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Comprehensive Study on Deposition inside the Gap of Castellated Tungsten Blocks of Different Shapes

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In this paper, we report the results from a series of experiment using special tungsten block tiles performed in KSTAR on fuel retention inside the gap of castellated blocks of different shapes. Results presented in this paper suggest a comprehensive understanding on deposition procedure inside the gap and would give valuable information on the Be deposition inside the gap of castellated tungsten tiles in ITER. For the experiment, we have manufactured tiles consisting of five different shapes of tungsten blocks. These tungsten block tiles are exposed to L- and H-mode discharges during 2014-2015 campaign, then removed from the vacuum vessel after the campaign for further analysis. PIC-EDDY code is employed to simulate the deposition inside the gaps. The surface density of gaps is in a range from 1.0×1015 C atom/cm2 up to 7.0×1015 C atom/cm2. Comparing the surface density of toroidal and poloidal gaps of different shapes, contribution of each species can be separated, since the contribution of neutrals is independent of the shape and depth of the gap (or height of the leading edge). At the gap entrance, neutral contribution is about 5.0×1015 atom/cm2, decreases down to 2.0×1015 atom/cm2 at a depth of 0.5 mm, and remain constant at 1.0×1015 atom/cm2 afterwards down to the depth of 5 mm. The contribution of ions is concentrated on very narrow position within 0.6 mm from the entrance. Modeling of the deposition patterns by using PIC-EDDY code is underway. Raman spectra of deposited layers along the gap shows different chemical bonding structures. At the entrance, Raman spectra show typical feature of diamond-like carbon layers, while somewhat polymer-like carbon feature was identified at the bottom of the gap. From divertor IR measurements, the surface temperature of tungsten blocks has reached over 500 ⊠C, causing hydrogen reduction and graphitization. This can be also seen from the decrease of the intensity ratio I(D)/I(G) along the gap: sp3 sites in a-C:H films are bound to hydrogen, thus, highly sp3-bonded a-C:H are hydrogen-rich films (soft, low density, and polymeric).

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