Role of energetic tritium chemistry on developing thermonuclear fusion reactors

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Knowledge about chemical behavior of energetic hydrogen isotopes, especially tritium, in solid states has increasingly required for development of thermonuclear fusion reactors. In D-T fusion reactors, energetic tritium will be produced by the nuclear reactions of ^{6}Li(n, α)T and ^{7}Li(n, n' α)T in lithium-bearing materials, and also will escape from the D-T plasma, and then implanted into the plasma facing materials, such as graphite, beryllium, tungsten and so on. Both of them could behave hot-atomically in the lithium ceramics and plasma-facing materials, respectively. Especially, the chemical behavior of energetic tritium produced in the tritium breeding materials is interested from the viewpoint of radiochemistry. In the present paper, we will review hot atom chemical behavior of energetic tritium produced in the tritium breeding materials of fusion reactors.

Our previous experiments revealed that the thermal neutron-irradiated Li_2O tritium existed in three chemical states of T^+, T^- and T^0, whereas only T^+ was existed in Li_2O thermally-doped with tritium[1]. It was also reported that the T^- species were eventually converted to the T^+ species through thermal annealing above 570 K for the ternary lithium oxides. These results showed that hot atom behavior played an important role to determine the recovery rates of hot tritium in the ternary lithium oxides in fusion reactors.

Recently, detail studies on kinetics of annihilation of the irradiation defects induced by the nuclear reactions, 14 MeV neutrons, and γ-ray in the ternary lithium oxides were carried out by means of the Electron Spin Resonance (ESR)[2] method. The measurements showed that there was a close correlation between the irradiation defects and tritium exiting states[3]. Moreover, extensive studies on kinetics of tritium release processes from neutron-irradiated lithium bearing materials by Thermal Desorption Spectroscopy (TDS) suggested that tritium migration triggered by the annihilation of the irradiation defects. From both of ESR and TDS results, we proposed a comprehensive migration model for energetic tritium produced in the ternary lithium oxides.

[1] K. Okuno and H. Kudo, *J. Nucl. Mater.* **1986**, *138*, 31.

[2] M. Oyaidzu *et al.*, *J. Nucl. Mater.* **2008**, *375*, 1.

[3] H. Ishikawa *et al.*, *Fusion Sci. Des.*, **2008**, *54* 127-130.