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Fast 2D Fluid-Analytical Simulation of IEDs and Plasma Uniformity in Multi-frequency CCPs[1] E. KAWAMURA, M.A. LIEBERMAN, D.B. GRAVES, Univ of California - Berkeley — A fast 2D axisymmetric fluid-analytical model using the finite elements tool COMSOL is interfaced with a 1D particle-in-cell (PIC) code to study ion energy distributions (IEDs) in multi-frequency argon capacitively coupled plasmas (CCPs). A bulk fluid plasma model which solves the time-dependent plasma fluid equations is coupled with an analytical sheath model which solves for the sheath parameters. The fluid-analytical results are used as input to a PIC simulation of the sheath region of the discharge to obtain the IEDs at the wafer electrode. Each fluid-analytical-PIC simulation on a moderate 2.2 GHz CPU workstation with 8 GB of memory took about 15–20 minutes. The 2D multi-frequency fluid-analytical model was compared to 1D PIC simulations of a symmetric parallel plate discharge, showing good agreement. Fluid-analytical simulations of a 2/60/162 MHz argon CCP with a typical asymmetric reactor geometry were also conducted. The low 2 MHz frequency controlled the sheath width and voltage while the higher frequencies controlled the plasma production. A standing wave was observable at the highest frequency of 162 MHz. Adding 2MHz power to a 60 MHz discharge or 162 MHz to a dual frequency 2MHz/60MHz discharge enhanced the plasma uniformity.

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