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Preparation of PFCs for the efficient use in ITER and DEMO –plasma-wall interaction studies within the EUROfusion consortium

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Particle and power exhaust compatible with first wall components and the edge plasma is a key area of research and mandatory for a successful operation of ITER and beyond. Within EUROfusion, the research includes tokamak (JET and Medium-Sized Tokamaks) research studies and dedicated laboratory experiments in linear plasma devices, electron and ion beam loading facilities. The connection of both research areas is done via common physics studies, qualification and specification of plasma-facing components (PFCs), and most importantly, by simulation of plasma exhaust and plasma-material interaction starting from basic process modeling by e.g. molecular dynamics to integrated tokamak modelling by e.g. erosion-deposition codes like ERO. Laboratory heat load facilities and linear plasmas are presently essential for predicting the PFC performance during long pulse operation at the high particle fluence (>102727D+/m2) and number of thermal cycles (>1 Mio. ELMs), though WEST will be available soon for complementary tokamak studies.
The WP PFC is addressing these critical points in order to ensure reliable and efficient use of conventional, solid PFCs in ITER (Be and W) and DEMO (W) with respect to heat load capabilities (transient and steady-state heat and particle loads), lifetime estimates (erosion, material mixing, and surface morphology) and safety aspects (fuel retention, fuel removal, material migration, and dust formation) as well as to develop alternative scenarios and concepts (liquid Sn or Li PFCs) for DEMO if the conventional solution turns out not to be functional. The development of diagnostics to determine crucial physics quantities like e.g. the fuel content and material composition in PFCs exposed to divertor-like plasma conditions (mixed fuel, helium, and seeding gas) by LIBS is covered in a supporting activity.
Here an overview of results will be given with emphasis on (i) the observed synergistic effects in particle and heat loading with the available set of exposition devices on material properties such as roughness, ductility and microstructure, (ii) the progress in understanding of fuel retention, diffusion, and outgassing in W-based materials including the impact of damage and impurities like N, and (iii) the preferential sputtering of Fe in EUROFER steel providing in-situ a W surface and a potential alternative first wall solution for DEMO.

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