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Development of Ion Energy Distributions Through the Presheath and Sheath in Dual-Frequency Capacitively Coupled Plasmas[1]
YITING ZHANG, U. Michigan, NATHANIEL MOORE, PATRICK PRIBYL, WALTER GEKELMAN, UCLA, MARK J. KUSHNER, U. Michigan — Ion properties in the sheath and pre-sheath, and ion energy and angular distribution functions (IEADs) to surfaces, are of critical interest to plasma etching. In single frequency capacitively coupled plasmas, the narrowing in angle and spread in energy of ions as they cross the sheath are well definable functions of frequency, sheath width and mean free path. When using multiple frequency biases, the development of the IEAD is significantly more complex. In this paper, we report on a computational investigation of the development of IEADs in low pressure plasmas having multi-frequency substrate biases as the ions transition from the bulk plasma, through the presheath and sheath, and strike the substrate. The simulations were performed with an ion Monte Carlo Simulation embedded within the Hybrid Plasma Equipment Model. IEADs are tracked as a function of height above the substrate and phase in the rf cycle. Computed results are compared to laser-induced fluorescence experiments of ion velocities in an inductively coupled plasma with a multi-frequency substrate bias. Gas pressures are a few to 10s of mTorr, in Ar and Ar/O_2 mixtures.

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