A 2D Inductively Coupled Plasma Chamber Model

Yang Xing[1], Yu Zhang[1], ShaoZhi Deng[1], [2]

[1]State Key Lab of Optoelectronic Materials and Technologies, Guangdong Province Key Lab of Display Material and Technology, School of Electronics and Information Technology, Sun Yat-sen University, Guangzhou 510275, People’s Republic of China
[2]

Abstract

Inductively Coupled Plasma Chemical Vapor Deposition (ICPCVD) has been widely used for carbon-based nanomaterial synthesis because it provides high plasma densities and uniform plasma distribution and allows plasma to be generated in room temperature.[1] During the ICPCVD process, the plasma sheath and built-in electric field effectively impact the nanomaterial growth. Since plasma is a highly nonlinear system, it's crucial to precisely describe the plasma behaviors and built-in electric field distribution in the ICP chamber in order to understand how plasma impacts the nanomaterial growth and realize the controllable synthesis of nanomaterial.

The goal of this work is to get a better understanding of the distribution of electric potential inside the ICP chamber under various electric potential conditions and the effect of the irregular structures on the cathode plate on the distortion of electric potential.

The geometry and the boundary conductions of the model are set up in the COMSOL Multiphysics® software. The Argon-based plasma chemistry and surface reactions are implemented. The plasma module is used to compute the electron density and mean electron energy, the transport of the non-electron species, the electrostatic field and magnetic field. A metal structure and various electric potential conditions of the cathode plate are inducted to observe their impacts.

The simulation results in Figure 1-3 shows the distribution of the electric potential inside the ICP chamber, including the positive charged plasma zone at the center of the chamber and the plasma sheath near the cathode plate, which can be explained by plasma physics[2]. The results in Figure 4 shows the distortion of electric potential caused by the irregular structure on the cathode plate.

Reference

1. Frischmuth, T., et al., Inductively-coupled plasma-enhanced chemical vapour deposition of hydrogenated amorphous silicon carbide thin films for MEMS. Sensors and Actuators A: Physical.
2. Zhang, Y., et al., Growth direction manipulation of few-layer graphene in the vertical plane with parallel arrangement. Carbon, 2013. 56: p. 103-108.

Figures used in the abstract

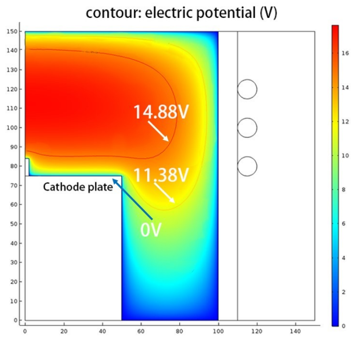

Figure 1: Figure 1: The electric potential distribution when the cathode plate is grounded

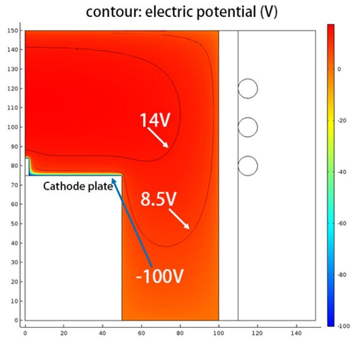

Figure 2: Figure 2: The electric potential distribution when the potential of cathode plate is -100V

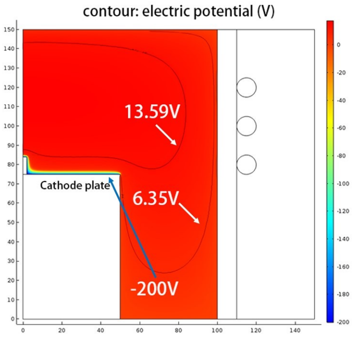

Figure 3: Figure 3: The electric potential distribution when the potential of cathode plate is -200V

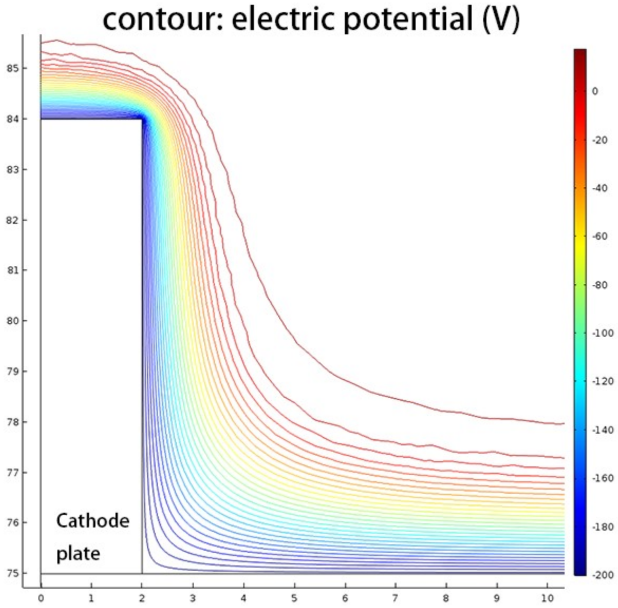

Figure 4: Figure 4: The electric potential distribution near the cathode plate when the potential of cathode plate is -200V