April 2002 Progress Report on the Laboratory for Laser Energetics
Inertial Confinement Fusion Program Activities

Cryogenic Target Ice Layering: Prior experience in deuterium-ice layering showed that the ice temperature must be very close to the triple point of deuterium to achieve a smooth ice layer. Cryogenic target designs, however, require an internal gas temperature 1.7 K below the triple point to achieve the desired convergence ratio.

In recent work to explore these temperature limits, a 900-μm-diam CH target (4.9-μm wall) containing a 92.5-μm-thick ice layer with a rms roughness of 3.2 μm was cooled from 18.7 K to 16.9 K at a rate of 1 mK/min. The ice roughness increased, as expected, due to the ~1% change in density of the constrained deuterium ice with temperature (see Fig. 1). It was observed, however, that as the target was layered with IR laser light for over 12 h at the lower temperature, the ice layer recovered its original smoothness (see Fig. 2). Subsequent warming of the target back to 18.7 K introduced a roughness that annealed with time. The same result was observed by repeating the cooling process at a faster cooling rate (8 mK/min).

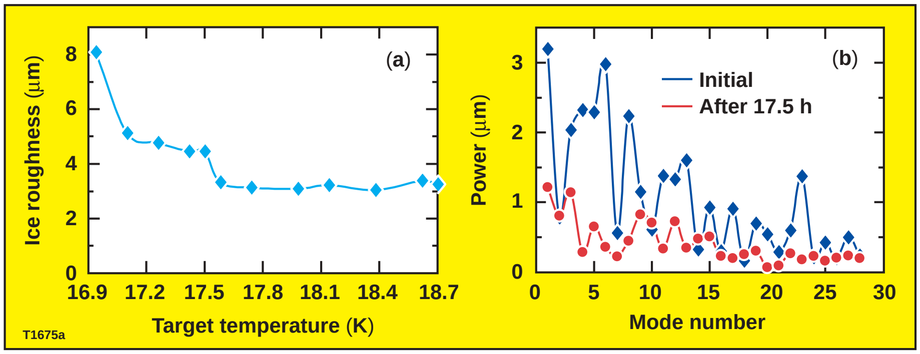

Figure 1. (a) Ice roughness plotted as a function of target temperature as the temperature was lowered from 18.7 K to 16.9 K at a rate of 1 mK/min. (b) Spectrum of target roughness measured immediately after lowering the target temperature to 16.9 K (blue line) and after "soaking" at 16.9 K for 17.5 h. The original target smoothness is restored after 17.5 h.

Modulated Shock Waves: The investigation of shock waves produced by laser-driven ablation is an important part of the study of inertial confinement fusion (ICF), equation of state (EOS), and other high-energy-density sciences. Recent OMEGA experiments investigated direct-drive targets driven with a laser beam having a single-mode spatial intensity modulation. The resultant ablation-pressure modulations produced shocks with spatially varying strengths (and velocities). The shock arrival at two surfaces was measured by placing an embedded layer within the target and observing the changes in target reflectivity (see Fig. 2). *ORCHID* 2-D simulations modeled the observed shock-breakout time and modulations accurately.

OMEGA Operations Summary: During April 2002, a total of 142 target shots were taken for experiments by Lawrence Livermore National Laboratory (LLNL), Commissariat à l'Énergie Atomique (CEA), LLE, and the National Lasers Users' Facility (NLUF). The 77 LLNL shots included radiation physics, hydrodynamic instability, capabilities development, cocktail hohlraum physics, x-ray Thomson scattering, high-*Z* equation of state, and IDrive campaigns. Nine shots were taken for CEA programs in the physics of radiation-driven ablators and hohlraum symmetry. The NLUF experiments totaled 15 shots carried out by two teams: One team headed by the University of Nevada, Reno, including collaborators from LLNL and LLE, investigated the measurement of density gradients in hohlraum-driven implosions. A second team headed by the University of Michigan, including collaborators from the University of Arizona, LLE, Los Alamos National Laboratory, and LLNL, carried out laboratory astrophysics experiments. The 41 LLE shots were taken for the integrated spherical experiments, EXAFS, Rayleigh–Taylor test bed, and cryogenic target campaigns.

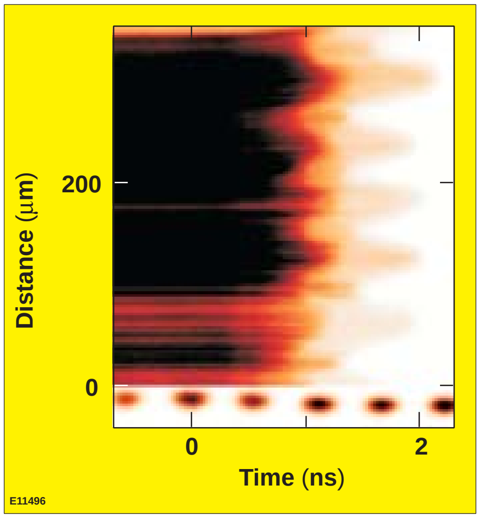

Figure 2. Streak record of reflection from a modulated shock experiment (shot 24566). The dots across the bottom are temporal fiducial pulses separated by ~548 ps. A probe beam penetrates the rear portion of the target (a 10-μm-thick transparent CH layer) and reflects off an embedded Al layer. This reflection is observed as the dark portion of the image that extends from less than –1 ns to +1 ns. The drive laser pulse starts at 0 ns. At about +1 ns, the shock arrives at the Al layer and reduces its reflectivity. The modulations result from different arrival times of the modulated shock in the target.

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