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Li_2TiO_3におけるトリチウム捕捉・脱捕捉の中性子照射量依存性に関する研究

Study on dependence of neutron irradiation fluence for tritium trapping/de-trapping in Li_2TiO_3

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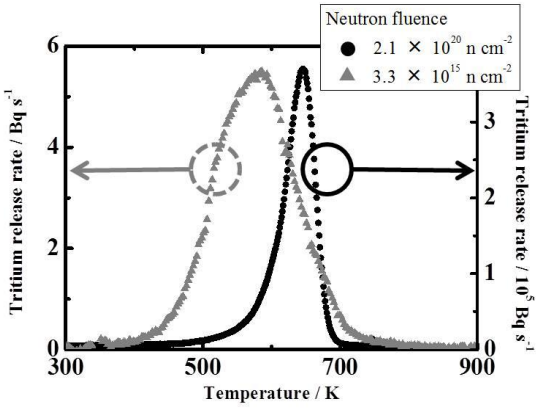
Clarification of migration processes of tritium produced by nuclear reaction, such as ^{6}Li (n, α) T in tritium breeding materials, is important to establish the blanket system in fusion reactors. In our previous study, it was found that irradiation defects formed by neutron irradiation in lithium titanate (Li_2TiO_3) acted as tritium trapping sites.[1] In actual conditions, it is expected that the amount of the irradiation defects will be increased with an increase of neutron irradiation until the irradiation defects become saturation at some neutron fluence. Therefore, understanding of the relation between the formation behavior of the irradiation defects and the tritium release behavior affected by neutron irradiation fluence is needed. In this study, lithium titanate was irradiated with thermal neutrons at two kinds of neutron fluences. Tritium release behavior was clarified by thermal desorption spectroscopy (TDS) to discuss the relation between neutron irradiation fluence and tritium migration process.

Powders of Li_2TiO_3 purchased from Kaken Co. were used as samples. These samples were introduced into quartz tubes and preheated at 1173 K under He gas with the pressure of less than a few Pa for 3 h. After heating, thermal neutron irradiations were performed with the thermal neutron fluence of 3.3×10^{15} n cm^{-2} and 2.1×10^{20} n cm^{-2} at Research Reactor Institute, Kyoto University (KURRI). After the neutron irradiation, tritium release experiments were performed by means of TDS with a heating rate of 0.5 K min^{-1} up to 1173 K at Shizuoka University. The isothermal heating experiments were also carried out to evaluate tritium release dynamics in these samples. The heating temperature region was set to be 570 - 750 K.

Figure shows Tritium TDS spectra for neutron irradiated Li_2TiO_3 with the neutron fluences of 3.3×10^{15} n cm^{-2} and 2.1×10^{20} n cm^{-2}. Tritium was released from 400 K to 700 K for both samples. The TDS spectrum for the sample irradiated with the fluence of 3.3×10^{15} n cm^{-2} showed wide release peak at around 580 K. On the other hand, that for the sample irradiated with the fluence of 2.1×10^{20} n cm^{-2} showed sharp release peak at around 650 K, indicating that tritium release behavior was changed with the increase of neutron irradiation fluence. Tritium release ratio obtained by isothermal heating experiments was compared to that calculated by Fick's diffusion equation and first order reaction equation. Tritium release for the neutron irradiated sample with the fluence of 3.3×10^{15} n cm^{-2} was only represented by Fick's diffusion equation. On the other hand, that with the fluence of 2.1×10^{20} n cm^{-2} was only represented by first order reaction equation. In previous study, it was revealed that the amount of irradiation defects is increased with the increase of neutron irradiation fluence and tritium was tapped by oxygen. In addition, detrapping process of tritium trapped by oxygen or irradiation defects was governed by first order reaction. These results indicated that rate determining step of tritium release was changed with the increase of neutron fluence by contribution of tritium trapping site.

[1] M. Kobayashi, et al., Fusion Engineering and Design 87(2012)471-47



Tritium TDS spectra for neutron irradiated Li_2TiO_3