Temporal evolution of spatial perturbation on diamond foils due to non-uniform laser irradiation

Hiroki Kato[1], Keisuke Shigemori[1], Hideo Nagatomo[1], Hideaki Yamada[2], Shinya Ohmagari[2], Akiyoshi Chayahara[2], Yoshiaki Mokuno[2], Mitsuo Nakai[1], Tatsuhiro Sakaiya[3], Hidenori Terasaki[3], Youichirou Hironaka[1], and Hiroshi.Azechi[1]

1) Institute of Laser Engineering, Osaka University, Japan

E-mail: kato-h@ile.osaka-u.ac.jp

2) *Diamond Materials Team, Advanced Power Electronics Reseach Center, AIST, Japan*

3) Department of Earth and Space Science, Graduate School of science, Osaka University, Japan

In inertial confinement fusion targets, laser imprinting due to non-uniform irradiation should be as small as possible because small perturbations on the target surface grow exponentially with time via Rayleigh-Taylor instability (RTI). Previous investigations on mitigating the laser imprinting have been done mainly by thermal smoothing effect. In this studty, we focus on effects due to stiffness of diamond for mitigating the laser imprinting.

In our experiments, target foils (diamond and polystyrene) were irradiated with a foot pulse at intensity of ~4.0×10^{12} W/cm^2 (low foot) or ~5.0×10^{13} W/cm^2 (high foot), on which intensity non-uniformity with sinusoidal perturbation of 100 μm wavelength. The foils were subsequently accelerated by uniform main pulses with intensity of ~10^{14} W/cm^2. The amplitude of laser imprinting was observed by amplifying its perturbation via RTI with face-on x-ray backlighting technique.

Figure 1 shows experimental results and calculation with 2D hydrodynamic simulation (PINOCO). When the irradiation non-uniformity of the foot pulse is ~10%, the experimental results are in good agreement with the 2D simulation. The imprinting amplitude (fundamental) was reduced for the diamond foil due to material compressibility (Fig. 1(b)). On the other hand, when the foot pulse non-uniformity is ~40%, harmonic contents of the areal density perturbations for diamond arose before the foil acceleration. We estimate there is different physics on generation of crack-like structure due to large pressure perturbation in solid state.

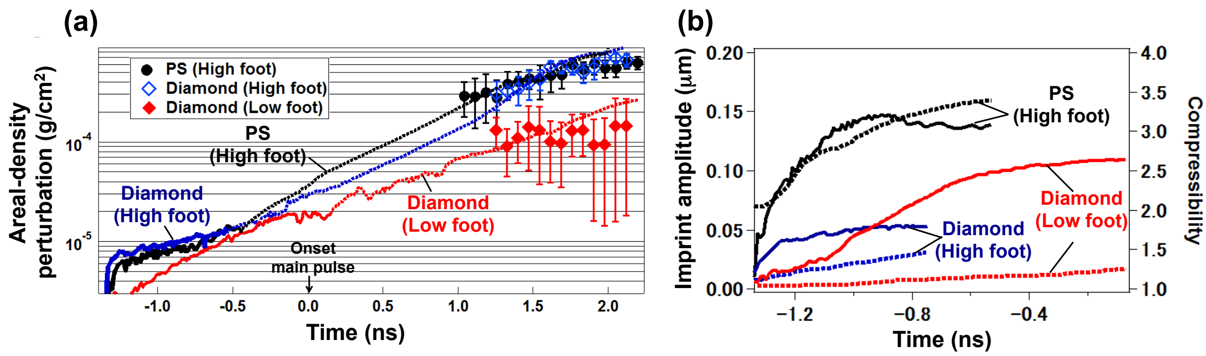

Figure 1: (a) Areal-density perturbation growth for targets from experiments (symbols), and from the PINOCO-2D simulation for each experimental configuration prior to the foil acceleration (solid curves) and after the acceleration (dotted curve). (b) Temporal evolution of imprint spatial amplitude (solid curves) and target compressibility (dotted curve) with 2D simulation (PINOCO).