§89. Evaluation of Tritium Doping Using Ultraviolet Irradiation for Laser Fusion Target

Yamanoi, K., Iwasa, Y., Norimatsu, T. (Osaka Univ.), Hara, M., Matsuyama, M., Noborio, K. (Univ. Toyama)

The characterization of ultraviolet (UV) irradiation method for tritium doping into polystyrene was investigated. In this study, we revealed the efficiency of the enhancements and the tritium distribution in the polystyrene.

Deuterated-polystyrene shell targets have been used for laser fusion experiments. The tritium-doped shell targets are desired for nest experimental stage. The tritium-doped targets enable to measure the ion temperature and ρR of the core plasma, and also improve the neutron diagnostics under hard X-ray environment such as fast ignition.

To avoid using a large amount of tritium (~100 TBq) with tritiated-deuterated-polystyrene emulsion method, tritium were doped into deuterated-polystyrene shell in the tritium atmosphere (Wilzbach method). The tritium doping rate of this method is, however, too low to fabricate the targets. Thus, UV and plasma were irradiated to improve doping rate and this enhancement efficiency was measured.

In the UV irradiation method, the 4th harmonics of Nd:YAG laser (266 nm) was irradiated to duterated-polystyrene film in tritium atmosphere for 2 hours. Laser energy was 10 mW at 3-mm-diameter spot sizes. The tritium concentration of the surface was measured by imaging plate (BAS-IP TR). The exposure time was 10 min exposure and tritium standard source was used for calibration. The tritium concentration at the irradiated point was higher and its radioactivity was 1.4×10^{11} Bq/g. Figure 1 shows the tritium concentration of the UV irradiated film.

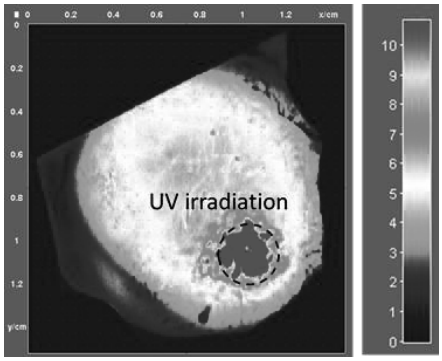

Fig.1 The tritium concentration of UV irradiated film measured by imaging plate with 10 min exposure and values shows PSL counts. The concentration at UV irradiated point was the higher concentration due.

In the other method, the plasma irradiation method was carried out. The voltage of DC 250 V was applied to hydrogen gas (120 Pa, H:D:T = 82:13:5) and the plasma was irradiated to polystyrene film for 1 hour. The tritium concentration of the irradiated surface was 2.0×10^{11} Bq/g. With increasing of irradiation time and partial pressure of tritium, these methods are achievable to fabricate 1 % (6.6×10^{11} Bq/g) tritium doping shells. These methods contribute low risk target supply because of less tritium consumption.

On the other hand, the tritium distribution of the radial direction is also important factor for fusion experiments, because the outer surface of the shell ablated and the inner surface only compose the high dense core plasma at time implosion.

The autoradiography images of the cross section of the irradiated films were obtained. Fig.2 (a) shows the scheme of the autoradiography. The films embedded in resin were exposed to slide glass coated with photo emulsion. The mean particle size of the photo emulsion was 0.3 μm. The exposure time was 10 minutes for UV irradiation film and 7 hours for plasma one, respectively. After exposure, the photo emulsion were developed and observed Ag particles by the microscope.

Fig.2 (b) shows the signal intensity of the cross section of the film obtained from the autoradiograph image. Although tritium were distributed over 15 μm from irradiation surface in UV irradiated film, the tritium were localized <5 μm from irradiation surface. The UV irradiation method showed high uniformity of tritium distribution and it is suitable for shell targets of 7-μm thickness.

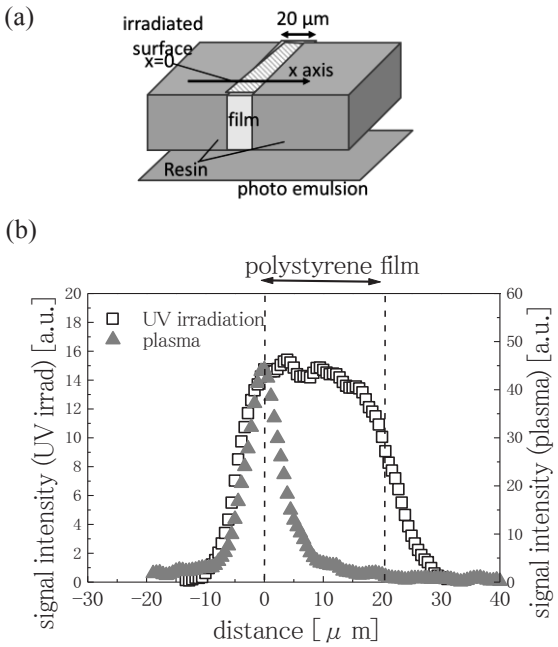

Fig.2 (a) The irradiated film was embedded into resin and the expose to photo emulsion. (b) The tritium distribution o