Dependence of gamma-ray Dose on Annihilation Processes of Irradiation Defects in Li_2TiO_3

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Lithium titanate (Li_2TiO_3) is a candidate for the solid tritium breeders of the ITER-TBMs. In our previous studies, it has been reported for the neutron-irradiated Li_2TiO_3 that there was a correlation between the tritium release and the annihilation of irradiation defects produced by the reaction of $^6Li(n, \alpha)T$, especially E'-center which was oxygen vacancy occupied by one electron [1]. Therefore, to understand tritium behavior in the ITER-TBMs, elucidation of correlation between tritium behavior and annihilation of irradiation defects could be one of the critical issues. Irradiation defects were found to be generated by collision of energetic particles and electron-excitation. Hence, the elucidation of each process is important for understanding a comprehensive defect formation and annihilation behavior. Especially, only electron-excitation processes were caused by gamma-ray irradiation. In addition, it was thought that the annihilation kinetics of the defects would change by the accumulation of defects according to an increase of gamma-ray dose. Therefore, to consider elementary steps for the annihilation of the irradiation defects, the annihilation behavior of each defect was revealed by changing the amount of the defects. In this study, our attention was focused on elucidation for the annihilation behavior of the defects induced in Li_2TiO_3 irradiated by various gamma-ray doses.

The Li_2TiO_3 powder purchased from Furuuchi chemistry Co. Ltd. was irradiated for 75-240 kGy at Co-60 Gamma-ray Irradiation Facility in the Research Reactor Institute, Kyoto University. Before and after the irradiation, electron spin resonance (ESR) measurements were performed at 77 K to evaluate irradiation defects. Isochronal annealing experiments were carried out in the temperature range of R.T.-625 K to determine the annihilation temperature of the irradiation defects. The isothermal annealing experiments were also performed at 423-673 K through a maximum heating time of 8 hours to understand the annihilation kinetics of the irradiation defects.

The ESR spectrum of gamma-ray-irradiated Li_2TiO_3 consisted of two major peaks, namely, the O^--center, which was an oxygen hole center, and the E'-center[2]. These defects are known to be Frenkel pair and could be produced by the electron excitation processes. In the isochronal annealing experiments, the O^--center and E'-center were simultaneously annihilated by a recombination with each other in the temperature region of 550-650 K. From kinetics analysis, the recombination was determined to be governed by a second-order reaction. As a result, the activation energy of the recombination process increased with the increase of gamma-ray dose. This indicated that stabilization of the defects was occurred by increasing density of defects. In the presentation, influence of several gamma-ray doses on the annihilation behavior of defects will be discussed in detail from the viewpoint of kinetics,

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