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Numerical Simulation on the Profile of Plasma and Radicals in Plasma Chambers

IKUO SAWADA, Tokyo Electron Limited

With the dimensions of integrated circuit devices approaching less than 45nm regime, the control of uniformity of plasma and radicals in etching chamber becomes more and more important. In spite of many studies on the capacitively coupled plasma, there had been no matured one which can predict the plasma and radical profiles in a plasma chamber reasonably. Recently, I. Lee et al. [1] proposed a new model to predict the non-uniformity of radial power deposition caused by electromagnetic effects such as standing wave and skin effects. Y. Yang et al. [2] has proposed a coupled solution method between plasma fluid eqs. and Maxwell eqs. to consider both EM and electrostatic effects. In this report, we present some results on our methodology-mix to predict the profile of plasma and radicals comparing with the measured data. The non-uniformity of plasma and radicals are governed by many process and tool parameters like as pressure, gas species, gas flow-rate, frequency and power of RF, configuration of electrodes and wall, solid materials surrounding plasma and so on. From a physical standpoint of view, these parameters change the impedances of plasma or boundary materials and affect some non-linear phenomena among plasma, sheath and boundary materials. Considering these aspects, we developed a several kind of models and methods. One of them is the introduction of a new dimensionless parameter to predict the uniformity of plasma. One of the other is the hybrid method to predict the plasma and radicals profiles by using the two-dimensional numerical simulation models described above. Based on the chemical reaction database either developed by ourselves or obtained in the published papers, we've calculated the profiles of plasma and radicals and compared the calculated electron density profile with the measured one in a mass-production chamber in case of some gases to confirm the good accuracy of the calculation. [1] I. Lee et al. : Plasma Sources Sci. Technol. (17) 2008, p16 [2] Y.Yang et al. : Proceeding of IITC 2008