On the possibility of a two dimensional, multimode RM experiment on EP

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Abstract

The Richtmyer-Meshkov (RM) [1,2] process occurs when a shock wave passes through an interface separating two materials with different densities, and deposits vorticity on it, in consequence of structures on the interface and/or the shock front. As a result of the vorticity deposition, the initial structure grows in time, linearly for initial modulations of small amplitude and in a decaying fashion as the amplitude increases. This process also occurs when astrophysical shock waves cross density gradients. It has been suggested that RM is responsible for the observed structure in the remnant of the Tycho thermonuclear supernova [3]. Since the initial experiments of Meshkov,mesh69 there have been a large number of RM experiments done in shock tubes, focused on the behavior of a single sinusoidal mode or a two mode interaction [4,5]. Previous HED RM experiments using machined interfaces have examined only single-mode behavior, often in the regime of high Mach number and large amplitude such that the interaction of the RM spikes and the shock is significant [6]. In the case of multimode initial perturbations, non-linear processes of mode coupling and

equivalently bubble competition are dominant. In the bubble competition process, large bubbles overtake the volume originally occupied by smaller bubbles. Due to this mechanism, the average wavelength of the multi-mode perturbed interface increases with time and the width of the overall mixing zone grows faster than in the case of a single-mode interface. At late time the mixing zone is theorized to become self-similar and to grow as t^θ, where θ =0.2 for a three-dimensional [7] flow and $\theta = 0.4$ for a two-dimensional flow [8] for the bubble front and in the range of 0.2-1 for the spike front, depending on the Atwood number. Although there have been studies of RM using three dimensional multimode, uncharacterized perturbations, allowing one to reach conclusions only about the thickness of the overall mixing zone, none of the prior work has examined the evolution of a well-characterized, multimany-mode interface in order to observe the evolution of the spectral structure in the bubble-merger regime. In the present study, we propose to undertake that, doing experiments that are enabled by the ability of Omega EP to drive targets for several times larger than was feasible on previous high-energy lasers.

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