Plasma-Wall Interaction studies towards realizing a DEMO fusion reactor

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The interface between the boundary plasma and the plasma-facing components in a fusion reactor is covering a manifold of complex interaction processes within the plasma (e.g. power and particle detachment), at the surface (e.g. erosion and deposition), and within the bulk material (e.g. implantation and diffusion). These processes have significant impact on the operation of a reactor and its duty cycle as they have a substantial impact on the tritium cycle and the lifetime of plasma-facing components. In a reactor, presumably tungsten and steel components like Eurofer are foreseen as materials exposed to a mix of deuterium-tritium plasma with medium or high-Z impurity seeding gas such as argon and xenon. In addition, neutron damage will occur with operational time and change material properties and therefore have an impact on the plasma-wall interaction processes such as wall erosion and tritium retention.

There is currently no device available to study, in an integrated way, close to the conditions expected in a fusion reactor such as DEMO, the operation under long-pulse steady-state conditions. Therefore, plasma-wall interaction studies in present day toroidal (JET, ASDEX Upgrade, WEST etc.) and linear plasma devices (PSI-2, MAGNUM etc,) as well as laboratory experiments, can only address aspects of the expected plasma-wall interaction in a reactor. Plasma-wall interaction codes such as ERO2.0 and WallDYN-3D are benchmarked against present-day devices and are used to predict the expected behavior in a reactor such sa DEMO based on plasma boundary information e.g. from SOLPS-ITER simulations. We present first estimations on the W erosion at the fist wall and in the divertor, the tungsten migration in the facility based on ERO2.0 as well as the storage of tritium in the first wall by WallDYN. Moreover, the open and critical questions to be addressed in view of a high duty cycle reactor will be presented

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