KINETIC PLASMA AND INTERSPECIES-ION DIFFUSION STUDIES USING DT, DT/^{3}HE, DT/H IMPLOSIONS

Y. Kim[1], H.W. Herrmann[1], N.M. Hoffman[1], M.J. Schmitt[1], G. Kagan[1], A. McEvoy[1], S. Gales[2], C.J. Horsfield[2], M. Rubery[2], A. Leatherland[2], M. Gatu Johnson[3], J. Frenje[3], V. Yu. Glebov[4], W. Seka[4], F.J. Marshall[4], C. Stoeckl[4], and J. Church[5]
[1]Los Alamos National Laboratory, Los Alamos, NM, USA
[2]Atomic Weapons Establishment, Aldermaston, United Kingdom
[3]Massachusetts Institute of Technology, Cambridge, MA, USA
[4]Laboratory for Laser Energetics, Rochester, NY, USA
[5]Lawrence Livermore National Laboratory, Livermore, CA, USA
yhkim@lanl.gov

Reduced fusion yield in deuterium-based ICF implosions has been observed for high Knudsen number conditions (i.e., high temperature, low pressure) [1] and for fuel fill mixtures (i.e., D/^{3}He, D/Ar) [2]. We have developed tritium-based implosion targets to study such reduced fusion yield in ICF.

Kinetic plasma effects have been studied using a series of DT-filled plastic-shell implosions at the OMEGA laser facility. Plastic capsules of 4 different shell thicknesses (7.4, 15, 20, 29 micron) were shot at 3 different fill pressures (2, 5, 15 atm) in order to vary the ion mean free path compared to the size of fuel region (i.e., Knudsen number). The empirical Knudsen number was varied by a factor of 25 (from 0.02 up to 0.5), which was inferred from the burn-averaged ion temperature and fuel areal density. Implosion data show that as the empirical Knudsen number increases, fusion performance metrics (e.g., neutron yield) increasingly deviate from hydrodynamic simulations unless ion kinetic terms (e.g., enhanced ion diffusion, viscosity, thermal conduction, as well as Knudsen-layer fusion reactivity reduction) are considered. A reduced ion kinetic (RIK) numerical code has been developed and benchmarked against DT implosion data.

Anomalous ICF yield degradation in DT/^{3}He has been observed [3], where the interspecies ion diffusion theory [4, 5] has been suggested to explain such yield decrease, whereas the theory expects yield increase in DT/H. We are developing hydro-equivalent DT, DT/^{3}He, DT/H targets to validate the interspecies ion diffusion theory in ICF conditions.

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