§32. Knowledge and Technology Transfer from IFMIF-EVEDA Accomplishment to Systemization of Liquid Blanket Research

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This study aims to transfer the knowledge and technology learned through IFMIF-EVEDA project to the systemization of liquid blanket research. During IFMIF operation, several impurities are generated as non-metallic impurities such as hydrogen isotopes, nitrogen, oxygen, carbon and so on in liquid lithium. Therefore, it is important to control the concentrations of impurities in the lithium. Removal of hydrogen isotopes in liquid lithium is investigated in this year. Since lithium has large solubility of hydrogen isotopes, it is difficult to remove the isotopes down to the target concentration from lithium. The most effective recovery method is to use yttrium hot trap because yttrium has good compatibility with lithium and has higher solubility of hydrogen isotopes than lithium. By constructing the forced convection lithium loop in Kyushu University, the performance of yttrium hot trap experimentally is investigated. Figure 1 shows the removal ratio of deuterium in lithium, where c_D denotes the bulk concentration of deuterium in lithium and $c_{D,0}$ is initial value of that. The recovery ration of deuterium in lithium flow was achieved up to 99.99%, which corresponds to the value of less than 1 wppm deuterium/lithium atomic ratio under both temperature conditions, 523K and 573K. Furthermore, through this experiment, it is found that 100ppm order impurity of nitrogen in lithium had impact on the recovery performance of yttrium. In the case of lithium blanket, the leakage of tritium is negligible because of its low equilibrium partial pressure. And it is demonstrated that the recovery of tritium is theoretically possible by means of yttrium pebble bed as hot trap. Provided that the reaction between liquid lithium and oxygen and water contained in lithium itself should be taken into account. When the above model is applied to the estimation of leak ratio of tritium in FFHR self-cooling blanket, the value of 99.9998% of recovery ratio should be required to keep the leak ratio less than 10 Ci/day.

Hydrogen isotope in liquid lithium can be trapped with metal yttrium, as mentioned above. However, surface degradation by oxidization and/or nitridation reduces the recovery performance. Therefore, Y-Nb alloy is taken into consideration as the instead material of trapping. In this fiscal year, we fabricated three types of Y-Nb alloy by arc furnace as shown in Fig.3. By using these alloys, the experiment for recovery of hydrogen isotope from lithium is performed from next fiscal year. In order to establish the method of tritium recovery from liquid lithium, the hydrogen isotopes permeation monitor for liquid lithium has

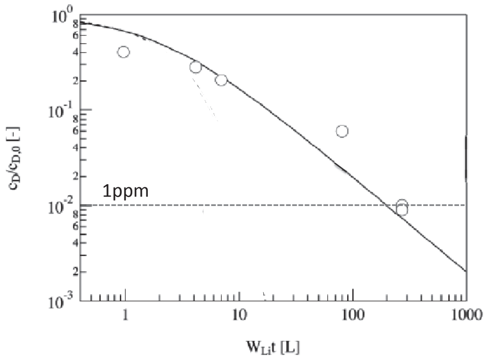

Fig. 2 Removal ration of deuterium in lithium

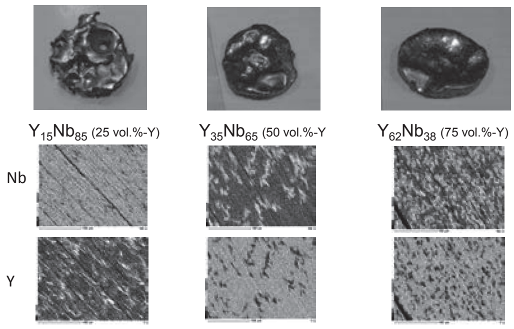

Fig.3 Fabricated Y-Nb alloys and their cross sectional concentration profiles of niobium and yttrium

been developed in IFMIF-EVEDA project. Permeation of hydrogen isotope through the material (window) depends on hydrogen concentration in lithium, that is to mention, hydrogen permeation enables the hydrogen concentration monitoring. This system has no moving element and can do monitoring continuously online. Furthermore, this monitor is available not only for the lithium blanket but also the lithium lead blanket and molten-salt blanket as it is. As the permeation window material, NbZr or Ti become candidate because their permeability is high, however they are not stable against oxidization or nitridation. On the other hand, pure iron is comparatively stable against oxidization or nitridation while permeability is not so high. In this research, we challenge to upgrade the hydrogen isotope permeation monitor by means of pure iron as the permeation window material. The sensitivity of pure iron window was investigated for the low hydrogen-concentration liquid lithium. In this case, the liquid lithium was flowed by bubbling of argon gas. At 600^{o}C, 10 wppm of hydrogen permeation was detectable. The effect of argon gas bubbling on hydrogen permeation was limited, because the hydrogen solubility in liquid lithium is much higher than that in the iron.

The liquid metal appeared in IFMIF-EVEDA project is lithium. However, these achievements are expected to contribute to the systematization of advanced blanket research by applying the challenges of liquid lithium blanket and cooperating with the liquid blanket research by utilizing Oroshhi-2 of NIFS.