ITER-Like-Wall (ILW) project has been carried out at Joint European Torus to test plasma facing materials relevant to International Thermonuclear Experimental Reactor – ITER [1]. First wall of the vacuum vessel is made of bulk beryllium tiles, whereas for the divertor bulk tungsten and tungsten coated carbon fibre (CFC) composite tiles are used. During the shutdowns in 2012, 2014 and 2016, selected beryllium and tungsten tiles were removed from the vacuum vessel. In this study, beryllium tiles from three positions were analysed, and results compared regarding both the tile position in the vacuum vessel and differences in the exploitation conditions during three ILW campaigns. Tiles were from the inner wall, outer wall and upper region of the vessel. Tritium retention has been also assessed in the bulk tungsten and tungsten coated CFC samples from the divertor tile.

A number of methods were used to determine tritium content – tritium measurement during chemical and electrochemical etching, combustion and thermodesorption. Prior to tritium measurements, scanning electron microscopy and energy dispersive x-ray spectroscopy were used to study structure and chemical composition of the plasma-facing surfaces.

Experimental results revealed that tritium content in beryllium samples is in range of $6.0 \times 10^{10}$ to $2.5 \times 10^{13}$ tritium atoms per square centimetre of the plasma-facing surface area. Highest tritium content was found in the samples from outer wall of the vacuum vessel - up to $1.9 \times 10^{13}$ atoms/cm$^2$ in ILW1 and $2.5 \times 10^{13}$ atoms/cm$^2$ in ILW2. Whereas, the lowest - in the upper part of the vacuum vessel: $2.0 \times 10^{12}$, $2.0 \times 10^{12}$ and $6.0 \times 10^{10}$ atoms/cm$^2$ in ILW1, ILW2 and ILW3, respectively. Tritium results have been compared to deuterium data published by other authors. In contrary to the deuterium, higher tritium concentrations were found in the central part of the tiles where plasma induced erosion had occurred according to the SEM analysis data. Difference between tritium content in the central part and side part of tile could reach a magnitude of an order - for example, $2.5 \times 10^{13}$ and $2.7 \times 10^{12}$ atoms/cm$^2$ in outer wall tile from the ILW2 campaign. In samples of tungsten coated CFC divertor tiles from ILW1 campaign tritium content is in range from $9 \times 10^{11}$ and $1 \times 10^{13}$ atoms/cm$^2$, whereas for the bulk tungsten – $3.4 \times 10^{12}$ atoms/cm$^2$. Results obtained within this study give possibility to assess tritium retention mechanism and make estimates of its possible inventory in larger machines such as ITER.


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1 See the author list of “Overview of the JET preparation for Deuterium-Tritium Operation with the ITER like-wall” by E. Joffrin et al. to be published in Nuclear Fusion Special issue: overview and summary reports from the 27th Fusion Energy Conference (Ahmedabad, India, 22-27 October 2018)

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