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Particle-in-cell simulation of multi-frequency low-pressure capacitively-coupled plasma JUN-CHIEH WANG, PENG TIAN, JASON KENNEY, SHAHID RAUF, Applied Materials, Inc., IHOR KOROLOV, JULIAN SCHULZE, Ruhr-University Bochum — Multi-frequency capacitively coupled plasmas (CCPs) at low pressure (<10's mTorr) are essential for critical plasma processing applications such as high aspect ratio (HAR) dielectric etching for 3D memory fabrication. To meet the stringent requirement of optimum feature profile and high etch rate, plasma simulation has been used to help design the industrial CCPs in the hope of accurately controlling the ion energy and ratio of ion to radical flux. Significant effort and progress have been made to improve plasma models over the past few decades. Having said that, high-quality measurements of ion energy distribution functions (IEDF) in low-pressure CCPs are still in high demand for model validation. In this paper, a 1D particle-in-cell (PIC) simulation is used to study the kinetic behavior of charge species in low pressure (a few to 10's mTorr) multi-frequency (100s kHz to 10s MHz) Ar CCPs. Measurements from the corresponding experiments are compared to our 1D PIC model. With pressure as low as 2 mTorr, a double-peak IEDF was predicted by the model; as the pressure increases to 20 mTorr, the double-peak IEDF gradually shifts to an IEDF with a strongly depleted high energy tail due to the higher ion-neutral collision frequency. The simulation results have good agreement with IEDF measurements. Further discoveries will be discussed.

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