Beneficial Deuterium Retention Properties of Tungsten Heavy Alloy

H. Maier, R. Neu, T. Schwarz-Selinger, U. von Toussaint, A. Manhard,
T. Dürbeck, K. Hunger

Max-Planck-Institut für Plasmaphysik, Garching, Germany

Hans.Maier@ipp.mpg.de

We performed a study of the deuterium retention of the tungsten heavy alloy HPM 1850 (HC Starck, Germany), which is a two-phase material consisting of tungsten powder grains in a nickel/iron matrix. This material has been investigated with respect to other relevant properties and its application in the divertor of the tokamak ASDEX Upgrade was demonstrated in [1, 2]. This work was performed to obtain information on the tritium retention of this material in case of its application as plasma-facing material in a fusion reactor.
We exposed HPM 1850 to a low-temperature deuterium plasma at a bias voltage of -100 V with a flux of 10^{20} D/m² for implantation fluences of 1×10^{23} D/m² to 4×10^{25} D/m² at temperatures between 100°C and 250°C. Subsequently we analysed the deuterium retention by ^{3}He nuclear reaction analysis depth profiling up to a depth of 10 µm as well as by thermal desorption to obtain the total retention. For each implantation condition, we compared these data to those of commercial hot-rolled polycrystalline tungsten samples, which were exposed in parallel.
Our results clearly demonstrate that the deuterium retention in HPM 1850 is systematically lower than the comparative values in tungsten and the relative retention decreases with increasing implantation fluence and exposure temperature [3]. We attribute this to the different thermodynamic properties of deuterium in the Ni/Fe phase as compared to tungsten and support this conjecture with numerical simulation results. The reduced hydrogen isotope retention represents an important qualification criterion for plasma-facing materials in fusion reactors.

[1] R. Neu et al., Fus. Eng Des. 124 (2017) 450
[2] R. Neu et al., J. Nucl. Mater. 511 (2018) 567
[3] H. Maier et al., Nucl. Fusion 60 (2020) 126044