§46. Mitigation of Hydrodynamic Instability with Diamond Ablator for Direct Drive Inertial Confinement Fusion Targets

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Laser imprinting is a very important issue on direct-drive inertial confinement fusion targets because the seed of the imprinting is amplified due to Rayleigh-Taylor instability growth, resulting reduced density/temperature of the imploded core. We have been developing a scheme to mitigate the laser imprinting with stiff target material because the compressibility of the target material is one of the important parameters for the imprint amplitude. We employed diamond foils as the stiff target material in order to measure the imprint amplitude, and polystyrene (PS) foils as well for the reference conventional target material.

Experiments were done on GEKKO-XII glass laser system at ILE, Osaka University. The baseline of the experiment is same as the experiment in the last fiscal year. The last experimental results showed that the imprint amplitude was clearly reduced for the diamond foils. Although the experimental results were promising, the shape of the imprint perturbation was non-sinusoidal which is very difficult to compare with a simple model coupled with one-dimensional hydrodynamics simulation code[1]. The interpretation of the non-sinusoidal perturbation is local melting on the diamond foils due to non-uniform irradiation. We employed a diamond foils with Cu coating of 0.1 μm-thickness in order to prevent local heating on the diamond layer.

Figure 1 shows the raw streaked image of the diamond foils with and without Cu coating. The experimental results for the diamond without Cu coating indicates spiky dip perturbations whereas the diamond with Cu coating shows "normal" perturbation growth, in which single-mode perturbation (λ: 100 μm) exponentially grows in early timing then higher harmonics arises at the later timings. This indicates that there is no local mixed-phase on the laser-irradiated foil for Cu coated diamond.

From the streaked x-ray shadowgraph images, we analyzed areal-density perturbation from both PS and diamond (with Cu coating) foils. Figure 2 shows the temporal evolution of areal-density perturbation amplitude for both foils. Also shown in Fig. 2 is calculated areal-density perturbation with the simple incompressible model coupled with 1-D hydrodynamic simulation code ILESTA. The calculated amplitudes before the first-shock breakout are in good agreements with the experimental results. The amplitude for the diamond foil is approximately 20% of the amplitude of PS foils. The reduction factor is due to the difference of compressibility which is also in good agreements with previous EOS data.

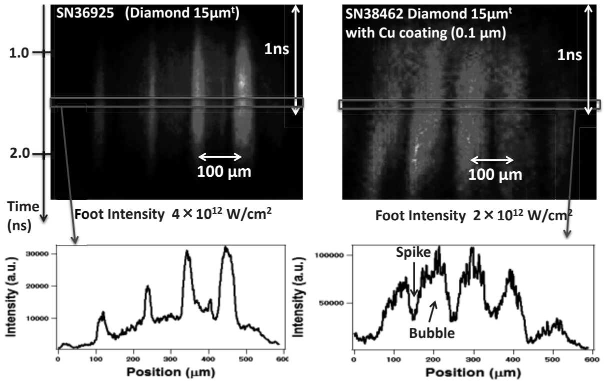

Fig. 1. Raw streaked image with face-on radiograph measurements with and without Cu coating.

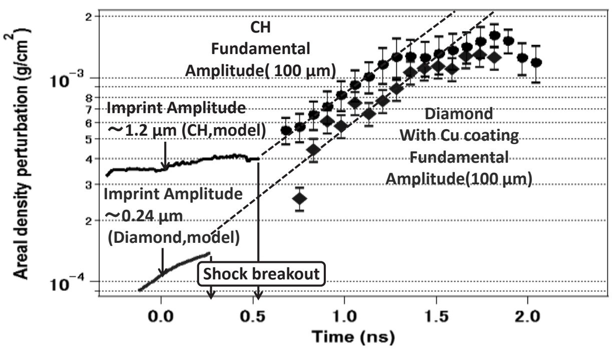

Fig. 2. Temporal evolution of areal-density perturbation for PS ad diamond foils.

1) Nakai, M., et al. Phys. Plasmas **9** (2002) 1734