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Equation of state research for ignition on NIF

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The design of Inertial Confinement Fusion (ICF) capsules for the National Ignition Campaign depends heavily on the use of models based on hydrodynamic simulations, which in turn require highly accurate equation of state (EOS) for the materials involved. In this talk, I will discuss our efforts to construct multiphase EOS and transport models for carbon at extreme pressures based on ab initio electronic structure calculations. In particular, the free energies of the solid phases are constructed from cold, ion-thermal and electron-thermal components determined from density functional based calculations and melting temperatures are computed with two-phase coexistence simulations. A simple solid-like free energy model is used to represent the liquid phase that is constrained by direct ab initio molecular dynamics simulations of the liquid phase as well as the computed melting temperatures of the different solid phases. By combining with a Thomas Fermi-based free energy model to represent the limits of extreme temperature and pressure a new multiphase EOS model has been constructed that is currently the basis for the high-density carbon ICF capsule design. A similar effort is underway to develop a multiphase table for beryllium as well. This work performed under the auspices of the U.S. Department of Energy by Lawrence Livermore National Laboratory under Contract DE-AC52-07NA27344.