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Developing Accurate Capacitively Coupled Plasma Models

SHAHID RAUF, JUN-CHIEH WANG, WEI TIAN, JASON KENNEY, Applied Materials Inc — Capacitively coupled plasmas (CCPs) are widely used for materials processing in the semiconductor industry. Significant progress has been made in developing 2D and 3D models of CCPs with complex chemistries. [1] In this paper, we go back to the fundamentals and investigate how to accurately capture the dynamics of low pressure CCPs in a fluid plasma model. 1D and 2D fluid models have been developed for Ar, He and N2 plasmas in the 25 – 1000 mT pressure range. These models include continuity equation for all species, drift-diffusion approximation for electron flux, ion momentum conservation equation, electron energy conservation equation, and the Poisson equation. Fluid modeling results are compared to corresponding particle-in-cell (PIC) modeling results as well as experimental diagnostic measurements from the Gaseous Electronics Conference reference cell. [2] The fluid and PIC models utilize the same geometry and chemistry engines, and only differ in the treatment of charged species transport and chemistry. Approximations and modifications that improve the accuracy of fluid plasma models at low pressure will be discussed. [1] Agarwal et al, J. Phys. D: Appl. Phys. 50, 424001 (2017). [2] L. J. Overzet, J. Res. Natl. Inst. Stand. Technol. 100, 401 (1995).

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