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PLATES and DIRECT LASER SHOCKS

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Laser/Matter Shock Interactions by Laser-Launched Plates and Direct Laser Shocks

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Abstract

Explosives, gas guns, laser-launched flyer plates, and direct laser-irradiation can be used to generate shocks and high-stress in materials. Each method has a unique diameter and thickness of shock that can be generated. In past years, small laboratory lasers have been used to launch flyer plates 2 – 200- μm thick to terminal velocities 0.1 to 5 km/s. Over the past few years we have been using our TRIDENT laser facility (1kJ in 0.2 to 2 μs) to accelerate larger diameter (8 mm) and thicker (0.1 – 1.5 mm) flyer plates. These larger diameters and thicker one-dimensional plates more closely compliment traditional experimental methods such as gas guns. The 8-mm diameter and 1-mm thick flyer plates can impart shocks in metals for constitutive dynamic property measurements. The versatility of laser-driven plates permits spatial and temporal profiles of the flyer plate impact on sample targets. LASNEX models and parameters of the laser drive can be used to optimize optical coupling efficiency. The flyer plate launch, acceleration, terminal velocity, and, depending on the experiment, flyer plate impact on to target materials are recorded using point-interferometry (VISAR), and line-imaging interferometry. These high speed optical and laser experimental methods will be described along with ancillary methods, and material data. Constitutive properties of bulk materials, rate effects, and grain size and/or orientation have been studied for several metals including copper, beryllium, gold, and some alloys. These optical techniques provide non-invasive, non-contact methods with rapid recording (10^{-6} – 10^{-10} sec) of surface motion and velocity as well as structural changes due to shocks, and high stress (0.01 to 100 GPa) and strain rates (10^5 – 10^9 sec $^{-1}$). In addition to interferometry, dynamic x-ray diffraction can be used to study dynamic lattice compression and release, and potentially phase changes under these conditions. By combining several different high-speed optical techniques, a more complete understanding of material response is elucidated. Direct –drive shock in metals have been used for material experiments for ICF with 2 – 4 ns pulse duration and will also be discussed.