Effect of edge ion temperature on the divertor W sputtering on WEST

Y. Li[1], N. Fedorczak[2], G. S. Xu[1], Y. Liang[3], S. Brezinsek[3], J. Morales[2], and the WEST team[4]

[1]*Institute of Plasma Physics, Chinese Academy of Sciences, Hefei 230031, China*

[2]*CEA, IRFM, F-13108 Saint-Paul-lez-Durance, France*

[3]*Forschungszentrum Jülich GmbH, Institut für Energie- und Klimaforschung – Plasmaphysik, Partner of the Trilateral Euregio Cluster (TEC), 52425 Jülich, Germany*

[4]*See (http://west.cea.fr/WESTteam) for the WEST team*

Email (speaker): ylli@ipp.ac.cn

Due to the lack of routinely ion temperature measurement at the SOL, the study of tungsten erosion and transport is usually limited to the electron temperature measurement, and the effect of the ion temperature is barely considered in theoretical simulations [1]. This presentation introduces a study of the edge ion temperature effect on the tungsten (W) sputtering in the WEST tokamak by means of the retarding field analyzer [2], the divertor Langmuir probe array [3] and the divertor visible spectroscopy [4]. By gradually decreasing the SOL electron density and maintaining a constant SOL power, the upstream ion temperature and its ratio over the electron temperature both gradually increase. This increment is observed to enhance the energy transfer from ions to electrons, which in turn increases the downstream electron temperature and enhances the downstream W sputtering. The energy transfer rate was estimated to gradually decrease with the increase of the normalized electron collisionality. Its value comparing with the perpendicular ion and electron energy transport rate are roughly $Q_{eq}/Q_{\perp,i}$~$1/5$ and $Q_{eq}/Q_{\perp,e}$~1. This indicates that the energy transfer from ions to electrons play an important role in governing the edge plasma energy balance. An analytical equation considering the ion and electron coupling term is introduced to predict the upstream and downstream electron temperature ratio (T_{eu}/T_{ed}). The result is more precise than the traditional analytical equation [5] in comparing with the experimental measurement. Based on the new analytical equation, increasing the upstream T_i/T_e ratio or electron collisionality would decrease the T_{eu}/T_{ed} ratio and potentially increase the W material sputtering risk. This work may help to facilitate the understanding of the effect of the coupled ion and electron energy on the W sputtering.

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