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Impact of First-Principles Property Calculations of Warm-Dense Deuterium/Tritium on Inertial Confinement Fusion Target Designs

S.X. HU, Laboratory for Laser Energetics, U. of Rochester

Accurate knowledge of the properties of warm dense deuterium/tritium (DT) is essential to reliably design inertial confinement fusion (ICF) implosions. In the warm-dense-matter regime, routinely accessed by low-adiabat ICF implosions,[1] strong-coupling and degeneracy effects play an important role in determining plasma properties. Using first-principles methods of both path-integral Monte Carlo and quantum molecular-dynamics (QMD), we have performed systematic investigation of the equation of state,[2] thermal conductivity,[3 4 5] and opacity[6] for DT over a wide range of densities and temperatures. These first-principles properties have been incorporated into our hydrocodes. When compared to hydro simulations using standard plasma models, significant differences in 1-D target performance have been identified for simulations of DT implosions. For low-adiabat ($\alpha \leq 2$) DT plasma conditions, the QMD-predicted opacities are 10 to 100$\times$ higher than predicted by the cold-opacity–patched astrophysical opacity table. The thermal conductivity could be 3 to 10$\times$ larger than the Lee–More model prediction. These enhancements can modify the shell adiabat and shock dynamics in lower-α ICF implosions, which could lead to $\sim 40\%$ variations in peak density and neutron yield. This material is based upon work supported by the Department of Energy National Nuclear Security Administration under Award Number DE-NA0001944.

[1]S. X. Hu *et al.*, Phys. Rev. Lett. **104**, 235003 (2010).
[2]S. X. Hu *et al.*, Phys. Rev. B **84**, 224109 (2011).
[3]V. Recoules *et al.*, Phys. Rev. Lett. **102**, 075002 (2009).
[4]F. Lambert *et al.*, Phys. Plasmas **18**, 056306 (2011).
[5]S. X. Hu *et al.*, Phys. Rev. E **89**, 043105 (2014).
[6]S. X. Hu *et al.,* "First-Principles Opacity Table of Warm-Dense Deuterium for ICF Applications," submitted to Physical Review E.