Thu1.4 Fincke et al.

Postponement of saturation of the Richtmyer-Meshkov instability by convergence

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Strongly driven cylindrically convergent implosions with well characterized surface perturbations were conducted on the OMEGA laser (Broehly, et al (1977)). The cylindrical targets, consisting of a low density foam core and an aluminum shell covered by an epoxy ablator, are directly driven by fifty laser beams (18±0.3 kJ, 351 nm, 1 ns pulse width). The outer surface of the aluminum shell is machined to form perturbations with wavenumbers ($k = 2\pi/\lambda$, μm^{-1}) $0.08 < k < 2.5$ (λ = 2.5, 9, 25, and 75 μm) and initial amplitudes $0.03 < \eta_0/\lambda < 0.8$. The perturbations are in the in the r-z plane with r being the radius in cylindrical coordinates and z is the axis of the cylinder. The aluminum shell is calculated to preheat to ≈3 eV prior to interaction with the Mach 6 shock launched by the laser drive. The Atwood number is ≈0.6.

We observe that the perturbations continue to grow approximately linearly, and even exhibit a noticeable increase in growth rate with time well into the amplitude range where saturation is expected in planar geometry. In planar geometry mode saturation and transition to a slow growing spike and bubble configuration has been experimentally observed at $\eta/\lambda \approx 0.3$ (Dimonte (1993). We, however, observe no evidence of saturation for an η/λ ratio as large as 5. The perturbation growth rate is observed to scale proportionally with k for $\eta_0 k < 1.4$, while for $\eta_0 k \geq 5$ wavenumber scaling is violated and what is likely a transition to turbulent growth is observed. The rate at which the apparent mix width grows, a consequence of both convergence and instability growth, is consistent with Bell's linear theory (Bell (1951)) of perturbation growth in a converging geometry.

References

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