Abstract Submitted
for the MAR16 Meeting of
The American Physical Society

Real-time dynamics of high-velocity micro-particle impact DAVID VEYSSET, Massachusetts Inst of Tech-MIT, ALEX HSIEH, U.S. Army Research Laboratory, STEVE KOOI, ALEX A. MAZNEV, SHENGCHANG TANG, BRADLEY D. OLSEN, KEITH A. NELSON, Massachusetts Inst of Tech-MIT — High-velocity micro-particle impact is important for many areas of science and technology, from space exploration to the development of novel drug delivery platforms. We present real-time observations of supersonic micro-particle impacts using multi-frame imaging. In an all optical laser-induced projectile impact test, a monolayer of micro-particles is placed on a transparent substrate coated with a laser absorbing polymer layer. Ablation of a laser-irradiated polymer region accelerates the micro-particles into free space with speeds up to 1.0 km/s. The particles are monitored during the impact on the target with an ultrahigh-speed multi-frame camera that can record up to 16 images with time resolution as short as 3 ns. In particular, we investigated the high-velocity impact deformation response of poly(urethane urea) (PUU) elastomers to further the fundamental understanding of the molecular influence on dynamical behaviors of PUUs. We show the dynamic-stiffening response of the PUUs and demonstrate the significance of segmental dynamics in the response. We also present movies capturing individual particle impact and penetration in gels, and discuss the observed dynamics. The results will provide an impetus for modeling high-velocity microscale impact responses and high strain rate deformation in polymers, gels, and other materials.

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Date submitted: 06 Nov 2015 Electronic form version 1.4