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Thin film graded density impactors for high rate off-Hugoniot loading: Application to Ta strength

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Graded density impactors (GDIs) have long been of interest to provide off-Hugoniot loading capabilities for impact systems. We describe a new technique for fabricating GDIs which utilizes sputter deposition to produce an approximately 40 μm-thick film containing alternating layers of Al and Cu. The thicknesses of the respective layers are adjusted to tailor an effective density gradient through the film. The GDIs were launched into samples of interest with a 2-stage light gas gun, and the resulting shock-ramp-release velocity profiles were measured over timescales of ~10 ns with a new velocimetry probe. Results are shown for the direct impact of the film onto a LiF window, which allows for the dynamic characterization of the GDI, as well as from impact onto a ~40 μm-thick, sputtered, single phase (body-centered cubic) Ta film sample backed by a LiF window. These measurements were coupled into mesoscale numerical simulations to infer the strength of Ta at the high rate (10^7 s^{-1}), and high pressure (1 MBar) conditions this unique capability provides. Initial results show this is a viable strength platform which fills a critical gap and aids in cross-platform comparisons with other high-pressure strength platforms.

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