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Contents

In Brief

This volume of the LLE Review, covering April–June 2009, features "Shock-Ignition Experiments on OMEGA at NIF-Relevant Intensities" by W. Theobald, R. Betti, K. S. Anderson, O. V. Gotchev, D. D. Meyerhofer, C. Ren, A. A. Solodov, and C. Stoeckl (LLE and Fusion Science Center for Extreme States of Matter and Fast Ignition Physics); V. A. Smalyuk, J. A. Delettrez, V. Yu. Glebov, F. J. Marshall, J. F. Myatt, T. C. Sangster, W. Seka, and B. Yaakobi (LLE); and J. A. Frenje and R. D. Petrasso (Plasma Science and Fusion Center, MIT). In this article (p. 117), the authors discuss shock-ignition experiments that have been performed with peak shock-generating laser intensities of ~1×10^{16} W/cm^2. Shock ignition is a two-step inertial confinement fusion (ICF) concept in which a strong shock wave is launched at the end of the laser drive pulse to ignite the compressed core, relaxing the driver requirements and promising high gains. In the experiments described in this article, room-temperature plastic shells filled with D_2 gas were compressed on a low adiabat by 40 beams of the 60-beam OMEGA Laser System. The remaining 20 beams were delayed and tightly focused onto the target to drive a strong shock into the compressed core. Good coupling of the shock-beam energy was observed in these experiments, leading up to an ~20× increase in neutron yield. The authors observed significant stimulated Raman backscattering of laser energy; however, fast-electron measurements showed a relatively cold energy distribution. These fast electrons are actually beneficial for shock ignition since they have short mean-free-paths and are stopped in the thin outer layer of the imploding target, augmenting the strong hydrodynamic shock.

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

- O. V. Gotchev, D. D. Meyerhofer, O. Polomarov, and R. Betti (LLE and Fusion Science Center for Extreme States of Matter and Fast Ignition Physics); P. Y. Chang and J. P. Knauer (LLE); J. A. Frenje, C. K. Li, M. J.-E. Manuel, R. D. Petrasso, and F. H. Séguin (Plasma Science and Fusion Center, MIT); and J. R. Rygg (LLNL) discuss laser-driven magnetic-flux compression in high-energy-density plasma experiments (p. 123). The authors demonstrated for the first time magnetic-field compression to many tens of megagauss (MG) in cylindrical implosions of inertial confinement fusion targets. The very high magnetic-flux compression was achieved using the ablative pressure of the OMEGA laser to drive a cylindrical shell at high-implosion velocity, trapping and compressing an embedded external field to tens of MG, high enough to magnetize the hot-spot plasma. The magnetic fields in the compressed core were probed via proton deflectrometry using the fusion products from an imploding D^3He target. Line-averaged magnetic fields between 30 and 40 MG were observed.

- R. D. Petrasso, C. K. Li, F. H. Séguin, J. R. Rygg, and J. A. Frenje (Plasma Science and Fusion Center, MIT); R. Betti, J. P. Knauer, and D. D. Meyerhofer (LLE); and P. A. Amendt, D. H. Froula, O. L. Landen, P. K. Patel, J. S. Ross, and R. P. J. Town (LLNL) show that monoenergetic proton radiography combined with Lorentz mapping can be used to uniquely detect and discriminate magnetic and electric fields (p. 129). Protons were used to image two identical expanding plasma bubbles, formed on opposite sides of a 5-μm-thick plastic (CH) foil by two 1-ns-long laser-interaction beams. The second bubble reverses the sign of any magnetic fields relative to the first bubble by the protons, while keeping the electric fields the same. Field-induced deflections of the monoenergetic 14.9-MeV probe protons passing through the two bubbles, measured quantitatively with proton radiography, were combined with Lorentz mapping to provide separate measurements of magnetic and electric fields. The authors' results provided absolute identification and measurement of a toroidal magnetic field around each bubble and determined that any electric field component parallel to the foil was below measurement uncertainties.

- J. Bromage, C. Dorrer, J. R. Marciante, and J. D. Zuegel use a spatially resolved spectral interferometry technique, known as S^2 imaging, to measure for the first time, higher-order-mode content of a large-mode-area amplifier at full power (p. 134). The technique was adapted for the short-fiber amplifier at full power and revealed a small amount of a co-polarized LP_{11} mode. This mode's power, relative to the fundamental LP_{01} mode, depends on the alignment of the input signal at injection to the rod amplifier, and ranged from –18 dB, for optimized alignment, to –13 dB when the injection alignment was offset along the LP_{11} axis by 15 μm (30% of the 55-μm mode-field diameter). The increase in LP_{11} contributed to the M^2 degradation that was measured when the injection was misaligned.

- A. V. Okishev demonstrates for the first time optical differentiation in a regenerative amplifier (RA) with temperature-tuned volume Bragg grating (VBG) as an intracavity spectral filter (p. 141). The VBG as a spectrally selective resonator mirror works as an optical differentiator when the VBG reflection peak is detuned from the central laser wavelength. A simple, reliable laser system that produces multi-millijoule ~150-ps pulses without mode-locking, using an RA with VBG as an optical differentiator, is described.

- J. C. Lambropoulos and H. Liu (Department of Mechanical Engineering, U. of Rochester) discuss crack growth in brittle glass plates using known finite element modeling to determine the maximum allowable initial crack size in plates undergoing radiative cooling (p. 145). In these simulations both BK7 borosilicate crown and LHG8 phosphate glass were slowly cooled in vacuum from 200°C down to room temperature. The authors used finite elements and incorporated available experimental results on crack growth in BK7 and LHG8. Numerical simulation showed that the heaviest stressed locations were the midpoints of the plate's long edges, where any crack growth was likely to originate. This article outlines a procedure to estimate the deepest-allowable surface flaw to prevent fracture. Fracture is analyzed in terms of strength, fracture toughness, or slow crack growth. Merits of these approaches are discussed, and an extensive comparison of cracking in BK7 versus LHG8 is presented.

- G. Guarino, W. R. Donaldson, and R. Sobolewski (LLE); M. Mikulics and M. Marso (Institute of Bio- and Nanosystems, Research Centre of Jülich); and P. Kordoš (Institute of Electrical Engineering, Slovak Academy of Sciences) apply finite element analysis to ultrafast photoconductive switches of the metal–semiconductor–metal (MSM) type to explain why MSM devices with alloyed electrodes show improved photoresponse efficiency compared to devices with surface contact electrodes (p. 154). The alloyed device, despite having a somewhat larger capacitance, has an active region of lower resistance with a more-uniform and deeper-penetrating electric field and carrier transport current. The authors use the latter to explain the experimentally observed faster response of the alloyed device in terms of the equivalent lumped parameters. They also use the model to predict improved responsivity, based on electrode spacing and antireflective coating.

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Editor