Interaction of GD Oxygen and Deuterium cold plasmas with Lithium and Boron active coating and film characterization with LIBS

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Some fusion experiments use lithium and boron films to lower the recycling and impurity content of the plasma and hence its radiation. However, the synergies between the Li and the underlying B(C) layer or the effect of glow discharge cleanings on the getter properties are not fully understood. In TJ-II, a boron coating is used to extend the lifetime of the very reactive Li films deposited by direct evaporation. O-carborane is used as the precursor of the coating due to its low-risk operation. Conceptual experiments were therefore initiated to gain a deeper insight on the characteristics of B(C)/Li films and further extend the use of this conditioning strategy on the performance of fusion plasmas. The coatings are exposed to oxygen-rich gases and Glow Discharge plasmas while the uptake and release of O_2 is followed by mass spectrometry. Upon saturation of the oxidation process, the O content of a simple Li coating is about half the number of Li atoms, consistent with the formation of Li_2O. Conversely, the behavior of B(C)/Li walls depends on the nature of the process, neutral gas (O:Li ≈ 0.13) or plasma (O:Li ≈ 0.42). The plasma gettering is lithium-like regardless of the residual or neutral gas pre-oxidation, indicating an extended useful life. In stark contrast to pure Li, deuterium retention in B(C)/Li does not seem connected to the oxidation state. Moreover, we observe an almost full recovery of the B(C)/Li getter properties following a 30 min He discharge cleaning.

In situ characterization of the film composition was performed through Laser Induced Break-down Spectroscopy (LIBS). The decrease of the Li signal upon boronization was used as a diagnostic of the boron film deposition thickness. This was investigated as a function of the distance of the boron oven to the analysis point. Interestingly, it was observed that the initially depleted Li signal was slowly recovering with time under vacuum, suggesting some kind of segregation of this species through the boron coating at room temperature. These unexpected features of Li films deposited together with B(C) layers clearly point to a complex chemistry between film constituents and the oxygen-rich environment of fusion devices.