved hydrodynamic interparticle interactions (Scirocco et al. 2005).
• Small Amplitude Oscillatory Experiments show that the fluid is dominated by viscosity.
• Addition of the particles leaves linear rheology unchanged.

International Space Station (ISS) Onboard Experiments
• The onboard experiments consist of three distinct stages: Preshear, stretch, and capillary thinning.
• Each test point is uniquely determined through the preshear rate and the stretch rate (Preshear time = 30 s). 25 different test points were measured during SHERE II operations.

Conclusions
• Specialized algorithms were written to carry out the data analysis and calculation of the rheological parameters according to the flowchart above.
• From the elasto-capillary regime of the filament thinning phase, the relaxation time as well as the extensional viscosity of test fluid can be obtained.
• The stretch phase yields the extensional viscosity of the test fluid as a function of nominal strain rate.

References

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