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Depth profiling of tritium in bulk tungsten divertor tiles from JET with metal walls: tritium quantification and surface decontamination

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Quantification of tritium (T) in bulk tungsten (W) is foreseen to be a challenging point in the determination of fuel balance and retention rate in a reactor with metal plasma-facing components (PFC). This calls for the development and testing of laboratory procedures to determine T on the surface and in the bulk of tiles, i.e. depth profiling.
Bulk W divertor tiles, especially Tile 5 lamella, retrieved from JET with metal walls after consecutive D2-fueled campaigns is the most relevant material for such studies which constitute an entry point for future T analyses in the JET divertor after DT campaigns, and materials from next step reactor-class machines. Therefore, JET samples cut from heavily plasma-loaded Stack C were chosen to accomplish lateral and in-depth T mapping. The procedure is based on: (i) chemical etching of W, (ii) T determination on the W surface and in the etchant after consecutive experimental steps [1]. The overall approach involves radiography, W weight loss measurements, liquid scintillography counting and microscopy. Masking techniques enable T profiles to be obtained separately for the plasma-facing surface (PFS) and side surfaces located in poloidal gaps between adjacent lamellae (ion and electron drift sides), and stacks in the divertor module (toroidal gap). Measurements were performed on samples after three JET operating periods spanning 2011-2016. A brief summary of the results are:

- Depth resolution is 0.2-0.3 µm, but for practical reasons each etching step is 0.8-1.5 µm.
- Results clearly show that following the D2-fueled shots one deals with the implantation of the non-confined 1 MeV T from the D-D reaction, and with the deposition of re-eroded T, i.e. species that entered a regular material migration regime.
- On the PFS the maximum T content is detected at a depth of around 2 µm thus indicating high energy T implantation.
- In the poloidal gaps there is a 1-2 mm wide belt of high T content from the PFS. This is followed by a continuum of a lower T level further into the gap.
- The results demonstrate the use of etching as a surface decontamination method for post exposure handling of components, for example, during decommissioning.

Detailed results will be given together with a discussion of advantages/limitations of the method, and with plans for dealing with samples from DT campaigns.

[1] Y. Torikai et al., Fusion Sci. Tech. 54 (2008) 515