Topic number: 5

A modified fluid simulation of an inductively coupled plasma discharge with radio frequency bias considering heat transfer effect

Y. D. Jeong[1], Y. J. Lee[1], D. C. Kwon[2], H. H. Choe[1]

[1] *School of Electronics and Information Engineering, Korea Aerospace University, Goyang, Republic of Korea*
[2] *Plasma Technology Research Center, National Fusion Research Institute, Gunsan, Republic of Korea*

The plasma characteristics in an inductively coupled plasma (ICP) discharge with radio frequency bias (RF) were investigated. A two-dimensional axisymmetric structure was simulated by using a modified fluid model. Large and multi-size zones were used for the calculations of the Two-Term Boltzmann approximation electron energy distribution function (EEDF) and ion energy distribution function (IEDF) calculated by using spatial averaged plasma parameters. The energy and mobility of ion were calculated by using the IEDF at each zone. In addition, the heat transfer was considered. Voltage drop across the coils due to the reactance were considered that the capacitive field effect of the antenna was also considered. Effects of these application were analysed.

1. Introduction

Simulations for an inductively coupled plasma (ICP) Argon discharge with radio frequency (RF) bias for semiconductor device processes were conducted and plasma characteristics were investigated.

Although the fluid model, one of the models describing the plasma, has some accuracy problems, it provides relatively rapid computation and satisfactory solution for moderate pressure conditions [1-2]. The simulation model is based on this.

In this study, a two-dimensional axisymmetric structure was used for the simulation. Voltage drop of the antenna coil is considered and this effect was investigated. In addition, the electron energy distribution function (EEDF) was calculated. The EEDF is a dominant factor for determining plasma characteristics, since it is a key parameter in calculations of electron transport properties (e.g., the electron mobility, the electron diffusivity, reaction coefficients). Ion temperature and mobility were computed using particle tracing mechanism. The effects of these applications were studied.

2. Model description

To describe the electrons, the continuity, electron energy balance equation and drift-diffusion approximation were applied. Two-term Boltzmann approximation EEDF was applied to the model. The ion was calculated by adapting the continuity equation and the drift-diffusion approximation. The ion temperature and mobility were computed using the ion energy distribution functions (IEDFs). In addition, the energy and mobility of neutral species were considered. A block diagram for calculation of the ion temperature, mobility and the EEDF is shown Fig. 1.

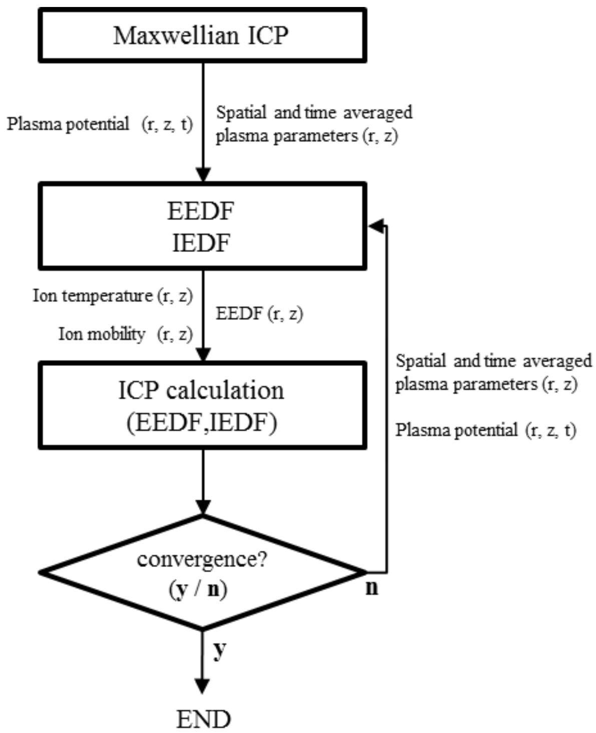

Fig. 1. A block diagram for calculations of the ion temperature, mobility and the EEDF.

3. References

[1] L. L. Alves, L. Marques, Plasma phys. Control. Fusion. 54 (2004) 124012.

[2] J. van Dijk, G. M. W. kroesen, A. Bogaerts, J. Phys D: Appl. Phys. 42 (2009) 190301.