Spatial structures of ring-shaped hollow cathode RF plasma with a single narrow trench for high-density plasma sources

°Yasunori Ohtsu[1], Naoki Matsumoto[1], Yuto Morita[1], Julian Schulze[2] , Edmund Schuengel[2]
(1.Saga Univ. , 2. West Virginia Univ., U.S.A.)
E-mail: ohtsuy@cc.saga-u.ac.jp

Functional thin film preparation for solar cell and large diameter display panels by plasma enhanced chemical vapor deposition and physical sputtering as well as microfabrication of large scale integrated circuits by dry etching have been widely performed by capacitively coupled plasma (CCP) sources. The CCP is a useful plasma source, because its experimental setup is very simple for the chamber maintenance and large-diameter substrate treatment is possible. However, CCPs suffer from low plasma densities compared to other plasma sources. This limits the system throughput.

In this work, we propose structured powered electrodes [1-3] with various shaped hollow cathodes as a method to solve this problem. Plasma density profiles of the ring-shaped hollow cathode RF plasma with a narrow hollow trench of 2 mm in width are presented and are described theoretically by a diffusion model. Figure 1 shows radial profiles of the plasma density at various axial positions above the RF powered electrode. Here, the width, *W*, and the depth, *D*, of the trench are 2 mm and 5 mm, respectively. Ar gas pressure p_{Ar} and RF power P_{RF} are fixed at 53.2 Pa and 20 W, respectively. At a closer position of z = 3 mm the density profile has a mountain like distribution near the trench. It is found that the density profile is much more homogenous at a greater distance from the electrode. The lines in Fig.1 correspond to the results of the diffusion model [3]. The model is in good agreement with the measured radial density profiles. However, the measured data at r = 5 cm near the RF electrode are lower than the values of the model. The difference might be ascribed by a wall loss due to the influence of the grounded enclosure for the RF powered electrode located at r = 5.2 cm.

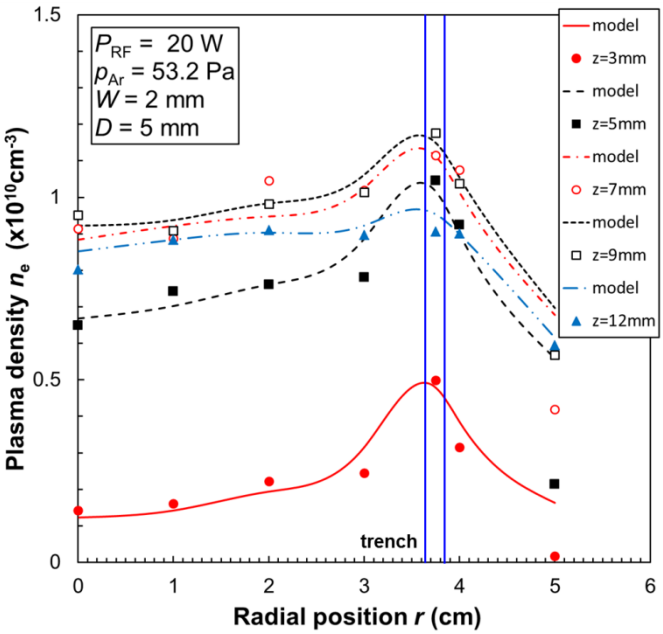

Figure 1. Radial profiles of plasma density with the diffusion model at various axial positions.

References

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