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赤外線加熱法を用いた高速点火クライオターゲット固体燃料層の形状制御に関する研究

Control of Solid Hydrogen Layer by Infrared Heating Method for Fast Ignition Targets

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The cryogenic target for the Fast Ignition Realization EXperiment (FIREX) Project has been developed under a bilateral collaboration between Institute of Laser Engineering (ILE), Osaka University and National Institute of Fusion Science (NIFS). In FIREX project, a cryogenic target with both a uniform thickness solid deuterium layer and a gold cone guide is planned to be used. Our goal is to develop the cryogenic target by applying infrared heating method[1)] to fast ignition targets. Infrared heating method is a technique to make the thickness distribution of the fuel layer uniform using sublimation of fuel caused by infrared heating. If infrared heating method is simply applied to the fast ignition targets, the distribution of the solid fuel in the equilibrium state becomes non-uniform because of its non-spherical symmetry appearance. In addition to infrared heating, adjusting the temperature of the cone is required to reduce the non-uniformity of the distribution.

In this study, we developed the targets that we were able to vary the temperature of the cone and succeeded in making the solid fuel layer uniform by adjusting the temperature of the cone. The cone used in this experiment was connected to a copper block thermally. It is possible to vary the temperature of the cone by adjusting the temperature of the copper block. Figure 1 shows the time variation of the shape of the solid hydrogen in the experiment. Light hydrogen was used as a surrogate fuel for the proof-of-principle experiment. At the beginning, the cone was cooled and hydrogen was condensed near the cone. Irradiating the target with infrared after raising the temperature of the cone, solid hydrogen began to move from the cone to the bottom of the shell. In the initial stage of the movement (After 20 min in Fig. 1), the particle of solid hydrogen was formed at the bottom of the shell and the particles grew individually. From this situation, it is considered that polycrystalline of hydrogen was formed in the bottom part. Then, the solid hydrogen was distributed to be more uniform shape than the initial state at the equilibrium state. In the presentation, we will describe the detailed thickness distribution in the equilibrium state and the relationship between the thickness distribution of solid hydrogen and the temperature of the copper block.

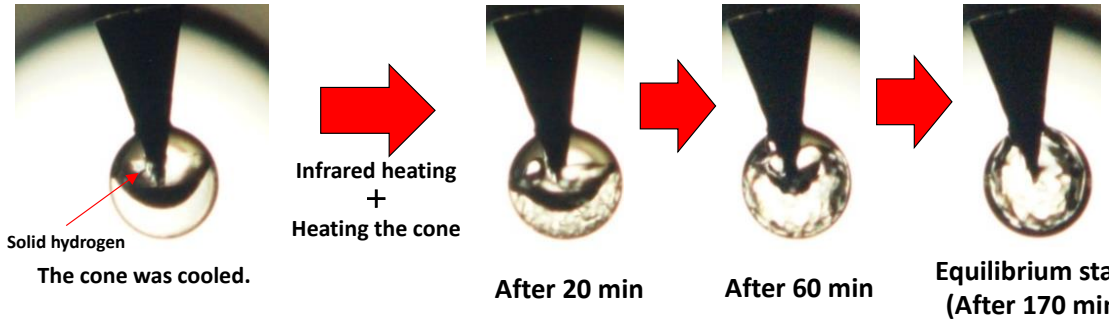

Fig. 1 The time variation of the solid fuel layer in the fast ignition target by infrared heating method

Reference
[1)] G. W. Cellins, et. al., J. Vac. Sci. Technol. A14, 2897 (1996).