D and He outgassing in the post discharge of WEST during He changeover experiment studied with threshold ionization mass spectrometry

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In the current planning of ITER operational phases, it is foreseen to realize helium (He) plasma discharges to demonstrate high confinement mode without nuclear activation of the vacuum vessel components. However, there are some concerns about the evolution of the performance of the tungsten (W) divertor under intense He flux, both from the thermomechanical and the helium/hydrogen isotopes retention and outgassing perspectives. He quantification in ITER exhaust pumping lines is foreseen as a straightforward method that does not rely on modelling of plasma parameters. Threshold ionization mass spectrometry (TIMS) is one of two methods envisioned at ITER for this purpose and its use for He product quantification in the plasma is a work in progress [1]. In this paper we present another potential application of TIMS, namely, the analysis of deuterium (D) and He outgassing following a plasma discharge in a tokamak with sub-second temporal resolution, as it has been tested in WEST during its He campaign.

In WEST, constituted of ITER-like W units and W-coated graphite, plasma facing components previously exposed to D plasmas were subjected for the first time to a large number of He plasmas in so-called He changeover experiment. TIMS was used to perform D and He particles balance analysis both during the discharge and in the post discharge phase. In this contribution, we focus on the post discharge particles balance. It was found that the time scale for He and D outgassing in the post discharge is markedly different. On the one hand, He outgassing is instantaneous and decays within 30 seconds until the He signal gets below detection level. On the other hand, D outgassing is delayed by several seconds and lasts for about 10 minutes. These striking differences may be related to different retention and outgassing mechanisms from WEST plasma facing components, with a starting temperature of 350 K that can reach temperature above 950 K at the strike line. Indeed, the observation that the D outgassing delay increases with the cumulated He fluence, up to tens of seconds, suggests either that deuterium retention and subsequent outgassing may occur in deposition area away from strike lines or/and that D retention occurs deeper than He in the bulk of plasma facing components.