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Space and Phase Resolved Modeling of Ion Energy Angular-Distributions from the Bulk Plasma to the Wafer in Dual Frequency Capacitively Coupled Plasmas[1] YITING ZHANG, University of Michigan, NATHANIEL MOORE, PATRICK PRIBYL, WALTER GEKELMAN, UCLA-Dept. Physics, MARK J. KUSHNER, University of Michigan — The control of ion energy and angular distributions (IEADs) is of critical importance for anisotropic etching or conformal deposition in microelectronics fabrication. Dual-frequency capacitively coupled plasmas (CCPs) are being investigated with the goal of having flexible control where the high frequency (HF) controls the plasma density, while the ion energy is mainly determined by the low frequency (LF). However, over select ranges of LF and HF, the IEAD has characteristics of both the LF and HF. To understand this coupling, we report on results of a numerical investigation of phase and spatially resolved transport of ions through the sheath. These results were generated using a two-dimensional plasma hydrodynamics model having an ion Monte Carlo simulation. Inductively coupled plasmas sustained in Ar/O_2 with a multi-frequency bias on the substrate were modeled. The IEADs are tracked as a function of height above the substrate and phase within the rf cycle. The computed results are compared to laser-induced fluorescence (LIF) experiments. We found that the ratios of HF/LF voltage and driving frequency are critical parameters in determining the shape of the IEADs, with evidence of the HF component occurring up to 30 MHz. This tunability may provide additional control for the width and maximum energy of the IEADs.

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