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P4.193 Microstructural evolution in neutron irradiated beryllium pebbles at DEMO relevant temperatures

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Beryllium pebbles produced by the rotating electrode method were selected as a reference neutron multiplier material for the DEMO fusion reactor blanket. Recently they were characterized for this application after neutron irradiation at relevant temperatures. Under neutron irradiation at elevated temperatures, beryllium suffers from significant volumetric swelling stimulated by transmutation gases, helium and tritium. Insoluble helium precipitates as gas bubbles. In contrast, an exact location of tritium was uncertain, until our recent studies have revealed that tritium is trapped inside He-bubbles directly. Thus, the extended porosity formed within grains and along grain boundaries (GBs) is a natural trap for tritium. Accumulated inventory of this -radioactive element bears potential risk of burst T-release during operation and complicates nuclear waste management after blanket end of life. However, GBs and triple junctions (TJs) play essential role as accelerated gas-release pathways and are investigated in detail.
This work is devoted to the cross-correlation study of microstructural changes observed by optical and transmission electron microscopy in pebbles irradiated as unconstrained pebbles at 370-650℃ up to generation of 3600-6000 appm He and 370-650 appm T. We thoroughly characterized size distribution and number density of bubble formed inside grains. Significantly larger bubbles with smaller number density were found along GBs. Analytical studies with EDX revealed formation of Fe-Al-Be precipitates suggesting an essential role of iron in beryllium swelling, as these precipitates are always covered by large number of small bubbles. The role of GBs and TJs is increased due to formation of bubble-denuded zones with a thickness of up to several µm, as all helium and tritium produced within these zones precipitate at GBs increasing size of the gas bubbles grown there.
This study is extremely important for reliable assessment of tritium accumulation within 300 tons of beryllium required for the tritium-breeding blanket of DEMO.

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