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Understanding the impact of ablator micro-structure and fuel-ablator mixing on ICF implosions[1]

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ICF implosions on the National Ignition Facility (NIF) have used high-density carbon (HDC) ablators to achieve record fusion performance, but the final compression of the fuel is less than expected. Compression will need to be increased to improve confinement and achieve a robust fusion burn. A leading hypothesis for reduced compression is that the hotter ablator material is mixing with the cold fuel, increasing its entropy and lowering its density. Mixing at this interface may be worse than originally predicted due to HDC's micro-structure, which is composed of anisotropic nano- to micro-crystalline grains with lower density between grains. Measurements using the two-dimensional VISAR diagnostic at the Omega laser facility revealed velocity modulations on the shock wave that are larger with HDC ablators than with amorphous plastic. Simulations that directly model the HDC micro-structure can reproduce these velocity modulations and show that, when applied to an implosion, more fuel-ablator mixing is observed than previously expected. Implosion radiographs using the Crystal Backlighter Imager (CBI), which provides images of the shell near peak velocity, are better matched when using this micro-structure model to increase internal mixing. Experiments are planned to use this platform to further measure mixing and test mitigation schemes. With this increased level of mixing, the compression of DT-layered implosions is in better agreement with the simulations.

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