EFFECT OF RF VOLTAGE NON-UNIFORMITY ON CAPACITIVE DISCHARGE

T. Ohshita, M. Matsukuma, S.-Y. Kang and I. Sawada
Technology Development Center, Tokyo Electron Ltd., Nirasaki 407-0192, Japan

Capacitively Coupled Plasma (CCP) using a very high frequency (VHF) has been developed to achieve high density plasma and low ion bombardment energy. However, excitation with the higher frequency makes the standing wave effect more emphasis because of the relation between the RF wavelength and the reactor size.
Standing wave effect has been discussed in several papers. For example, Satake[1] indicated that measured RF voltage distribution on RF electrode shows a good agreement with the plasma distribution observed from the plasma emission and the ion saturation current. And Barnat[2] measured the radial distribution of the voltage drop across a sheath and indicated the magnitude and spatial extent of the non-uniformity of sheath voltage become greater with increasing frequency. Though the effect of standing wave on VHF CCP has been verified experimentally, the mechanism standing wave affects plasma distribution is not clear. In this report, that mechanism is investigated with the assumption of RF voltage distribution non-uniformity imitated the standing wave using Particle in cell with Monte Carlo Collision (PIC-MCC) method.

As a result, calculated plasma distribution has a peak at the position of maximum amplitude of RF voltage. And the dependence of electron density profile across a sheath on the RF voltage distribution is found. Excessive electron inflow from bulk plasma to RF electrode is occurred in the sheath at the maximum RF voltage position. On the other hand, lack of electron is occurred in the sheath at the minimum one. Because of that concentration of electron, stochastic heating is localized at the maximum RF voltage position and plasma distribution has a peak at that position.

It is important for the discussion of standing wave effect to consider the behavior of electron in a sheath.

1. K. Satake, H. Yamakoshi and M. Noda, “Experimental and numerical studies on voltage distribution in capacitively coupled very high-frequency plasmas”, Plasma Sources Science and Technology, Vol. 13, 2004, pp. 436-445.
2. E. V. Barnat, P. A. Miller, G. A. Hebner, A. M. Paterson, Theodoros Panagopoulos, Edward Hammond, and J. Holland, “Measured radial dependence of the peak sheath voltages present in very high frequency capacitive discharges”, Appl. Phys. Lett. 90, 201503 (2007).