Hydrocarbon film deposition inside cavity samples in remote areas of the JET divertor during the 1999-2001 and 2005-2009 campaigns

S. Krat[1], Yu. Gasparyan[1], A. Pisarev[1], M. Mayer[2], U. von Toussaint[2], P. Coad[3], A. Widdowson[3], JET-EFDA contributors[+]

JET-EFDA, Culham Science Centre, Abingdon, OX14 3DB, UK
[1]National Research Nuclear University "MEPhI", Moscow Kashirskoe sh. 31, 115409, Russia
[2]Max-Planck-Institut für Plasmaphysik, EURATOM Association, Boltzmannstr. 2, 85748 Garching, Germany
[3]Culham Science Centre, EURATOM/UKAEA – Fusion Association, Abingdon, Oxfordshire OX14 3DB, UK
[+]See the appendix of F.Romanelli et al., Proc 24th IAEA Fusion Energy Conference 2012, San Diego, USA

Hydrocarbon film deposition in shadowed areas of fusion devices can lead to the accumulation of large amounts of hydrogen isotopes, including tritium, making it an important question from the radiological safety perspective. The mechanism of hydrocarbon layer formation in these shadowed areas is still not fully understood.

Hydrocarbon film deposition was studied using "cavity samples", consisting of two plates one above the other, forming a cavity, with an entrance slit in one of the plates. Those samples were installed in the divertor of JET during the 1999-2001 and 2005-2009 campaigns. The thicknesses and compositions of hydrocarbon deposits were measured by nuclear reaction analysis, using $^3He^+$ ions with several energies and 0.5 mm spatial resolution.

Monte-Carlo simulation was used in order to generate thickness profiles of films deposited inside the cavity samples. The positions of incident particle sources and the surface loss probabilities, i.e. the sum of sticking coefficient and the probability for the particle to transform into a stable molecule after each collision with a wall, for particles forming the film were varied and matched to the experimental data.

The particle sources for the cavity samples located in the inner divertor were similar in both campaigns. The main amount of particles originated from the tilted center area of divertor tile 4, about 15° below the horizontal plane, and a smaller amount of particles originated from the area located about 20° above the horizontal plane. The particle source for the septum cavity sample, located below the fifth divertor tile, exposed during the 1999-2001 campaign was strongly focused, with the maximum particle flux originating from a small area in the center of divertor tile 3, near the strike point. The film in the outer divertor cavity sample of the 2005-2009 campaign partially peeled off, making the reconstruction of the particle source impossible.

The surface loss probabilities for the films deposited in the cavity samples during the 1999-2001 campaign were 0.92-0.95 for the inner divertor cavity and 0.97-0.98 for the septum cavity. Films deposited during the 2005-2009 campaign had lower surface loss probabilities: 0.6 for the outer divertor cavity and 0.7 for the inner divertor cavity. For all cavities (except the 1999-2001 septum sample), the deposition profile could be well described by a single surface loss probability for each cavity.

In all samples an almost homogenous distribution of small amounts of beryllium (below $2x10^{17}$ atoms/cm^2) on all surfaces was detected, which is most likely due to beryllium dust contamination.