SELF-CONSISTENT SIMULATION STUDY ON THE MAGNETIZED INDUCTIVELY COUPLED PLASMA FOR 450 MM SEMICONDUCTOR WAFER PROCESSING

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The needs for 450 mm wafer fabrication capability of plasma sources are now emerging in the semiconductor industry. The applicability of weakly magnetized inductively coupled plasma (MICP) to 450 mm process equipment has been investigated using self-consistent fluid simulation. MICP is a plasma source utilizing cavity mode of low frequency branch of right hand circularly polarized wave.[1,2,3] Particle and energy conservation equation was solved using drift-diffusion approximation with anisotropic transport coefficients and thermal conductivity. RF wave field was obtained from vector potential formulation of ampere's law with anisotropic conductivity tensor. The validity of this approach was verified by comparing with experimental results from small size chamber having diameter of 320 mm. Although this model cannot resolve collisionless heating of electron, behaviors of plasma variables needed for equipment design such as time averaged plasma density, electron temperature, space potential and harmonic rf field profile were reasonably agreed with experimental results. It is found that the wave launched from antenna is refracted toward center of the chamber due to density gradient in radial direction. For the chamber diameter of 700 mm, the simulation results show that plasma density uniformity is improved by 12 % within 450 mm area by applying weak magnetic field of 10 Gauss for 5 mTorr Ar plasma. Furthermore, the resistance component of system impedance increases by a factor of 5, which implies that MICP can be operated in a very stable impedance matching and high power transfer efficiency region even for a large size plasma chamber. These results demonstrate that MICP can be a promising candidate for a plasma source suitable for 450 mm semiconductor wafer processing..

1. Ho-Jun Lee, Il-Dong Yang and Ki-Woong Whang, "The effects of magnetic fields on a planar inductively coupled argon plasma", Plasma Sources Sci. Technol. 5 (1996) 383-388
2. S.S. Kim and C.S.Chang, N.S. Yoon, Ki-Woong Whang "Inductively coupled plasma heating in a weakly magnetized plasma", Phys. Plasma, 6(7), July,1999
3. Ho-Jun Lee, Hae June Lee, Wang Sun Lim, Ki-Woong Whang, "Power Deposition Profiles in Magnetized Inductively Coupled Plasma", Volume 36, Issue 4, Part 1, Aug. 2008 Page(s):1394 - 1395