November 2000 Progress Report on the Laboratory for Laser Energetics
Inertial Confinement Fusion Program Activities

SSP Material Properties Studies: As part of the participation in the Stewardship Science Program (SSP), LLE is studying the feasibility of using extended x-ray absorption spectrum (EXAFS) for characterizing the properties of strongly shocked materials. EXAFS can measure the density and temperature of such materials and study their transient melting. Initial tests are very encouraging. Figure 1 shows the x-ray spectrum emitted by an imploding CH shell, transmitted through a cold, 12.5-μm-thick Ti foil. The EXAFS modulations are clearly seen. The remarkably high-contrast modulations are due to three factors employed in these tests: (a) the intense (and spectrally smooth) x-ray emission of an imploding target; (b) the use of very high attenuation (<2% transmission), which increases the relative modulations in the spectrum; and (c) low-noise CID electronic detection rather than film. Figure 2 shows the relative modulations in the absorption coefficient derived from Fig. 1. The amplitude of the Fourier transform of the spectrum of Fig. 2 (shown in Fig. 3) gives the charge distribution around an absorbing Ti atom. This distribution is seen to be reproducible and agrees well with the published data obtained with synchrotron radiation. The major peak is due to the nearest neighbors around the absorbing atom, whereas the minor peak is due to the next shell of neighbors. The density is given by the modulation period in Fig. 2 and the temperature by the modulation decay rate. Of particular importance is the ability to observe the minor peak since it is very sensitive to melting, or any change in longer-range order.

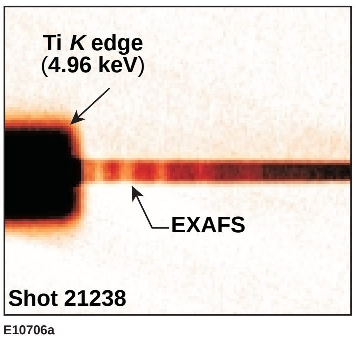

Figure 1. EXAFS modulation observed above the Ti *K* edge, measured by a CID x-ray spectrometer. Ti foil is backlit by an OMEGA-imploded target.

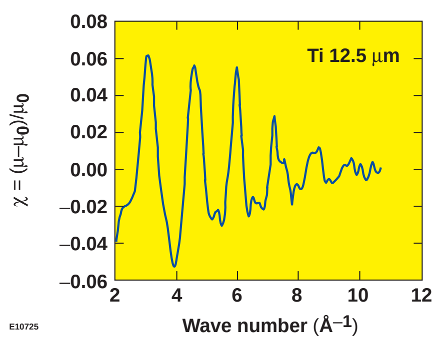

Figure 2. Measured relative modulation of the absorption in Ti derived from Fig. 1 as a function of the wave number of the ejected photoelectron (following *K*-shell photoionization).

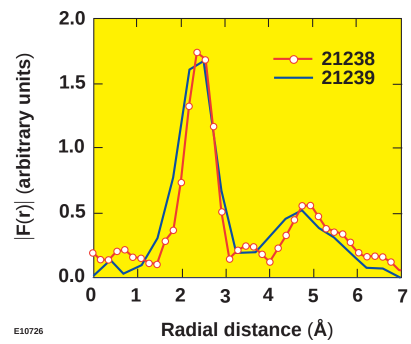

Figure 3. Fourier transform of the spectrum in Fig. 2, yielding the charge distribution around the absorbing Ti atom in the crystal. The spectrum for two consecutive OMEGA shots shows consistency. The weaker peak, due to the second shell of nearest neighbors, is sensitive to order reduction due to shock heating.

LANL's Double-Shell, Indirect-Drive Implosions: During November, scientists from the Los Alamos National Laboratory continued a campaign to investigate the feasibility of double-shell, gas-filled capsules for NIF indirect-drive implosions. Initial experiments on OMEGA with tetrahedral hohlraums showed relatively high neutron yield performance for double-shell targets with reduced M-band absorption. The November experiments extended these results to double-shell capsules driven with cylindrical hohlraums.

OMEGA Operations Summary: In November, 12 target shot days yielded 120 shots for five campaigns. OMEGA's 60-beam uniformity continues to improve. The average on-target energy balance was 3% rms for 61 spherical shots (LLE-ISE). The LLE-RTI campaigns continued to investigate imprinting and adiabat control with and without a "picket" in front of a drive pulse (23 shots). CEA, NRL, and LLE used a single day of shots to cross calibrate hard x-ray detectors and bring on a new NRL-designed hard x-ray spectrometer (11 shots). LANL users conducted experiments that extended prior tetrahedral-hohlraum, double-shell implosion data to cylindrical hohlraums. LANL also conducted a week-long series of halfraum and backlighter target shots (25 shots).

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