NOMATEN JUNIOR SEMINAR

Radiation Damage and D retention in tungsten irradiated by different ions

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Tuesday, NOV 30th 2021 13:00 (1.00PM CET)

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Abstract:
Tungsten is a promising candidate material for the wall of a future fusion reactor due to its low erosion yield and low hydrogen solubility. However, fusion neutron irradiation will induce radiation defects in the material which can strongly increase hydrogen retention. Therefore, it is important to study the mechanism of defect creation and its influence on hydrogen retention in tungsten. Neutron displacement damage is often simulated by high-energy ion-irradiation. However, it is not clear to what extent the displacement damage created during different ion irradiations is comparable and to what extent it resembles that after neutron-irradiation. In this study, different ions with different energies are used to study the effect of the primary knock-on energy spectrum on damage creation and deuterium uptake. Tungsten samples were irradiated with different ions (H, D, He, Si, Fe, Cu, W) at energies between 0.3 and 20 MeV to two damage levels: 0.04 dpa and 0.5 dpa, calculated using SRIM. The microstructure was investigated using transmission electron microscopy (TEM). For TEM observations lamellas were prepared with focused ion beam microscopy to image the whole damage depth profile. The dislocation structure was comparable in tungsten irradiated by the medium- to high-mass ions (Si, W) beside the large differences in incident energies. At low damage levels mainly small dislocation loops are observed. A change from dislocation loops to lines was observed at about 0.1 dpa. The dislocation structure of tungsten irradiated by low-mass ions (H, D, He) was significantly different. For studying hydrogen retention, the samples were exposed to a low-temperature D plasma to decorate the defects at 370 K. The D retention was studied using nuclear reaction analysis (NRA) with D(3He, p)α and thermal desorption spectroscopy. Tungsten irradiated by high-mass ions to identical damage levels shows similar D depth profiles and D desorption spectra, i.e., D retention, is comparable. For tungsten damaged by low-mass ions significant differences in the D desorption spectra (peak intensity) were found.

Bio:
Barbara Wieluńska is a postdoc researcher at Max-Planck-Institut für Plasmaphysik in the area of the investigation of the dislocation structure in tungsten in collaboration with Warsaw University of Technology. She obtained her PhD diploma at Technical University in Munich in the area of “Characterization of Radiation Damage in Tungsten”. at her scientific work she utilize such tools as Transmission Electron Microscopy (TEM), skills Scanning Electron Microscopy (STEM), Sample preparation with focused ion beam microscopy (FIB), Metalographical end electrochemical sample preparation, Confocal Microscopy Ion beam Analysis (nuclear reaction analysis NRA, Rutherford Backscattering analysis RBS, Eleastic Recoil Detection ERDA, Ion-implantation) Temperature Programmed Desorption (TPD) Positron Annihilation Lifetime Spectroscopy (PALS).