Tritium retention in W plasma-facing materials: impact of the material structure and of He and He-D irradiation

E. Bernard[1*], R. Sakamoto[2], A. Kreter[3], N. Yoshida[4], F. Ghiorghiu[5], R. Bisson[5] , T. Angot[5], M.F. Barthe[6], M. Thompson[7], C. Corr[7], R. Doerner[8]; S. Markelj[9] and C. Grisolia[1,10]

[1]*IRFM, CEA Cadarache, St Paul lez Durance, 13108 France.*
[2] *National Institute for Fusion Science, Toki, Japan.*
[3] *Forschungszentrum Jülich GmbH, Jülich, Germany.*
[4] *Kyushu University, Fukuoka, Japan.*
[5] *PIIM, Aix Marseille University, Marseille, France.*
[6] *CEMHTI, CNRS, Orléans, France.*
[7] *Australian National Laboratory, Canberra, Australia.*
[8]*Center for Energy Research, UCSD, La Jolla, CA, United State*
[9]*Jozef Stefan Institute , 1000 Ljubljana, Slovenia*
[10]*National Research Nuclear University "MEPhI", Moscow, 115409 Russian Federation*

Plasma-facing materials for next generation fusion devices, like ITER and DEMO, will be submitted to intense fluxes of light elements, notably He and H isotopes (HI). Our study focuses on tritium (T) retention on a wide range of W samples: first, different types of W materials were investigated to distinguish the impact of the pristine original structure on the retention, from W-coated samples to ITER-grade pure W samples submitted to various annealing and manufacturing procedures, along with monocrystalline W for reference. Then, He and He-D irradiated W samples were studied to investigate the impact on He-damages such as nano-bubbles (exposures in LHD or PSI-2) or W fuzz (PISCES-B exposure) on T retention.

We exposed all the samples to tritium gas-loading using a gentle technique which is not introducing new damage in the material. Tritium desorption is measured by Liquid Scintillation counting (LSC) at ambient and high temperatures (800°C). The remaining T inventory is then measured by sample full dissolution and LSC. Results on T inventory (activity/exposed sample surface) is observed to vary greatly depending on the material structure with a retention of 0.29 MBq/mm^2 for pure ITER-like W but only 0.09 MBq/mm^2 for monocrystalline W for instance. The presence of He bubbles in the close vicinity of the surface increases the T quantities trapped as gas (HT or T_2) in the material. The initial conditions of the sample surface also appear to have a huge impact on T desorption: for instance, a preliminary reduction of the native tungsten oxide at the sample surface allows a decrease in HTO desorption by a factor 3. The presence of W fuzz does not change T desorption dynamic, but while tritium desorbing as gas stays in the same order of magnitude compared to the original W material, HTO desorption at ambient temperature decreases by a factor 7, highlighting the presence of more permanent trapping sites for T.

To complement our T retention study and investigate potential isotopic impacts, D inventories were measured on the same set of samples by Temperature Programmed Desorption (TPD) at PIIM. D and T profiles were measured by Nuclear Reaction Analysis at JSI to allow an insight on the long term trapping sites localization. These results were coupled with modelling efforts to address the general tendencies of tritium trapping in W and extrapolate potential inventory for future full W machine.

**Presenting Author's e-mail: elodie.bernard@cea.fr*