§20. Preliminary Results of Fuel Layering on the Cryogenic Target for the FIREX Project

Iwamoto, A., Maekawa, R., Mito, T., Sakagami, H., Motojima, O.,
Nakai, M., Fujimura, T., Norimatsu, T. (ILE, Osaka Univ.)

i) Introduction

The program of the FIREX project, which comprises two phases: FIREX-I and FIREX-II, is underway at the Institute of Laser Engineering (ILE), Osaka University. To execute the project, there are two key technologies: development of high-power lasers and a foam cryogenic target. This report focused on the target development for FIREX-I.

Issues for the target development are fabrication of a foam shell, assembling the target, and a fuel layering technique. A new fabrication process of the foam shell has been successfully developed at ILE,[2] and the foam shell target is being fabricated. Fueling into the foam target is studied at NIFS. The apparatus for the off-site demonstration has been developed and the fuel layering process is being proved. In this report, the preliminary demonstration of the fuel layering for a dummy foam shell target is described.

ii) Specification of the target

Figure 1 shows the schematic illustration of the target for FIREX-I. The target consists of three parts: a foam shell, a conical laser guide made of a gold thin plate and a gas or liquid feeder made of a glass tube. The shell is 500 μm in diameter and ~20 μm in thickness. Its surface is coated with a gas barrier. The foam layer is low density porous plastic and a supporting material of fuel. The laser guide is partially inserted into the shell. The foam shell is expected to be impregnated uniformly with solid fuel, so that an ideal target would be formed.

iii) Dummy foam target and experimental procedure

For a preliminary fuel-layering test, a dummy foam target was fabricated as shown in Fig. 2. The foam shell which was supplied by General Atomics (GA) is ~800 μm in diameter and ~60 μm in thickness. The density of the foam material is ~100 mg/cm^3. The shell surface was coated with a parylene membrane (some μm thickness) as a gas barrier. The inner tip diameter of the glass feeder is ~20 μm. Its assembling method is the same as that for a typical foam target. The shell size is larger than that for FIREX-I. However, the property of the foam shell as a supporting material of the fuel can be examined.

The cryogenic system cool-down was started after filling the target can with heat exchange GHe at the pressure of ~200 Pa. At first, the temperatures of the exchange GHe was controlled at 12.5 K, and the exchange GHe pressure became ~20 Pa. Then, gaseous H_2 (GH_2) filled in the shell and liquefaction occurred at 7.3 kPa. Normal-H_2 was substituted for the fuel of D_2 or DT, due to self-imposed controls of NIFS. After the liquid H_2 (LH_2) was fully permeated in the foam layer, we proceeded with solidification. Both the H_2 pressure and the exchange GHe temperature were regulated to keep the liquid quantity constant during solidification process. When the temperature was 12.4 K, the phase transition to solid occurred. After the solidification, the exchange GHe temperature was lowered from 12.4 K to 11.8 K in fifteen minutes to observe the variation of the solid H_2 (SH_2) crystallization.

iv) Results

Solidification and liquefaction of H_2 were demonstrated using the dummy foam target. Figures 3(a)-(d) show the liquefaction and the solidification sequence in the foam shell. The optimum cooling conditions are expected to realize the ideal fuel layering.

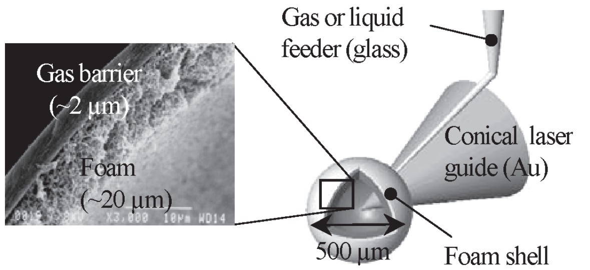


Figure 1. Cryogenic target for FIREX-I.

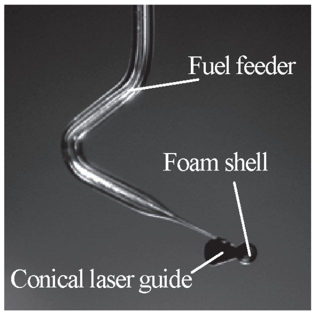
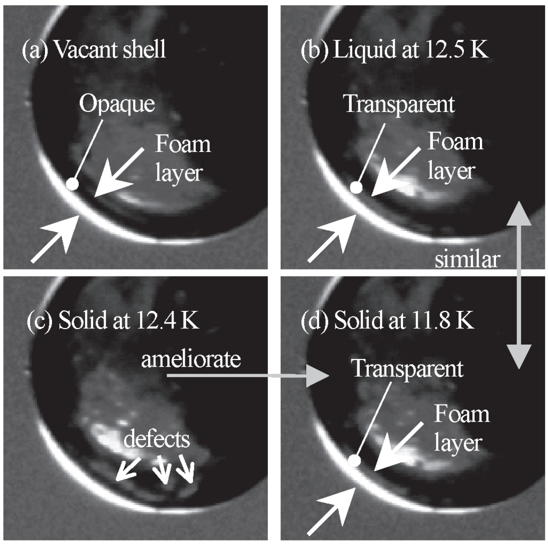


Figure 2. Dummy foam target.



Figures 3(a) - (d). Sequence of H_2 liquefaction and solidification.