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P4.2006 Experiments and simulations of laser-irradiated additive-manufactured foams

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In indirect drive inertial confinement fusion (ICF), a high-Z enclosure (or "hohlraum") surrounds a low-Z capsule containing DT fuel. Laser beams irradiate the interior of the hohlraum, creating an x-ray radiation bath that compresses the fuel to ignition conditions. Motion of the irradiated hohlraum wall induces dynamic drive symmetry swings leading to a degradation of the implosion performance. Lining the inside of the hohlraum wall with a low density foam material has been proposed as a method to help control the wall motion thus minimizing the radiation symmetry swings. The interaction of laser radiation with foams of various porosity sizes and densities has been the subject of several numerical and experimental studies [1]. In all cases, modelling low-Z foams (as a uniform gas of the same average density) using standard rad-hydro codes have shown considerably disagreement with experimental observations. We have shown that this deficiency can be largely overcome by taking advantage of modern computer architectures (many processors) coupled to a simple statistical representation of the foams [2]. Recently, developments in additive manufacturing (AM) have allowed for the fabrication of structured foams, thus eliminating the statistical nature inherent in the chemical fabrication process. This technique also allows for composition and density variations that may be beneficial in reducing possible laser backscatter losses. To understand the behaviour of these foams, experiments were carried out at the Jupiter Laser Facility. Foam samples were heated with a single 0.5 micron (green light) laser at 3x10^14 W/cm^2 intensity (conditions similar to ICF implosions). Several materials and structures were tested and the laser-foam interaction was quantified by measuring several aspects of interest to lined-hohlraums dynamics. We use the rad-hydro code HYDRA configured to assess our ability to simulate these foams and to improve our constitutive material models. Here we present comparisons between data and simulations and lay out possible ICF implosion experiments using these foams.

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