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Optimization of single crystal mirrors for ITER diagnostics

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Diagnostic mirrors are planned to be used as plasma-viewing optical elements in all optical and laser-based diagnostics in ITER. Degradation of mirrors due to e.g. deposition of plasma impurities will hamper the entire performance of affected diagnostics. In situ mirror cleaning by plasma sputtering is presently envisaged for the recovery of optical reflectivity of contaminated mirrors.
Previous studies have demonstrated sound advantages of single crystal mirrors, outlining their ability to withstand plasma sputtering without noticeable degradation of optical reflectivity. At the same time, there are studies made on polycrystalline substrates, showing a signature of sputtering dependence on crystal orientation. Should such a dependence exist, the sputtering of single crystals could be minimized, thus prolonging a mirror lifetime in ITER.
Four single crystal (SC) molybdenum (Mo) mirrors with different crystal orientation were produced to study the effect of crystal orientation on sputtering. Mirrors were exposed to steady-state argon plasma in linear plasma device PSI 2 under identical plasma conditions. The energy of impinging ions was about 60 eV. Mirror temperature was 250oC. Sputtering conditions in PSI 2 were corresponding to those expected inside the mirror cleaning system of ITER. The average amount of sputtered mirror material was about 1200 nm corresponding to about 120 mirror cleaning cycles.
Plasma exposures did not affect the optical performance of all mirrors. The maximum measured decrease of specular reflectivity did not exceed 5% in the ultraviolet range at the wavelength of 250 nm. No increase of the diffuse reflectivity was detected. The single crystal mirrors with orientations [110]/[101] demonstrate at least 25% less removal of sputtered material than mirrors with other crystal orientations. Summary of results, their analysis will be presented along with a feasibility assessment of the use of optimized mirrors in ITER.

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