Reduction of wall re-deposition on DC-grounded ITER first mirrors using grid walls in a First Mirror Unit

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The First Mirrors (FMs), being the initial elements in the optical path in most diagnostic systems in ITER, will be subjected to deposition of the first wall materials (Be and W), severely compromising their optical properties. The FMs would thus need periodic conditioning for the restoration of their optical properties, which is foreseen to be achieved using an *in-situ* plasma cleaning technique utilizing RF discharges [1]. Additionally, most FMs would require an active water cooling system, for which one of the considered schemes involves designing the water cooling lines as an RF quarter wavelength filter (notch filter). The notch filter DC-grounds the FMs and the plasma potential increases considerably (from 30 V to over 100 V) [2]. This leads to an increased sputtering of the surrounding walls and their re-deposition on the FMs, significantly reducing the cleaning efficiency in ITER. Strategies to mitigate re-deposition are therefore required.

In this study, experiments were conducted with a mock-up First Mirror Unit (FMU) using 60 MHz RF excitation and helium as the discharge gas, wherein the powered FM was DC-grounded using a notch filter. Metallic grids were introduced between the mirrors and the FMU walls as a strategy to mitigate the erosion of the walls and subsequent re-deposition on the FMs. The grids confined the plasma and were observed to reduce the flux of ions on the walls by over 50%. Furthermore, the ion energy distribution (IED) at the walls revealed an additional peak at a lower energy when compared to the IED without any grids, resulting in lowering of the average ion energy at the walls. The IED with grids was observed to vary with the RF power, He pressure, the dimensions of the grids as well as the distance between the grids and the walls. Based on the parametric study, grids were placed at 4 mm from the walls and a 7 hour plasma discharge was run to study the net re-deposition on the FMs. The re-deposition was significantly reduced in comparison to a similar discharge without any grids, evidencing a promising mitigation strategy.

[1] Moser, L., et al. Physica Scripta 2016.T167 (2016): 014069.
[2] Soni, K., et al. Plasma Physics and Controlled Fusion (2021)

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