Crushing Strength Test of $Li_{2+x}TiO_{3+y}$ for advanced Tritium Breeder materials of ITER-TBM

K. Mukai[1,*], K. Sasaki[1], T. Hashimoto[2], T.Hoshino[3], A.Suzuki[1], T. Terai[1]

1. The University of Tokyo, Bunkyo-ku 2-11-16 ,Tokyo 113-0032 , Japan.

2. Nihon University, Setagaya-ku, Tokyo, Japan.

3. Japan Atomic Energy Agency, Oarai-machi, Ibaraki, Japan.

Lithium titanate (Li_2TiO_3) is one of the most promising candidates among the proposed solid breeding materials for fusion reactors. Addition of H_2 to inert sweep gas has been proposed for enhancing the release of bred tritium from breeder material. However, the mass of Li_2TiO_3 has been found to decrease with the time in the sweep gas mixed with hydrogen, this mass change indicates the oxygen content of the sample decrease, suggesting the change from Ti^{4+} to Ti^{3+}[1]. This change can result in the decline of mechanical strength of Lithium titanate pebbles in fusion reactor. In our previous work, we have extensively investigated to synthesize Lithium titanate with Li ($Li_{2+x}TiO_{3+y}$) which compensates expected Li loss due to the nuclear reaction with neutron and vaporization of Li under the operating condition. The color of Li_2TiO_3 has changed from white to black under the hydrogen atmosphere at high temperatures. This color-change corresponds to reduction of Li_2TiO_3. In the case of $Li_{2+x}TiO_{3+y}$, the color has not changed. This result qualitatively indicates the possibility that $Li_{2+x}TiO_{3+y}$ has higher stability in H_2 atmosphere compared with Li_2TiO_3. In this study, we have synthesized Li_2TiO_3 and $Li_{2+x}TiO_{3+y}$ by mixing powders of LiOH-H_2O and H_2TiO_3 as starting materials, and then mixing powders were sintering at 1200^oC. The chemical composition and the crystal structure of the synthesized materials were analyzed by the inductively coupled plasma atomic emission spectroscopy (ICP-AES) and the powder X-ray diffraction (XRD) respectively. X-ray absorption near edge structure (XANES) was analyzed for investigating existing ratio of Ti^{3+} and Ti^{4+} in these samples. The results of XANES measurement showed that Li_2TiO_3 contains more Ti^{3+} compared with $Li_{2+x}TiO_{3+y}$ after annealing in Ar with 20%H_2 at 900 ^oC. Furthermore, crushing strength of the pellets of Li_2TiO_3 and $Li_{2+x}TiO_{3+y}$ was measured for investigating mechanical strength of each sample. The overall results indicated that the mechanical strength of solid breeding materials is largely-concerned with Ti valence ratio and Li/Ti ratio.

[1] T. Hoshino, K. Kato, Y. Natori , M. Nakamura, K. Sasaki, K. Hayashi, T. Terai, K. Tatenuma, Fusion Engineering and Design 82 (2007) 2269–2273