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P2.178 Iron-ion irradiation effects on microstructure and deuterium permeation in yttrium oxide coating fabricated by magnetron sputtering

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Tritium permeation through structural materials in a fusion reactor fuel system causes fuel inefficiency and tritium leakage to the environment. Tritium permeation barrier (TPB) has been intensively developed using ceramic coatings to establish liquid blanket concepts for several decades. In a TPB coating, not only tritium permeation reduction but also tolerance to high dose radiation is required due to a severe neutron irradiation environment in the blanket region. Yttrium oxide (Y2O3) has been recently investigated as a TPB coating material with high permeation reduction and low activation by neutron irradiation. In this study, the irradiation effect on the characteristics of Y2O3 coating has been investigated using iron-ion irradiation as a simulation of damage introduction by neutron irradiation.

Y2O3 coatings were fabricated on F82H plate substrates by reactive magnetron sputtering without substrate heating. The coated samples were annealed in vacuum (<10−6 Pa) at 600 °C for 24 h to promote crystallization of the coatings. Thereafter, the samples were irradiated by Fe ion at room temperature and 500 °C. The incident energies were 1.0, 2.8 and 6.4 MeV. The displacement damage was set at up to 0.5–20 dpa, and then cross-sectional observation using a transmission electron microscopy and deuterium permeation tests were performed for the irradiated samples.

The samples irradiated by 1.0 MeV-Fe ion up to 3, 10 and 20 dpa at room temperature showed an amorphous layer near the interface. The thickness of the amorphous layer was about 100 nm in all the irradiated samples. In addition, a microcrystal layer was confirmed on the amorphous layer in the 10 and 20-dpa-damaged samples. These layers included many iron atoms and some of them formed an iron oxide. Incident energy dependence on microstructure and deuterium permeation behavior for the samples will be included in the presentation.

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