Toward a Broadband Reflectivity Diagnostic on OMEGA EP: Measurements of optical reflectivity of compressed matter can be used to infer electrical and thermal conductivity, high-pressure insulator–conductor transitions, and benchmark electronic structure calculated by density functional theory. In this experiment, the reflectivity of aluminum, ramp compressed to 270 GPa (2.7 Mbar), was measured using a white-light (400- to 700-nm) probe in a reflective geometry. Aluminum exhibits strong absorption in the visible associated with splitting of parallel energy bands within its electronic structure.[1] By examining the high-pressure optical response of aluminum, we attempt one of the first measurements of electronic structure in matter at extreme conditions.

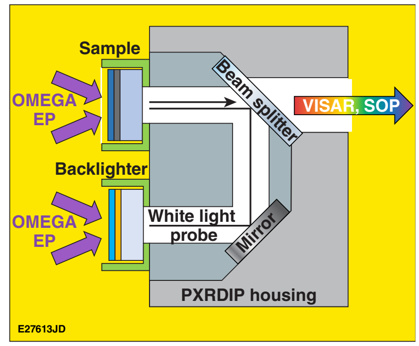

Figure 1. Schematic of the targets and optical train used in this experiment. UV beams drive the target packages mounted on the front of a powder x-ray diffraction image-plate (PXRDIP) box. White light from the backlighter is directed to the back surface of the aluminum sample via a titanium mirror and 50R/50T beam splitter. Additionally, this geometry allows the VISAR laser to probe the Al–LiF interface during exposure to the white light.

These experiments used the self-emission from a shock in low-density foam as a white-light source for reflectivity measurements (Fig. 1). The backlighter comprised a CH ablator, a single-crystal quartz pusher, and a low-density (200-mg/ cm^3) SiO_2 foam. Two of OMEGA EP's 351-nm beams drove the backlighter package at a near-constant irradiance of 1.5×10^{14} W/cm^2 for 4 ns. Ablation of the CH drives a shock wave into the foam that radiates as a blackbody with a temperature of ~9 eV for 6 ns. A titanium mirror and 50R/50T beam splitter redirected the broadband probe onto the back surface of the compressed aluminum sample. The aluminum sample was simultaneously ramp compressed by two additional drive beams. Samples were driven for 10 ns with a peak irradiance of 1.9×10^{13} W/cm^2, compressing the aluminum to 270 GPa. Targets were composed of a single-crystal diamond ablator, an aluminum sample, and a lithium fluoride (LiF) window. *LILAC* simulations were used to design the targets and pulse shapes and to predict the arrival time of the pressure wave at the Al–LiF interface. LiF remains transparent to at least 800 GPa in ramp-compression experiments.[2] The velocity interferometer for any reflector (VISAR)[3] measures the interface velocity of the Al–LiF interface, making it possible to deduce the pressure state in the aluminum sample. The white-light probe is collected by a streaked optical pyrometer (SOP).[4] The SOP streak image is shown in Fig. 2(a). Figure 2(b) shows lineouts of the SOP image overlaid with the Al–LiF interface velocity obtained from VISAR. A noticable drop in the reflected probe's intensity is recorded at 6 ns when the Al–LiF interface has achieved a pressure of 30 GPa. A decrease in reflectivity is expected at this pressure when the *d* band shifts to absorb strongly in the visible.

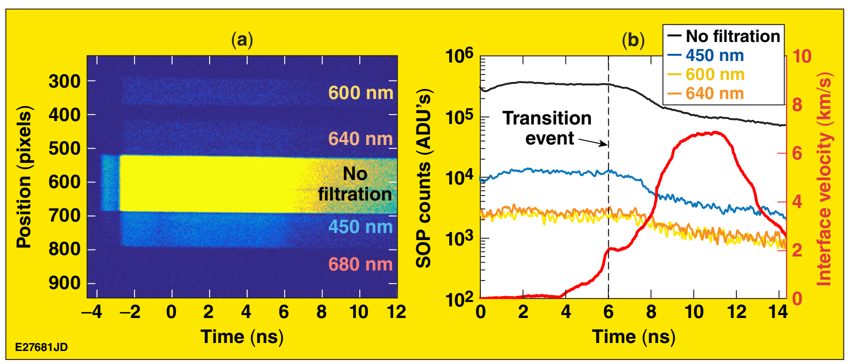

Figure 2: OMEGA EP shot 28400. (a) SOP streak image with filtered regions indicated by their filter's central wavelength. The region with no filtration is used to compare with undriven reference shots. (b) Lineouts of the SOP streak record overlaid with the Al–LiF interface velocity extracted from VISAR. A drop in the reflected probe's intensity, beginning at 6 ns, occurs when the pressure at the Al–LiF interface reaches 30 GPa.

Omega Facility Operations Summary: During June 2018, the Omega Laser Facility conducted 180 target shots with an average experimental efficiency (EE) of 96.7%. One hundred twenty-four of these shots were taken on the OMEGA laser with EE = 96.4% and 56 shots were taken on the OMEGA EP laser with EE = 97.3%. The ICF program carried out 88 target shots for experiments led by LLE, LLNL, and NRL while the HED program accounted for 47 shots led by LLNL and LLE. Three NLUF experiments led by the University of Michigan, MIT, and the University of California, Berkeley had 26 target shots and two LBS experiments led by LLNL had 11 target shots. The Centre Lasers Intenses et Applications (CELIA) of France carried out an eight-target shot campaign.

1. H. Tups and K. Syassen, J. Phys. F: Met. Phys. **14**, 2753 (1984); 2. D. E. Fratanduono *et al*., J. Appl. Phys. **109**, 123521 (2011); 3. L. M. Barker and R. F. Hollenbach, J. Appl. Phys. **43**, 4669 (1972); 4. M. C. Gregor *et al*., Rev Sci Instrum. **87**, 114903 (2016).