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Effects of high-energy C ions irradiation on the D retention behavior in V-5Cr-5Ti

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Alloys based upon the V-Cr-Ti system (e.g. V-4Cr-4Ti, V-5Cr-5Ti) are attractive candidate structural materials in future fusion reactors because of their low activation properties, high thermal stress factor, good strength at elevated temperatures, and usable fabrication properties. However, the high hydrogen isotope retention in vanadium alloys has been a serious concern in the potential application as fusion structural material. In addition, the high fluence radiation of 14 MeV fusion neutrons will produce various kinds of defects, which could make the problem of hydrogen isotope retention in vanadium alloys even worse. So far, this issue has not yet been investigated systematically, due to both the extreme lack of 14 MeV neutron sources and the activation of the neutron irradiated samples. High energy heavy ion beam has long been used to simulate radiation effects of high-energy neutrons. In this paper, samples made of V-5Cr-5Ti alloy are irradiated by 5.5 MeV carbon (C) ions with dose of 2×10ˆ14, 1×10ˆ15, 3×10ˆ15 C/cm2.

To investigate the defect properties in the irradiated samples, doppler broadening spectrometry of positron annihilation (DBS-PA) tests are carried out at room temperature with an energy-variable slow positron beam. In the measurement, the doppler broadening spectrum of the annihilation radiation was examined by a high-purity Ge detector, recording the gamma rays with energy 499.5–522.5 keV. The S parameter in DBS-PA increases significantly while the W parameter decreases with the increase of the irradiation dose, which indicates that the vacancy-type defects are introduced by C ions irradiation.

To characterize the effects of irradiation on the deuterium (D) retention property of V-5Cr-5Ti, the irradiated and unirradiated samples are implanted with D in an ECR linear plasma device at the Institute of Plasma Physics, Chinese Academy of Sciences (ASIPP). The electron temperature and density were Te ≈ 2.4 eV and ne ≈1.5×10ˆ17 m-3, respectively. Thermal desorption spectroscopy (TDS) experiments are followed, and the D retention behavior in the irradiated and unirradiated samples are compared and analyzed.

Eligible for student paper award?

Yes

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