Sputtering Yield as Structural and Compositional Signature in Refractory Complex Concentrated Alloys

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Abstract:

Plasma-facing components in fusion reactors must possess a low sputtering yield, while possessing high strength, thermal conductivity and low fuel retention at high temperatures. Sputtering must be minimized to maintain component lifetime and reduce material entering the plasma body. Refractory complex concentrated alloys (RCCAs) have shown high strength and hardness with good irradiation resistance, but there has yet to be a focused study on their sputtering yield, which is vital in understanding the erosion performance within a fusion environment. Sputtering rates are known to change based on alloy composition, but a direct relation between sputtering rate and composition has not been established. A mechanism for predicting their manufacturing and processing signatures has also yet to be developed.

Several RCCAs of varying compositions have been found to possess differing hardness, microstructures and present phases, with varying increases in hardness and structural homogenization after heat-treatment. Sputtering could be used as a signature to predict these properties, indicating its composition, elemental and structural homogeneity, and whether heat-treatment has been performed, informing the alloy's manufacture and processing history.

WTaV, WTaCrV and WTaCrVHf alloys of various compositions will be measured for sputtering yield using a 30 keV Ga^+ focused-ion beam. Each sample will be sputtered creating a trench of same depth, with the time measured for each sample establishing the sputtering rate for each. These results will be compared to pure W, measuring sputtering for each alloy as a function of composition, providing a method of collecting processing and property signatures for plasma-facing RCCAs.