Contribution ID: **1223** Type: **not specified**

P3.176 MeV energy ions accelerators for simulation the neutrons damage in fusion reactor materials

Wednesday, 19 September 2018 11:00 (2 hours)

Fusion reactors materials (FRM) will be exposed to 14 MeV fusion neutrons and damaged up to 15 dpa/year. The investigation of neutron irradiated materials is possible only in special conditions in a hot cell. The MeV-range energy ions can be used to simulate the effect of neutron-induced damages in FRM. Such simulation experiments can be used to study the effect of displacements on the materials structure and hydrogen isotopes retention properties.
In the work the experimental technique for MeV energy ions irradiation of FRM at NRC “Kurchatov Institute” – ITEP will be described and preliminary results of tungsten irradiation by Fe ions and protons will be presented. Two MeV-range linear ion accelerators uses for FRM irradiation: Heavy Ion Prototype (TIPr) with a 5.6 MeV Fe ions and I-2 with a 22 MeV protons. The accelerators were modified for simultaneous irradiation of 4 samples of 10×10 mm at controlled elevated temperature.
The use of 5.6 MeV Fe+ allows to create displacement to damage level 1 dpa during 10 hour of the near-surface layer (1.5 μm for tungsten). A thin damaged layer is suitable for investigation of a material structure, but it is inconvenient to study the hydrogen retention in the damaged layer. The heavy ions like Fe+ creates cascades of displacements with an inhomogeneous depth distribution while neutrons produce uniformly distributed defects. The light ions like protons leads to produce damages at depth up to 400 μm for tungsten with a uniform defect distribution that makes it possible to study the hydrogen isotopes retention in defects by many methods. The disadvantage of using high energy protons for W irradiation is a generation 183Re and 184Re with a half-life of 70 and 38 days respectively.
This study was supported by the Ministry of Education and Science of the Russian Federation (ID RFMEFI61317X0084).

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Session Classification: P3