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Ignition Capsule Design with a High-Density Carbon (HDC) Ablator for the National Ignition Facility (NIF)[1]

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An ignition capsule with a nano-crystalline, high density, carbon ablator is emerging as a promising alternative target for NIF. There are four main advantages in using the HDC ablator. First, for a given outer radius, the HDC ablator absorbs more hohlraum-driven x-ray energy than for a beryllium ablator. Second, the HDC ablator will have smaller and more uniform crystalline grains than beryllium, enabling more isotropic shock propagation. Third, the higher density reduces the coupling of the DT ice surface and the ablator/ice interface from the unstable ablation front, thereby reducing the growth of the surface perturbations seeded by ice roughness and inner-shell roughness. Fourth, material strength of the HDC can reduce instability growth at early times. Possible - though surmountable - challenges include: (1) The ice surface might in fact be rougher because of differences in the beta-layering in HDC vs Beryllium. (2) The need for smoother outer ablator surfaces because of slightly lower ablation rates, and larger mass perturbations for a given surface roughness. (3) Ensuring that the HDC does not spend time in a partially melted state in which density or velocity variations could seed Rayleigh-Taylor instabilities, the 2nd shock should completely melt the HDC ablator. LASNEX design simulations show good 1-D performance and overall favorable 2-D stability behavior. In particular, the ablator is completely melted upon the arrival of the 2nd shock, the capsule can tolerate about twice as rough a DT ice surface as with Beryllium, and instability growth is reduced by material-strength in the HDC ablator.

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