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Diagnostic mirrors for ITER: research in a frame of International Tokamak Physics Activity

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Mirrors will be used as first plasma-viewing elements in optical and laser-based diagnostics in ITER. Deterioration of the mirror performance due to e.g. sputtering of the mirror surface by plasma particles or deposition of plasma impurities will hamper the entire performance of the affected diagnostic. Specialists Working Group on First Mirrors (FM SWG) in the Topical Group on Diagnostics of the International Tokamak Physics Activity (ITPA) plays a crucial role in finding solutions for diagnostic first mirrors. Sound progress was achieved during the past decade. Single crystal (SC) rhodium (Rh) mirrors became available. SC Rh and molybdenum (Mo) mirrors survived in conditions corresponding to ~ 200 cleaning cycles without a degradation of reflectivity. These results are important for a mirror cleaning system, based on sputtering of contaminants by plasma.
Efforts are invested to the physics understanding of a cleaning discharge. Ion energy distribution and flux in radiofrequency (RF) discharge have been studied. Repetitive cleaning was tested on several mirror materials. Experiments comprised contamination/cleaning cycles. The reflectivity SC Mo mirrors was preserved after 34 cycles. First in-situ cleaning was conducted in EAST with a mock-up mirror of ITER Edge Thomson Scattering using RF plasma. Contaminants from the mock-up mirror were removed.
Mirror contamination can also be suppressed by a protecting diagnostic duct. A Deposition Mitigation duct system was exposed in KSTAR. The real-time measurement of deposition in the diagnostic duct was pioneered during this experiment. Results evidenced the dominating effect of the wall conditioning and baking on contamination inside the duct. A baffled cassette with mirrors was exposed in the main wall of JET ILW for 23,6 plasma hours. No significant degradation of reflectivity was measured on mirrors in the ducts. Predictive modeling was advanced. A model for the particle transport, deposition and erosion inside the port-plug was used in selecting an optical layout of the ITER core Charge-Exchange Recombination Spectroscopy diagnostic. These achievements contributed to the focusing of the first mirror research, accelerating the diagnostic development. Predictive modeling requires more efforts to be invested. Ensuring the progress in the remaining crucial areas will be a focus of the future work of the FM SWG

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