Modeling of the Damaged Surface Hydrodynamics Experiments

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ABSTRACT

das Three cylindrical, pulsed-power driven, damaged surface hydrodynamics (DSH) experiments have been conducted at the Los Alamos Neutron Science Center's (LANSCE) proton radiography facility. There the Precision High Energy-density Liner Implosion eXperiment (PHELIX) capacitor bank delivered 3.6 MAmp, 6 μs pulses in order to magnetically accelerate a thin aluminum liner (Diam. $= 5.4$ cm, thickness $= 0.5$ or 0.8 mm) to 1 km/s. The liner impacted an aluminum target cylinder (Diam. $= 3.0$ cm, thick $= 0.1$ mm) that was coated with a thin (100 μm) layer of micron size tungsten powder. The powder was shock launched into vacuum and 120 psia of Nobel gases (Ar or Xe). A 21-frame proton radiograph data set was collected for each experiment. Shocks in the gas, particle-cloud structure, and the target cylinder are clearly visible in the radiographs. See Figure 1.

This well-controlled, well-diagnosed set of experiments has produced a data set that challenges Lagrangian and ALE methods for modeling multi-material converging flows. While single-fluid, resistive magnetohydrodynamics (MHD) is adequate for modeling the condensed-state, converging liner, the main question is how best to describe the thin tungsten powder layer and its transport into both gas and vacuum. Three methods of increasing complexity are investigated. First, a fully fluid description where ALE is necessary to evolve the azimuthal structure and radial flow. Second, hybrid fluid-particle methods where Lagrangian material cells are shock converted into particles and transported through a background fluid, without particle-particle interactions. Finally, granular material models where full particle-particle interactions are taken into account.

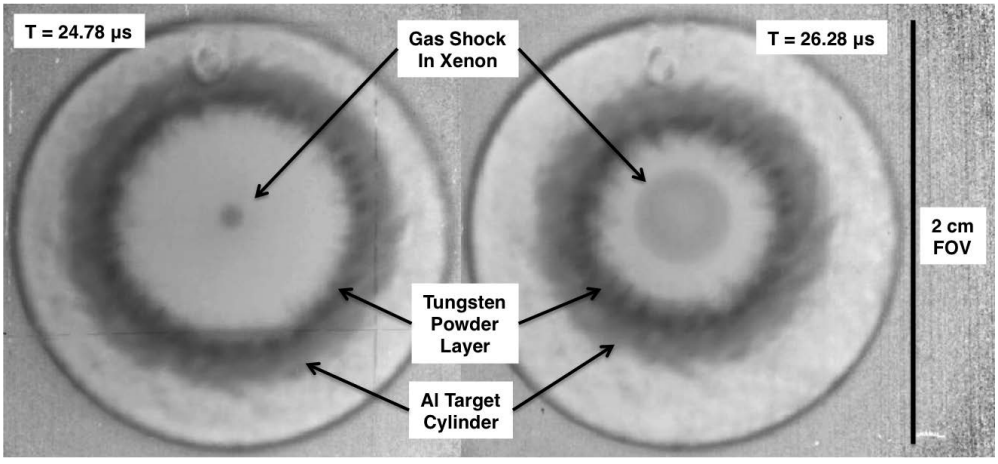

Figure 1: Axial proton radiographs of the DSH-2 experiment at two different times showing the shock in the Xe gas, the tungsten power layer, and the Al target cylinder.

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