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In-situ measurement of electron emission yields at plasma-exposed surfaces

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Plasma simulations require accurate yield data to predict the electron flux that is emitted when plasma-exposed surfaces are bombarded by energetic particles. One can measure yields directly using particle beams, but it is impractical to create a separate beam of each particle produced by typical plasmas. In contrast, in situ measurements, performed during plasma exposure, provide useful values for effective yield, which includes the effects of all the incident particles. Here, in situ measurements were performed in a radio-frequency (rf) biased, inductively coupled plasma (icp) system in 0.67 Pa and 1.33 Pa (5 mTorr and 10 mTorr) of argon gas. The rf current and voltage across the sheath adjacent to the rf-biased electrode were measured, along with Langmuir probe measurements of ion current density and electron temperature. The measurements are analyzed by a numerical sheath model, which allows the emitted electron flux to be distinguished from other current mechanisms. The effective yield, i.e., the ratio of the emitted electron flux to the incident ion flux is also measured, as a function of incident ion energy. Results for the effective yield of a sputter-deposited SiO2 film are reported and compared with previous work. From the effective yield and additional literature data, recommended emission yields are obtained for each incident particle: photons, Ar+ ions, Ar metastables and Ar fast neutrals. Effective emission yields were also measured in mixtures of Ar and CF4. Comparison of these results with mass spectrometer data allows bounds to be placed on the individual emission yields of the most prevalent positive fluorocarbon ions.