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**Probing Physical and Chemical Properties of Laser Shocked Materials using Ultrafast Dynamic Ellipsometry and Spectroscopies**

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Ultrafast laser techniques allow resolution of shock induced physics and chemistry picoseconds behind the shock front. In this presentation, the 350 ps sustained laser-generated shocks will be shown to combine with ultrafast dynamic ellipsometry to measure the shock state and transient absorption to measure the molecular electronic response to shock loading. Experimental data will be presented on shocked explosive crystals and liquids. Ultrafast dynamic ellipsometry was used to measure the shock and particle velocity as well as the shocked refractive index. Transient absorption spectra of RDX and simple molecular liquids in the spectral region from 440 to 780 nm were measured to map out shock reactivity during the first 350 ps, over shock stress states from 7 to 20 GPa. Additionally, nonlinear spectroscopic probes will be demonstrated to offer the potential to measure even more details of the molecular shock response, such as evolution of chemical species and vibrational temperature. Preliminary results of shocked phenylacetylene obtained using vibrational coherent anti-Stokes Raman spectroscopy (CARS) and the capability of femtosecond stimulated Raman scattering (FSRS) data to measure the nonequilibrium time evolution of mode specific vibrational temperatures on picosecond time scales will be discussed.