Effects of the lithium concentration on tritium release behaviors from advanced tritium breeding material Li$_{2+x}$TiO$_3$

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**Introduction**

Li$_2$TiO$_3$ : Candidate of tritium breeding materials

To increase the efficiency of tritium generation

Lithium-riched materials : Li$_{2+x}$TiO$_3$

$\cdot$Li$_{2+x}$TiO$_3$ : Mixture of Li$_2$TiO$_3$ and Li$_3$TiO$_2$ structures

Elucidation of tritium release behavior from Li$_{2+x}$TiO$_3$

- Observation of two tritium release stages (470 and 600 K) in Li$_2$TiO$_3$
- Increase of Peak 1 (470 K) with increasing the Li concentration
- Tritium release stage from Li$_{2+x}$TiO$_3$ structure as Peak 1 was observed in Li$_3$TiO$_2$

Tritium release from Li$_{2+x}$TiO$_3$ was consisted of that from Li$_2$TiO$_3$ and Li$_3$TiO$_2$.

In blanket system : Necessity of estimation for tritium inventory

Irradiation defects : Control of tritium release behavior

Elucidation of the Li concentration effects on annihilation kinetics of irradiation defects for tritium release behavior

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**Experimental**

Sample : Li$_{2.0}$TiO$_3$, Li$_{2.4}$TiO$_3$ powder (Kaken Co. Ltd.)

Preheating

R.T. – 1173 K for 3 h

Under He gas with less than few Pa

Neutron Irradiation @ KUR

Neutron flux : $5.5 \times 10^{13}$ n cm$^{-2}$ s$^{-1}$

Neutron fluence : $3.3 \times 10^{17}$ n cm$^{-2}$

Isocronal annealing

Heating region : R.T.-773 K

Heating step : 25 K

ESR measurement

To clarify the annihilation behaviors of the defect for Li$_2$TiO$_3$ and Li$_{2+x}$TiO$_3$

To evaluate the kinetics of the defects annihilation

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**Results and discussion**

Two irradiation defects : E’-center, O-related center

- E’-center (g = 2.01)
  - Oxygen vacancies trapping one electron
- O-related center [O-center, O$_2$-center] (g = 2.05)
  - Oxygen atoms in interstitial of lattice

Tritium trapping site

Frenkel pair : Annihilation by recombination

- E’-centers in Li$_{2.0}$TiO$_3$ were decreased above 600 K
- E’-centers in Li$_{2.4}$TiO$_3$ were decreased around 400 – 700 K

Irradiation defects formed in Li$_4$TiO$_3$ structure were annihilated easily.

Peak 1 (450 K) : Tritium release from Li$_2$TiO$_3$ structure

Peak 2 (600 K) : Tritium release from Li$_3$TiO$_2$ structure

Annihilation temperature region of defects formed in Li$_2$TiO$_3$ : Corresponding to Peak 1

Peak 1 : Tritium release triggered by annihilation of defects formed in Li$_2$TiO$_3$

Isocronal annealing

Activation energy in Li$_2$TiO$_3$

0.5+0.1 eV

Almost same in Li$_4$TiO$_3$

(0.5+0.1 eV)[3]

Contribution of Li$_2$TiO$_3$ structure for the apparent activation energy was underestimated.

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**Conclusion**

Irradiation defects formed in Li$_4$TiO$_3$ structure were annihilated easily compared to that in Li$_2$TiO$_3$.

Tritium trapped by defects in Li$_2$TiO$_3$ structure was triggered with annihilation of defects.

Tritium inventory in Li$_{2+x}$TiO$_3$ will be reduced with the increasing of Li concentration in the actual fusion reactor.