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Deuterium retention analysis in pre-damaged tungsten using laser-induced breakdown spectroscopy

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Energetic neutrons are a product of the DT-fusion reaction and can induce material damage in Plasma-Facing Components (PFCs) in future nuclear fusion reactors. The damage increases with time and causes enhanced fuel, tritium (T) and deuterium (D), retention in tungsten (W) PFCs, which imposes issues for safety and closure of the T cycle in the fusion plant. Laser-Induced Breakdown Spectroscopy (LIBS) is a potential in-situ technique to monitor tritium inventory in W PFCs. LIBS on pre-damaged W (W ions, 10.8 MeV, 0.23 dpa) with D contents of 0.1-1% owing to D plasma exposure in PlaQ and subsequent outgasing, was carried out to measure the depth-resolved fuel content in a laboratory set-up. LIBS was done using an Nd:YAG laser (35 ps, 355 nm, 20 mJ), ablating 15 nm per laser pulse. D was detected up to a depth of 1.3μm by observing Balmer α line from the laser-induced plasma plume. The depth profile and total amount was compared with nuclear reaction analysis (NRA) and showed good agreement. Deviations can only be observed for the first ablation cycle near the surface.