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Fluid simulation on plasma characteristics of RF capacitively coupled plasma sustained in $Ar/SiH_4/N_2O$

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Silicon oxide thin films grown by plasma enhanced chemical vapor deposition (PECVD) have been widely used in the semiconductor devices or integrated circuits. Generally, these thin films are deposited in radio-frequency (RF) capacitively coupled plasmas (CCPs) sustained in mixture gas of SiH_4/N_2O, where inert gases, such as Ar or He, are usually added in order to improve the discharge characteristic.

In this work, the discharge characteristic of $Ar/SiH_4/N_2O$ in a RF CCP reactor is investigated, based on a two-dimensional fluid model. The simulation results show that the axial densities of the metastable atom Ar* at high pressures of 1.0 Torr and 2 Torr follows double-peak rather than parabolic distribution. However, under these two cases, the reasons for the formation of the density peaks are quite different. At the pressure of 1.0 Torr, a saddle profile in the metastable atom density is caused by the loss of metastable atoms by the reaction of electron quenching to the resonant state in the bulk. But, as the pressure increases to 2.0 Torr, the more local discharge in the plasma is the main reason for the saddle profile of the metastable atom density. In addition, the role of the inert gases Ar in the mixed gas discharge is also analyzed. It is found that the increasing proportion of argon in the mixture gas can effectively promote the increase of the electron density, and slightly destroy it's radial uniformity. Furthermore, the effects of changing SiH_4 or N_2O content on the plasma characteristics including the electron density, radial uniformity and bombardment is studied. Finally, we also analyze the reason why the content of N in silicon oxide thin films grown by the $Ar/SiH_4/N_2O$ plasma is pretty low.

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