ABSTRACT ICTP-2014-SMR-2614

2014 Joint ICTP-IAEA Conference on Models and Data for Plasma-Material Interaction in Fusion Devices, 3–7 November 2014, International Centre for Theoretical Physics (ICTP), Trieste, Italy.

In situ study of isotope exchange mechanism in self-ion damaged tungsten

S. Markelj[a], O. V. Ogorodnikova[b,c], A. Založnik[a], P. Vavpetič[a], T. Schwarz-Selinger[b], P. Pelicon[a], I. Čadež[a]

[a]Department for Low and Medium Energy Physics, Jožef Stefan Institute, Ljubljana, Slovenia

[b]Max-Planck-Institut für Plasmaphysik, Boltzmannstrasse 2, D-85748 Garching, Germany

[c]National Research Nuclear University MEPhI (Moscow Engineering Physics Institute), Kashirskoe sh. 31, Moscow, Russia

Email address of corresponding author: sabina.markelj@ijs.si

Fuel retention in wall materials is an important issue due to safety limitation of total tritium amount in ITER and future fusion devices. Tungsten is the material which is due to its favourable properties of low hydrogen solubility, high melting point and low sputtering yield used in the present and future fusion devices. However, due to the high energy neutrons produced in the fusion reaction, the material will be damaged creating traps in the material which could lead to large amount of retained fuel. In order to study retention in such materials the neutron-damage was simulated by bombardment of tungsten by high energy 20 MeV W ions in the present experiment.

Up to now the hydrogen isotope retention in undamaged and damaged W was studied by *ex-situ* measurements, mainly by nuclear reaction analysis (NRA) and thermal desorption spectroscopy. In order to study the dynamics of deuterium retention we have investigated interaction of atomic deuterium with damaged tungsten by *in-situ* NRA employing nuclear reaction $D(^3He,p)\alpha$ [1]. With the same set-up the isotope exchange in damaged W was studied. Here, the sample was first exposed to deuterium atoms at 590 K to fluence of 4.5×10^{23} D/m^2, which was enough to almost completely saturate the damaged layer. After this the sample was exposed to hydrogen atoms with H flux of 5.55×10^{18} H/m^2. In order to see the effect of deuterium desorption due to the elevated temperature, the sample was between the two isotope exposures for one night (20 h) left at 590 K in vacuum, which resulted in D decrease for 27 % in the damaged layer. After the H atom exposure the D concentration in the damaged layer decreased in almost the same time (22h) for another 40 % from the initial concentration, which is a clear indication that isotope exchange took place. After 100 h of H exposure, fluence 2×10^{24} H/m^2, almost complete D removal was achieved, leaving 2 % of deuterium in the damaged layer. The isotope exchange was also studied at 500 K but in that case D was removed only in the near surface layers up to 1 μm.

[1] S. Markelj, O. V. Ogorodnikova, P. Pelicon, T. Schwarz-Selinger, P. Vavpetič, I. Čadež. Phys. Scr. T159 (2014) 014047.

This work was supported and carried out within the framework of the European Fusion Development Agreement and EUROfusion Consortium. Research Project was part of the CRP carried out under the sponsorship of the IAEA. The views and opinions expressed herein do not necessarily reflect those of the European Commission.