§31. Integrated Experimental Process Study for Removal of Tritium and Impurities from Liquid Lithium

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Liquid Li is proposed as a flowing target for a high-energy neutron generator of IFMIF. Since radioactive T is generated by the nuclear reaction and its solubility in the Li is quite high, T removal is one of the most important issues for IFMIF target. In addition, N impurity in the Li not only enhances corrosion or erosion to tubing materials, but also promotes nitride contamination on a surface of Y, which is considered to be a T gettering candidate. The Li flow of the target system will be divided into a main flow and a sub loop, where impurity will be controlled. Through the sub loop, Li after the reduction of N impurity will be sent to the T hot trap system. To realize this composite impurity recovery system, it is necessary to investigate on integrated recovery process of N and T, which is consists of cold trap, N hot trap, and T hot trap. N recovery by hot trap method with Fe-5at.%Ti alloy as a gettering material showed a high N reduction capacity. To enhance efficiency of the integrated recovery system, it is mandatory to shorten the N recovery time. As for T recovery, a Y particle bed is proposed as a method that can recover T down to 1 ppm. However, there was no study to prove 1 ppm T recovery by using Y. In this report, we describe recent progress on the integrated removal system, focusing on increase of N recovery coefficient by Fe-Ti alloys, and efficient T recovery by Y treated by HF.

Three plates of Fe-4at.%Ti alloy were immersed into 25 g of liquid Li in Mo crucible under Ar atmosphere. The crucible was put in a SUS316 stainless steel pot heated at 600, 700, or 800℃ for more than 100 hours. A small portion of the Li in the crucible was sampled out with adequate time interval, and the N concentrations in the sampled Li were observed by changing N to ammonia. Fig. 1 shows the change of N concentration in Li. The maximum recovery rates, pointed by arrows in Fig.1, became faster with increasing temperature. In case of 800℃, the N concentration was reduced below 20wt.ppm. However, a thick TiN layer, which is considered to decrease N absorption into bulk was observed. On the other hand, no Ti-rich layer nor TiN were observed on the surface of the alloy immersed in Li at 600℃ and 700℃. Optimization of temperature and Ti concentration in the alloy will be conducted to realize high efficiency consisted with long-life by avoiding TiN formation.

Y is a unique metal that can recover T dissolved in Li. However, since its surfaces are usually covered with oxides, hydrogenating rate is very low. As-received Y plate was treated by a 46% HF solution for 30 min. The HF treatment removed oxides on its surface and changed to YF_3. When a Y plate covered with YF_3 was immersed into Li, YF_3 was dissolved into Li and, therefore, metallic Y surface was disposed to Li. Thus the HF treatment is effective to remove oxide layer on Y loaded in the trap at primaly stage.

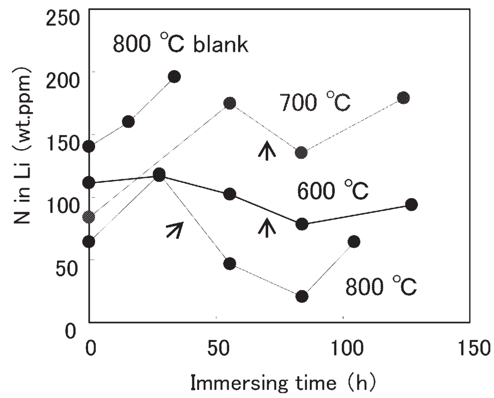

Fig.1 Temperature dependence of nitrogen recovery.

Several Li samples of 50 mg enclosed in a polyethylene capsule under He atmosphere were irradiated under a neutron flux of 2.75×10^{13} n/cm^2s for several minutes in KUR. After the irradiation, Li was put in a Mo crucible along with a Y plate with 0.25mm in thickness and $1.3cm^2$ in area. The concentration of T generated in Li was maximally 0.03 ppm in T/Li molar ratio. A set of Li and Y in a Mo crucible was heated at 300 – 500°C for 6 to 50 hours under Ar atmosphere. After heating, the T activity left in Li without absorption and that transferred to Y after heating were analyzed. The analysis revealed the following results on T recovery by Y plates: (i) Six hours heating at 400 or 500°C achieved the recovery of 1-6% of T generated in Li. The T chemical form in Li was atomic T. Its molecular form released to Ar is HT. (ii) 120 hours heating at 400 or 500°C made it possible to recover more T generated in Li (around 50%). (iii) T was transferred to Y more effectively by heating operation, and its chemical form was atomic T in Y. (iv) The HF treatment affected less the T recovery rate. This may be because oxygen that is inevitably present in Li delayed the T recovery rate regardless of the HT treatment. The last result revealed that the Y trap should be set after the oxygen and nitrogen traps in the IFMIF loop.

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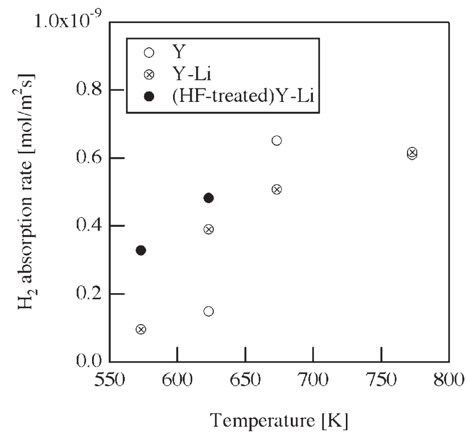

Fig. 2 Enhancement of H absorption rate by HF treatment