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Plasma-Material Interaction Issues in Magnetic Fusion Devices

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The processes involving plasma-material interactions in magnetic fusion devices are very multifaceted and include a wide spectrum of phenomena ranging from plasma recycling and transport of hydrogen species in the wall material to the modification of wall properties, surface morphology, and dust formation which, being ejected from the wall, can have crucial impact on plasma performance. Here we present the results of our studies of some issues related to the plasma-material interactions: (i) modeling of the role of the first wall outgassing on H-mode pedestal re-healing after the ELM crashes in DIII-D; (ii) transport of hydrogen (H) species in co-deposits; (iii) hydrogen outgassing from tungsten (W) surface; (iv) an impact of W dust on ITER plasma performance. We demonstrate that: (i) re-healing of particle content in H-mode pedestal after ELM crash in DIII-D is completely determined by the outgassing of divertor plates; (ii) transport of H in co-deposits, which are characterized by continues spectrum of traps, depending on the regime, can be described either by non-linear or fractional diffusion equations; (iii) Molecular dynamic (MD) simulations of H desorption from W surface show that the Tersoff potential for H-W interactions overestimates three-body interactions at tungsten surface and should be adjusted to reproduce experimental features of hydrogen desorption as molecules; (iv) Modeling of W dust injection into ITER shows that it can result in pronounced impact on both core and edge plasma performance and W concentration at Ψnorm=0.95 reaches potentially dangerous level ~10-5 for the dust mass injection rate ~1 mg/s.

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