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Contents

In Brief iii

Direct-Drive Cryogenic Target Implosion Performance on OMEGA 1

Hot-Core Characterization of a Cryogenic D_2 Target at Peak Neutron Production in a Direct-Drive Spherical Implosion 11

Extended X-Ray Absorption Fine Structure Measurements of Laser Shocks in Ti and V and Phase Transformation in Ti 16

Picosecond Response of Ultraviolet Photodiodes on GaN........... 25

Self-Assembly of Coated Colloidal Particles for Optical Applications 28

A Tunable, High-Repetition-Rate, Harmonically Mode-Locked, Ytterbium Fiber Laser 36

Deterministic Microgrinding, Lapping, and Polishing of Glass-Ceramics... 40

Publications and Conference Presentations

In Brief

This volume of the LLE Review, covering October–December 2003, features "Direct-Drive Cryogenic Target Implosion Performance on OMEGA," by P. W. McKenty, J. A. Delettrez, L. M. Elasky, R. Epstein, A. Frank (University of Rochester and LLE), V. Yu. Glebov, V. N. Goncharov, D. R. Harding, S. Jin, J. P. Knauer, R. L. Keck, S. J. Loucks, L. D. Lund, R. L. McCrory, F. J. Marshall, D. D. Meyerhofer, S. P. Regan, P. B. Radha, S. Roberts, W. Seka, S. Skupsky, V. A. Smalyuk, J. M. Soures, K. A. Thorp, and M. Wozniak; J. A. Frenje, C. K. Li, R. D. Petrasso, and F. H. Séguin–PSFC-MIT; K. A. Fletcher, S. Padalino, and C. Freeman–SUNY, Geneseo; and N. Izumi, J. A. Koch, R. A. Lerche, M. J. Moran, T. W. Phillips, G. J. Schmid, and C. Sorce–LLNL (p. 1). Layered and characterized cryogenic D_2 capsules have been imploded using high-contrast pulse shapes on the 60-beam OMEGA laser at the Laboratory for Laser Energetics. These experiments measure the sensitivity of the direct-drive implosion performance to parameters such as the inner-ice-surface roughness, the adiabat of the fuel during the implosion, and the laser power balance. The goal is to demonstrate a high neutron-averaged fuel ρR with low angular variance using a scaled $\alpha \sim 3$ ignition pulse shape driving a scaled all-DT ignition capsule. Results are reported with improvements over previous experimentsin target layering and characterization and in laser pointing and target positioning on the OMEGA laser. These capsules have been imploded using up to 23 kJ of 351-nm laser light with an on-target energy imbalance of less than 2% rms, full beam smoothing (1-THz bandwidth, 2-D SSD, and polarization smoothing), and new, optimized, distributed phase plates. Pulse shapes include high-adiabat ($\alpha \sim 25$) square pulses and low-adiabat ($\alpha < 5$) shaped pulses. The data from neutron and charged-particle diagnostics, as well as static and time-resolved x-ray images of the imploding core, are compared with 1-D and 2-D numerical simulations. Scaling of target performance to a weighted quadrature of inner-ice roughness at the end of the acceleration phase is investigated.

Additional highlights of research presented in this issue include the following:

- V. A. Smalyuk, J. A. Delettrez, S. B. Dumanis (visiting scientist, Columbia University), R. Epstein, V. Yu. Glebov, D. D. Meyerhofer, P. B. Radha, T. C. Sangster, C. Stoeckl, and N. C. Toscano; J. A. Frenje, C. K. Li, R. D. Petrasso, and F. H. Séguin–PSFC-MIT; and J. A. Koch–LLNL (p. 11) characterize the compressed-core, temperature-density profiles of a cryogenic deuterium (D_2) target using measured primary deuterium–deuterium (DD) and secondary deuterium–tritium (DT) yields, neutron-averaged ion temperature, and x-ray images at peak neutron production. In addition, the authors infer the electron pressure and the areal density of the neutron production region to be 2.7±0.4 Gbar and ~10 mg/cm^2, respectively.

- B. Yaakobi, D. D. Meyerhofer, and T. R. Boehly; J. J. Rehr–Dept. of Physics, University of Washington; B. A. Remington, P. G. Allen, and S. M. Pollaine–LLNL; and R. C. Albers–LANL (p. 16) use a laser-source-based, extended x-ray absorption fine structure (EXAFS) measurement to study the properties of laser-shocked metals on a nanosecond time scale. The ability of measuring shock-induced temperatures of the order of 0.1 eV is essentially unique to EXAFS. EXAFS measurements of vanadium shocked to ~0.5 Mbar with a 3-ns laser pulse yield a compression and temperature in good agreement with hydrodynamic simulations and shock-speed measurements. In laser-shocked titanium at the same pressure, the EXAFS modulation damping is much higher than warranted by the increase in temperature. This is explained by the α-Ti to ω-Ti phase transformation known to occur around ~0.1 Mbar in the longer (μs) shocks obtained in gas-gun experiments. In the ω-Ti phase, the disparate neighbor distances cause a beating of the modulation frequencies and thus an increased damping. These results demonstrate that EXAFS measurements can be used for the study of nanosecond-scale shocks and phase transformations in metals.

- J. Li and W. R. Donaldson (p. 25) tested metal–semiconductor–metal ultraviolet photodiodes fabricated on GaN in the picosecond regime with an electro-optic sampling system. The best performance of a device with a feature size of 1 μm showed a 1.4-ps rise time and 3.5-ps full width at half maximum, which represents the fastest ultraviolet GaN photodiode reported to date. The derived electron velocity in GaN was in good agreement with an independent photoexcitation measurement. A comparison with Monte Carlo simulation was made, and slower impulse response observed in a device with a smaller feature size of 0.5 μm was discussed.

- M. Z. Yates, C. Wolfe, J.-C. Lin, and F. Caruso (Dept. of Chemical Engineering, University of Rochester) (p. 28) consider photonic crystals that offer great promise in a variety of applications in optoelectronics, from lasers to the creation of all-optical circuits for computing. The presented research project focuses on the creation of novel photonic crystals through the self-assembly of core-shell structured colloidal particles. Layer-by-layer electrostatic self-assembly was used to deposit polyelectrolyte shells around spherical colloidal particles. By exploiting electrostatic attraction, shells of controllable thickness were formed by alternating the deposition of positive- and negative-charged polyelectrolytes. The coated colloidal particles were deposited as thin films of hexagonally close-packed crystals onto glass slides. The crystalline films display a partial photonic band gap and preferentially reflect light of a wavelength dependent on the size of the particles making up the crystal. The chemical functional groups in the shell surrounding the colloidal particles offer a potential route to immobilize optically active species in the shell to enhance the photonic band gap of the crystal.

- N. Usechak, G. Agrawal, and J. D. Zuegel (p. 36) report on a ytterbium fiber laser mode-locked at its 280th harmonic, which corresponds to a repetition rate greater than 10 GHz. The laser produces linearly polarized, 2.6-ps chirped pulses with up to 38 mW of average output power. The mode-locked pulses are tunable over a 55-nm window centered on 1053 nm.

- J. C. Lambropoulos [also Dept. of Mechanical Engineering and the Center for Optics Manufacturing (COM)], B. E. Gillman (Zygo Corp.), S. D. Jacobs (also COM), and H. J. Stevens (Corning, Inc.) (p. 40) report on a series of microgrinding and polishing experiments on glass-ceramics. Microgrinding includes deterministic microgrinding (fixed infeed rate) and loose-abrasive lapping (fixed pressure). Material mechanical properties (Young's modulus, hardness, fracture toughness) and chemical properties (chemical susceptibility, or mass loss under chemical attack) are correlated with the quality of the resulting surface (surface microroughness and surface grinding-induced residual stresses). Deterministic microgrinding (at fixed infeed) and loose-abrasive microgrinding (at fixed pressure) are compared in terms of material removal rates and resulting surface quality.

Valeri N. Goncharov
Editor