Modeling of plasma-material interaction experiments at PSI-2 with the 3D Monte-Carlo code ERO

E. Marenkov, A. Eksaeva, D. Borodin[a], A. Kirschner[a], M. Laengner[a], V. Kurnaev, A. Kreter[a]

National Research Nuclear University MEPhI, Kashirskoe sh., 31, Moscow, 115409, Russia
[a] Institute for Energy and Climate Research - Plasma Physics, Forschungszentrum Jülich, Association EURATOM-FZJ, Trilateral Euregio Cluster, Germany

edmarenkov@gmail.com

Linear plasma devices such as PSI-2 [1] are widely used for studying of plasma-surface interaction (PSI) because of their flexibility, continuous plasma operation and divertor relevant plasma conditions. However, due to complex physics of plasma surface interaction, the numerical modeling is still an essential tool to interpret the experimental results.

The 3D Monte-Carlo code ERO [2] is a recognized tool for the predictive modelling of the life time of ITER wall components and long-term tritium retention. It is also used for the interpretation of PSI experiments involving erosion, local impurity transport, spectroscopy and surface content evolution. It has been applied earlier to linear plasma devices [3], however for PSI-2 simulations further modifications of the code have been made to consider the specific shape of plasma density and temperature profiles, target geometry and position, and locations of available spectroscopy diagnostics.

Tungsten (W) is one of the most important materials for ITER wall construction. Therefore, understanding of its interaction with plasma is essential for the project. However, some of data concerning these interactions need verification or are not known at all. For example, the role of metastable states in tungsten light emission, which is important for interpretation of spectroscopy results, is still not clear; different databases give different values for the ionization rate coefficients etc.

Dedicated experiments were performed at PSI-2 facility and analyzed using the modified ERO code. In these experiments a tungsten target was exposed to argon plasma, which has been characterized by scanning Langmuir probe measurements. WI (emission from neutral tungsten atoms) line intensity profiles along the axial axis of PSI-2 were obtained using a spectrometer, and 2D picture of WI irradiation was observed by a camera with a filter.

ERO modeling shows good qualitative agreement with observed 2D picture. However, the decay rate for WI emission profiles shows some discrepancy between experimental and simulation results. Different factors responsible for this are discussed. The main contribution is associated with an uncertainty of atomic data for tungsten ionization and light emission taken from ADAS [4] and ATOM [5] databases. It is interesting to note, that the simulations show that the most of sputtered particles are deposited on the walls of the chamber and only about of 6% are coming back on the target surface.

[1] A. Pospieszczyk et al., J. Nucl. Mater. 438 (2013) S1249–S1252.
[2] A. Kirschner et al., J. Nucl. Mater. 363-365 (2007) 91-95.
[3] D. Borodin et al., Contrib. Plasma Phys. 50, No. 3-5 (2010) 432 – 438.
[4] http://www.adas.ac.uk/about.php
[5] D. Kondratyev et al., J. Nucl. Mater. 438 (2013) S351-S355.