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Tritium Release and Retention Properties of Highly Neutron Irradiated Beryllium Pebbles from HIDOBE-01 Experiment

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Beryllium is planned to be used as neutron multiplier in the Helium Cooled Pebble Bed (HCPB) concept of a DEMO blanket and it will accumulate during the blanket lifetime up to 26 000 appm Helium and about 640 appm Tritium at temperatures up to 923 K. A detailed knowledge on the tritium release behaviour and its dependence on impurities and microstructure is indispensable to predict on solid ground the tritium inventory for different operation conditions and beryllium grades. In this study beryllium pebbles with diameters of 0.5, 1 and 2 mm have been irradiated in the High Flux Reactor (HFR) in Petten (the Netherlands) within the HIDOBE-01 experiment at blanket relevant temperatures of 700, 800, 923 and 1023 K up to 3 000 appm helium accumulation. Despite of a large number of earlier studies dedicated to the release and retention properties of hydrogen isotopes in beryllium, details of the release mechanism are still unclear. The main part of the data has been obtained by implantation of deuterium ions or loading of hydrogen with a tritium mark in beryllium. Only a few data were obtained on neutron irradiated beryllium by temperature-programmed desorption (TPD) tests but it was mainly performed at low damage doses or low irradiation temperatures of beryllium.

In this work tritium and helium release/retention measurements were carried out by the use of a proportional counter, an ionization chamber and a mass-spectrometer to analyze the gas release in thermal desorption measurements. Two heating rates, 1 and 15 K/min were used for the TPD tests by the permanent heating up to maximum temperature of 1373 K. For a clearer understanding and adequate interpretation of the release/retention results microstructure examinations of the beryllium pebbles before and after TPD tests by optical and scanning electron microscopes were performed. The obtained results are analyzed and compared with literature data on low temperature irradiation experiments.

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