§9. Study on Annihilation Behavior of Defects Produced in γ-ray-irradiated Li_2TiO_3

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INTRODUCTION: Several studies have been carried out over years to establish a tritium recovery system. Especially, lithium titanate (Li_2TiO_3) is thought to be one of the candidates as the tritium breeding material on ITER. Our group has been reported that tritium release from neutron-irradiated Li_2TiO_3 correlated with the annihilation of E'-center which was an oxygen vacancy occupied by one electron[1].Therefore, elucidation of behavior of irradiation defects is an important issue to establish the tritium recovery system.

In this study, our attention was paid to the correlation between the produce and annihilation processes of the irradiation defects. The γ-ray irradiation which was different from neutron irradiation on the production processes of the irradiation defects, was performed. Measurements of Electron Spin Resonance (ESR) were employed to follow the irradiation defects which were produced with various irradiation doses. Additionally, the annihilation behaviors of these samples were evaluated by the isochronal annealing experiments.

EXPERIMENTS: The samples of Li_2TiO_3 were irradiated by γ-rays (dose rate: 3.24 kGy h^{-1}, temperature: R.T.) with irradiation dose up to 300 kGy using ^{60}Co irradiation setup in the Research Reactor Institute, Kyoto University (KURRI). After γ-ray irradiation, ESR (JEOL, JES-TE200) measurements were performed at liquid nitrogen temperature at the Center for Instrumental Analysis, Shizuoka University. Isochronal annealing experiments were performed to investigate the annihilation processes of irradiation defects. The annealing experiments were carried out until the ESR signals were either too small to detect or showed little further change.

RESULTS: Figure 1 shows ESR spectra of Li_2TiO_3 samples irradiated by each γ-rays dose. The γ-ray-irradiated Li_2TiO_3 consisted of three major peaks, namely, O^--center, which was an oxygen hole center, E'-center and metallic lithium (Li) colloid[2]. Here, O^--center and E'-center are a Frenkel pair. It was found that Li colloids increased as the irradiation dose increased up to 150 kGy, whereas the amounts of O^--center and E'-center were decreased. On the other hand, the concentration of Li colloids decreased in further irradiation dose, however those of O^--center and E'-center were increased. It was considered that the decomposition of the Li colloids by γ-ray irradiation above 150 kGy lead to the increasing of the amounts of O^--center and E'-center. This fact suggested that the existence of Li colloids affected the formation of O^--center and E'-center. Figure 2 shows the annihilation behavior of the irradiation defects in isochronal annealing on the γ-ray-irradiated sample with 300 kGy. From these results, it was found that the annihilations of O^--center and E'-center around 500-700 K were observed uniformly. Taking this result into consideration, these defects would be recombined in this temperature region. According to the results of isochronal annealing experiments on the γ-ray irradiated samples, both of the annihilation behaviors for O^--center and E'-center have a correlation with irradiation dose, suggesting that Li colloids affected the annihilation of O^--center and E'-center.

It was concluded that O^--center and E'-center, which produced by the γ-ray irradiation, were simultaneously annihilated by a recombination process, suggesting that this recombination process would be affected by the existence of Li colloids. In future work, an influence of Li colloids on the annihilation of O^--center and E'-center will be elucidated.

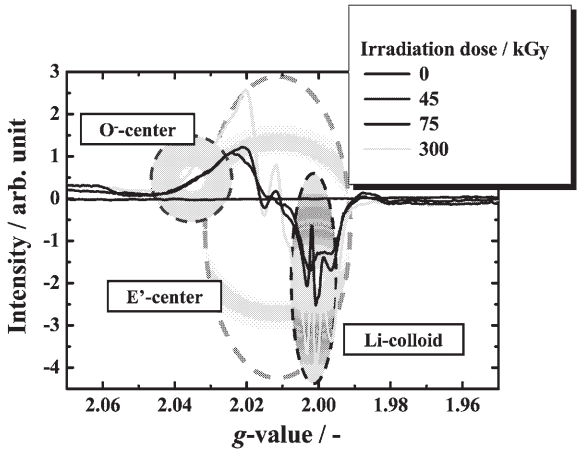

Fig. 1 ESR spectra of Li_2TiO_3 samples irradiated by each γ-rays dose

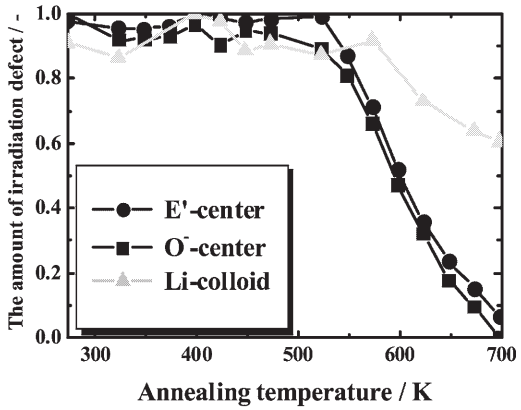

Fig. 2 Annihilation behavior of the irradiation defects in isochronal annealing experiments (300 kGy)

[1] K. Okuno and H. Kudo, J. Nucl. Mater., **138** (1986) 31-35.
[2] F. Beuneu, *et al.,* Colloids and Surfaces A: Physicochem. Eng. Aspects., **158** (1999) 83.