GIGABAR SHOCKS FOR SHOCK-IGNITION FUSION AND HIGH-ENERGY-DENSITY PLASMAS

W. Theobald[1,2], R. Betti[1,2,3], R. Nora[4], W. Seka[1,2], M. Lafon[5], K.S. Anderson[1,2], M. Hohenberger[1], F.J. Marshall[1], D.T. Michel[1], A. Shvydky[1], A.A. Solodov[1], C. Stoeckl[1], D.H. Edgell[1], B. Yaakobi[1], A. Casner[5], C. Reverdin[5], X. Ribeyre[6], A. Vallet[6], J. Peebles[7], F.N. Beg[7], M. S. Wei[8]
[1]Laboratory for Laser Energetics, University of Rochester, Rochester, NY, USA
[2]Fusion Science Center, University of Rochester, Rochester, NY, USA
[3]Depts. of Mechanical Engineering and Physics, University of Rochester, Rochester, NY, USA
[4]Lawrence Livermore National Laboratory, Livermore, CA, USA
[5]CEA, DAM, DIF, Arpajon, France
[6]Centre Lasers Intenses et Applications, University of Bordeaux, Bordeaux, France
[7]University of California at San Diego, La Jolla, CA, USA
[8]General Atomics, San Diego, CA, USA
wthe@lle.rochester.edu

Direct-drive experiments at incident laser intensities of up to 6×10^{15} W/cm^2 have been carried out on the OMEGA laser to produce strong shocks in solid spherical targets. The shocks are launched at pressures exceeding 400 Mbar and reach Gbars upon convergence. The timing of the x-ray flash from shock convergence in the target center is used to infer the ablation and shock pressures. Laser–plasma instabilities produce hot-electrons with a moderate temperature (<100 keV) and instantaneous conversion efficiencies of laser power into hot-electron power of up to ~15%. The large amount of hot electrons is correlated with an earlier x-ray flash and a strong increase in its magnitude, demonstrating that hot electrons contribute to the augmentation of the shock strength. The experiments investigate the strength of the ablation pressure and the hot-electron production in various ablator materials (Be, C, CH, and SiO_2) and various beam-focusing conditions, which are relevant to developing a shock-ignition target design for the National Ignition Facility. The results are also relevant to the development of an OMEGA experimental platform to study material properties at Gbar pressures. Targets with an inner deuterated core measured, for the first time, thermonuclear D_2 fusion neutrons from shock coalescence in highly compressed plastic material.

This material is based upon work supported by the Department of Energy under Cooperative Agreements No. DE-FC02-04ER54789 (Fusion Science Center), the National Nuclear Security Administration Award Number DE-NA0001944, the University of Rochester, and the New York State Energy Research and Development Authority. The support of DOE does not constitute an endorsement by DOE of the views expressed in this article.