# A study of asymmetric effect in the 3D ICP discharge simulation considering EEDF, flow and heat transfer

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In this study, a 3-dimensional plasma discharge simulation of an ICP (Inductively Coupled Plasma) based on the fluid model used in the semiconductor fabrication process is investigated. Due to the fact that high density plasma under low pressure is easily obtained using the ICP, it is widely used in field of microelectronics fabrication processes. The ICP chamber is typically cylindrical in the semiconductor processes, two-dimensional simulation models are actively conducted assuming azimuthal symmetry. However, the detailed parts of the chamber and the physical parameters are asymmetric such as gas flow, capacitive field in the ICP, temperature profiles, and etc.

The planar type ICP is chosen for this study with 1 turn spiral coil placed on top of the plasma chamber and separated by a ceramic plate. The electron energy distribution function (EEDF) has important effects on determining the major parameters of plasma such as electron mobility, diffusion coefficient, electron-neutral reaction rates, etc. Therefore, EEDF was obtained using the two-term Boltzmann solver utilizing the spatial-averaged plasma properties. The calculated eedf yields more accurate plasma characteristics.

Furthermore, the influence of gas flow and that of heat transfer were merged to improve simulation accuracy of plasma characteristics, such as the effect of gas temperature on the local pressure. The effect of asymmetric gas flow was analyzed which could be observed only in the 3-dimensional structure. Also, the voltage distribution on the antenna coil is considered to include the capacitive electric field.

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