§43. High Density Implosion with the High-Z Doped Target

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i) Introduction In this research, we attempt to reduce Rayleigh-Taylor instability by using the high-Z material doped targets for the implosion[1)]. The radiative ablation gives generally the high mass ablation rate, and lower Rayleigh-Taylor growth rate, compared with the case of the electron ablation. Therefore, this high-Z doped target can reduce the Rayleigh-Taylor growth in the implosion process. Our research aims at achieving the following: (1) experimental confirmation of reduction of the Rayleigh-Taylor instability, using the target by S. Fujioka at Osaka University, (2) feasibility study of introducing the target to fast-ignition experiments by A. Sunahara at Institute for Laser Technology, (3) theoretical and simulation research on the double ablation by A. Sunahara, at Institute for Laser Technology, N. Ohnishi at Tohoku University, Philippe Nicolai, at CELIA and Marina Olazabal at CELIA, (4) Target fabrication of CDBr for the current experiment by Y. Fujimoto, at Osaka University, and (5) a fundamental research on high-Z doped target by K. Nagai, at Tokyo Institute of Technology, and T. Norimatsu at Osaka University. In this report, we present our achievements in 2012.

ii) Experimental demonstration of low-Rayleigh-Taylor growth We tested reduction of Rayleigh-Taylor instability by using CDBr target ($C_{500}H_{497}Br_3$). A CDBr plate of 16μm thickness was irradiated by GXII 0.53 μm wavelength 5 beams.. From the face-on image, we can estimate the amplitude of the Rayleigh-Taylor instability perturbation, and we can measure the acceleration from the side-on image. Figures 1(a) and 1(b) show the face-on backlight images for (a) Polystyrene (C_6H_6) (b) Brominated PS ($C_{500}H_{49}7Br_3$), respectively. In Fig.1(b), we see significant reduction of perturbation contrast, indicating the lower growth rate of Rayleigh-Taylor instability compared to that in Fig.1(a). Although we used the CDBr target, which is doped with only 0.3 atomic % of bromine, our experimental results showed significant reduction of Rayleigh-Taylor growth.

iii) Development of CDBr target The well recognized difficulty in the CDBr target fabrication is the emulsion formation in the low viscosity oil used in dissolving CDBr polymer. In oder to overcome this problem, we improve the 2nd nozzle of double nozzle apparatus in the target production. Improved 2nd nozzle allow us to product the polystyrene in a wide viscosity range, especially low-viscosity region. Consequently, we successfully produced the CDBr target in the oil containing the brominated polymer. We show a photograph of the produced CDBr target in Fig.2(a) and its interferometry pattern in Fig.2(b), respectively. This target meets the requirement for the current experiment, regarding the size, thickness and concentration of bromine.

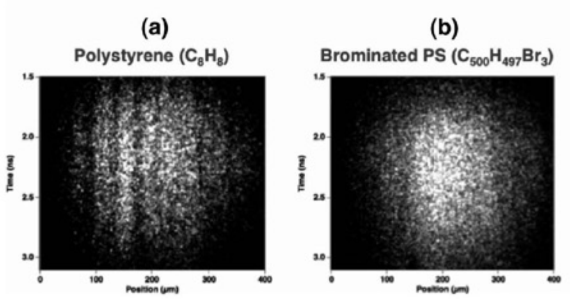

Fig. 1: (a) Face-on backlight images for the CD target, (b) face-on image for the CDBr target.

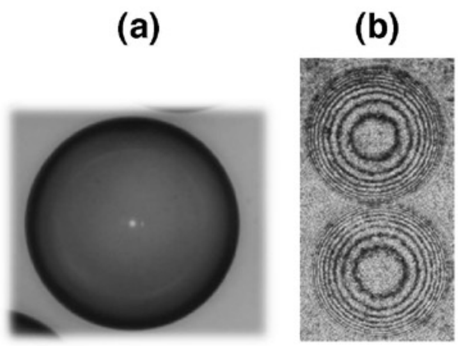

Fig. 2: (a) CDBr photograph (b) Interferometry pattern of CDBr target.

iv) Fundamental researCD on high-Z doped target fabrerication We successfully produced the brominated plastic target that was doped with 3.6-8.5 weight % of bromine in the plastic by using reaction. Also, we were able to prevent the phase-separation of brominated target by using this reaction.

v) Conclusion In 2012, we demonstrated that relatively low doping of 0.3 atomic % bromine in the plastic target is effective for reducing the Rayleigh-Taylor instability and its target trajectory is similar to that of the CD target. In the target fabrication, we have developed a new target fabrication technology. Using this technology, we successfully produced the CDBr target which meets the requirements in the current fast-ignition experiments. Also, we carried out a fundamental research on the bomination process. Based on these successes, we are planning to use the CDBr target in the implosion experiments and to demonstrate a highly dense implosion.

1) S. Fujioka, A. Sunahara, K. Nishihara, N. Ohnishi, T. Johzaki, et al., “Suppression of the Rayleigh-Taylor Instability due to Self-Radiation in a Multiablation Target”, Phys. Rev. Lett (2004) 92, 195001-1-4.