§17. Nitrogen Removal from Liquid Lithium and Improvement of Hydrogen Monitor for Liquid Lithium

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Liquid lithium is proposed as a flowing target for a high-energy neutron generator of IFMIF. Since radioactive tritium is generated by a nuclear reaction and its solubility in Li is quite large, T removal is one of the most important issues for IFMIF target. Furthermore, T concentration monitor is indispensable not only for the target Li loop, but also for further experiment on yttrium which will be used as gettering material for hydrogen isotopes in IFMIF. We developed a hydrogen monitor for Li based on permeation method in FY2007 and its applicability for deuterium monitoring has been studied. In addition, nitrogen impurity in Li must be reduced to low level not only because it enhances corrosion for tubing materials, but because it promotes nitriding on the surface of Y to suppress T trapping. As for N getter, Fe–Ti alloy has been shown to be effective in static conditions, while its practicality in dynamic condition has to be clarified for valid system design. In this report, we describe recent progress on the impurity removal system, focusing on nitrogen gettering of Fe-Ti alloys in a dynamic condition and improvement of a hydrogen monitor for isotopes monitoring.

Nitrogen gettering device was improved so that experiments could be done in dynamic condition, that is, a Fe-Ti alloy disk is rotated in lithium through a shaft connected to a rotary feed-through. The experimental device is shown in fig.1. Using a Fe-5Ti alloy disk –40 mm in diameter and 1 mm in thickness- rotating at 60 rpm, nitrogen concentration of 25 g lithium was controlled at 873 K, whose temporal change is shown in fig.2. Impurity nitrogen was decreased quickly and Fe-Ti alloy was shown to work properly as gettering material in a dynamic condition. As a result of these years' experiments, Fe-Ti alloy is confirmed to be a proper N gettering material for IFMIF purification system.

Quantitative capability of deuterium concentration in lithium was examined using the hydrogen isotopes concentration monitor with a pure iron permeation wall, vacuum gauges, a mass analyzer and an evacuation system constructed in FY 2007. Increasing deuterium concentration via D_2 gas feeding, the amount of deuterium permeation was measured as shown in fig.3. Deuterium discharge as water –HDO and D_2O- was comparably small, the sum of ion current for HD and that of D_2 was used as Y-axis. A good quantitative capability was found for the permeation device. Increasing temperature results in larger hydrogen isotopes permeation, so that more accurate quantification will be achievable at higher temperature.

To examine permeation capability for little concentration tritium, the permeation device was improved to connect to a tritium monitoring line and lithium in the device was irradiated in the fast neutron source reactor "YAYOI" of The Univ. of Tokyo to contain tritium up to about 1appb. After the irradiation, sweeping the permeation wall by high purity He gas, permeating tritium was measured as shown in fig.4. Tritium permeation was clearly observed and its temperature dependence was almost the same as that of deuterium or light hydrogen. As a result of experiments for these few years, a functional hydrogen isotopes monitor for liquid lithium has been constructed based on permeation method.

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[1] J. Yagi et al., SOFT2008, Sep2008
[2] J. Yagi et al., J. Nucl. Mater., in press

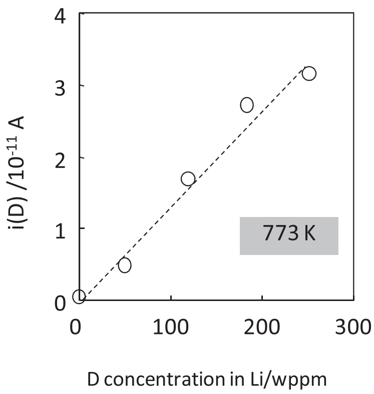

Fig.3: D permeation for various D concentrations in Li

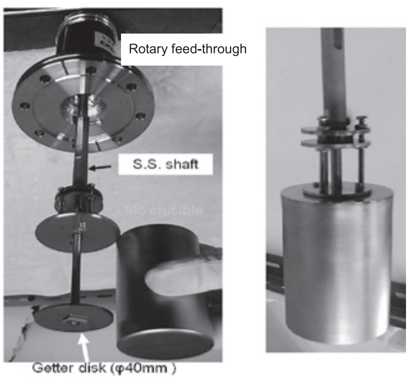

Fig.1: Improved gettering device for getter disk rotation

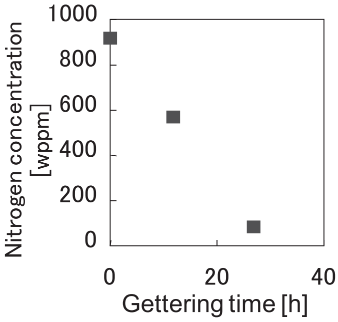

Fig.2: Nitrogen gettering by a rotating Fe-Ti alloy disk in lithium

Quantitative

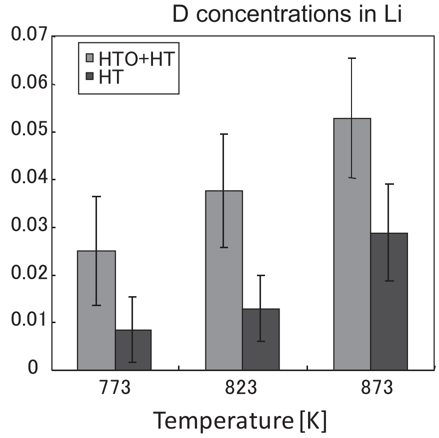

Fig.4: Temperature dependence of T permeation (T concentration: ~1appb, He sweeping: 10sccm)