§34. Target and Related Material Development for FIREX-I

Nagai, K. (Tokyo Institute of Technology),
Nemoto, N. (Dept. Eng., Nihon Univ.),
Yang, H., Norimatsu, T. (ILE, Osaka Univ.),
Iwamoto, A.

New materials are required for target fabrications. In this year, new design of FIREX-I was released [1]. Here new material developments will be described concerning bromine doped deuterated plastics capsule and aerogel capsule for cryogenic target of FIREX-I.

The bromine doped plastic ablator may significantly moderate the RT instability, making implosion more stable. Especially in the impact ignition concept, the present capsule plays important role of the impactor.

The high quality deuterated hydrocarbon target has been prepared by a density matched emulsion technique with use of deuterated polystyrene which was obtained from polymerization of deuterated styrene monomer. Doping of brominated compound induced a dissolution of halogenated hydrocarbon into water, and the use of brominated polymer cost high, then we have chosen a bromination of the deuterated polystyrene. The optimized synthesis method was slightly different from the previous report [2], for example, the solvent of the bromination. The weight ratio of Br in the obtained polyer was 3.5~8.5 % depending on the condition. Trace amounts of nitrogen was observed, maybe due to initiator of the polymerization. The sum of the concentration of C, H, N, and Br was 100±1%. According to their characterization bromine atom was not introduced to the aromatic ring but to the beta position as shown in Figure 1.

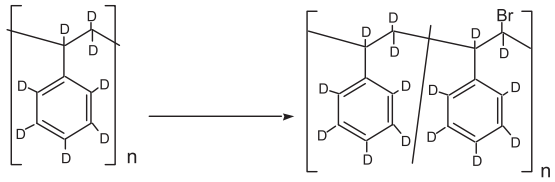

Figure 1. Scheme of the bromination to deuterated polystyrene.

The required concentration of bromine is 3.3 wt%, then it was mixed with non-brominated deuterated polystyrene in order to adjust the bromine content. The capsules were obtained using a modified density-matched emulsion technique. The mixture was dissolved into fluorobenzene and 1,3-difluorobenzene mixture whose specific gravity was 1.050. The obtained capsule was transparent without vacuoles. When the bromination was done using not distilled CH_2Br_2, capsules had a vacuoles maybe due to very small amount introduction of hydroxyl group on the polystyrene.

For the first stage of FIREX (FIREX-I), a cryogenic target was designed where low-density plastic shells with a conical light guide will be cooled down to the cryogenic temperature and will be fueled through a capillary. The required diameter and thickness of the capsule are 500 μm and 20 μm, respectively. The material should be low-density plastics foam. We have already prepared such foam capsules and fabricated targets [3], but further development would be preferable, for example, nanopore size control. Recently we found decananometer-pore foam which is one-order smaller than the previous one. Capsules with a thin aerogel shell were prepared by the $O_O/W/O_I$ emulsion process. (Phloroglucinol carboxylic acid)/formaldehyde (PF) was used as the water phase (W) solution to form the shell of the capsule [4]. PF is a linear polymer prepared from phloroglucinol carboxylic acid. The viscosity of the PF solution can reach a high level of 9 x 10^{-5} m^2/s without gelation while resorcinol/formaldehyde (RF) gels at ~3-4 x 10^{-5} m^2/s. Using the viscous PF solution, capsules with a 17 μm shell were fabricated. This thickness also satisfies the specification of (FIREX-I). When PF gel was extracted to remove the organic solvent, shrinkage of 9% occurred. The final density of the PF aerogel was 145 mg/cm^3. The pore size of the PF aerogel was less than 100 nm while that of RF was 200-500 nm. The SEM showed that PF had particle-like foam structure while RF had fibrous-like foam structure. The present difference can be explained the affinity of the solvent to polymer skeleton.

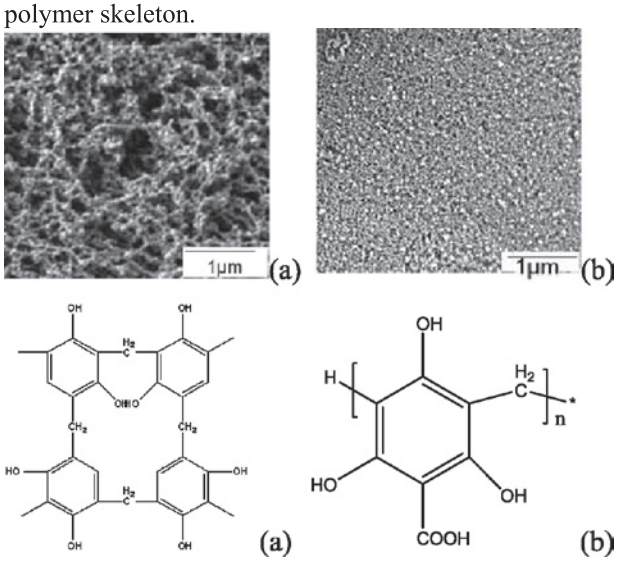

Figure 2. SEM images and chemical formula: (a) RF aerogel (b) PF aerogel. The pore sizes of RF and PF aerogel are 200-500 nm, <100 nm, respectively

1) Azechi, H. et al, "Plasma physics study and laser development for the Fast Ignition Realization Experiment (FIREX) project" *proceedings of 22nd IAEA Fusion Energy Conference 2008 (Geneva 2008)* OV/4-1
2) Camps, M. et al., *Eur. Polym. J.* **29** 99 (1993).
3) Ito, F. et al., *Jpn. J. Appl. Phys Part 2.*, **45** L335 (2006).
4) Yang, H., Nagai, K., Nakai, M., Norimatsu, T., *Laser Particle Beam*, **26** (3), 449, (2008)
5) Ito, F., Nakamura, N., Nagai, K., Nakai, M., Norimatsu, T., *Fusion Sci. Technol.* (2009), **55** (4) 465-471