Study of Tritium and Helium Release from Irradiated Lithium Ceramics Li_2TiO_3

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Lithium metatitanate Li_2TiO_3 attracts the great attention as a candidate material of the solid breeders in the blankets of future fusion reactors due to its chemical stability and high speed of tritium release under low temperatures (from 200 to 400ºC). This paper contains the results of the studies on tritium and helium release from the samples of irradiated lithium ceramics Li_2TiO_3 up to high burn-up level by Li^6.

The pebble samples (diameter of 1 mm) of lithium metatitanate Li_2TiO_3 enriched up to 96% by isotope lithium-6 were irradiated at the WWR-K research thermal reactor during 220 days; irradiation temperature was 650 − 660 ºC; burn-up by ^6Li reached about 20% for this period. Study of the tritium and helium gas release from the Li_2TiO_3 samples was carried out by using the thermodesorption technique. Samples' heating rate was 6 °C/min.

The experiments showed tritium release behavior to be qualitatively different for the various pebbles, which can be a result of such the factors as different irradiation conditions (temperature mode, neutron flux), volume/surface structure of the initial samples.

Assuming the tritium and helium release processes to be mainly controlled by bulk diffusion the following parameters were defined: pre-exponential factor for the Arrhenius dependence of effective diffusion coefficient and activation energies of tritium and helium release from the irradiated ceramics. The obtained values of the tritium diffusion coefficients in the irradiated lithium ceramics were in good compliance with the parameters calculated by the data on tritium release kinetics during reactor irradiation (at the moment of reactor irradiation termination). Helium diffusion parameters in the unirradiated lithium ceramics were assessed by using the "effective radius" model. The results of the measurements and modeling are as follows: $D(T)=(1.6\pm0.1)\cdot10^{-6}\exp(-63/RT)$ m^2/s; $D(He)=(1.5\pm0.1)\cdot10^{-2}\exp(-215/RT)$ m^2/s.

The obtained values of the diffusion coefficients for helium and tritium allow for better understanding of the gas release processes in irradiated ceramics and help in necessary assessments of temperature operation modes of the ceramics for prospective use as a breeder material in future fusion reactor.