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# Fluid simulation of RF capacitively coupled $SiH_4/N_2/O_2$ and $SiH_4$ dusty plasmas

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In plasma enhanced chemical vapor deposition (PECVD), in order to optimize the plasma characteristics, a layer of dielectric film is often deposited on the electrode prior to desired film deposition, called the pre-deposition process. In this work, a two-dimensional fluid model has been developed to investigate the effect of adding this dielectric layer on plasma properties in a radio frequency capacitively coupled plasma (RF CCP) sustained in $SiH_4/N_2/O_2$ gas mixture. The simulation results show that the introduction of the dielectric layer on the bottom electrode can effectively suppress the edge effect, as a valid means of improving the plasma uniformity. However, if the dielectric thickness exceeds a certain value, the discharge will be extinguished. In addition, since the gas-phase deposition precursors have not been well confirmed in $SiH_4/N_2/O_2$ gas mixture, nitrogen-, silicon- and oxygen-containing species are examined as a function of the pressure and composition ratio of the mixed gas. It is found that $SiH_3O$, $SiH_2O$, O, N and NO may be the most important deposition precursors, rather than SiN and $HSiNH_2$, etc. In addition, we have studied the effect of dust particles on the plasma properties, such as the plasma density, electron temperature, sheath properties, EEDF as well as the heating mechanism. The simulation shows that compared with a dust free plasma the presence of the large dust particles may lead to a transition in the heating mechanism from a hybrid combination of the α-mode and local field reversal heating or the drift-ambipolar field (DA) mode into a new combination of α mode and the bulk heating or even a pure bulk heating mode in the case of enough dust particles. Further, with the dust particle radius increasing to a certain value, the high energy tail of the electron energy distribution function will be enhanced, accompanied by the decline in the population of low-energy electrons in comparison to those of pristine plasma.

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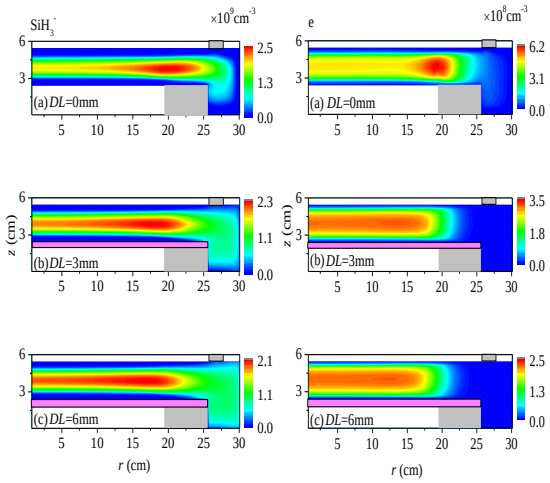


Fig.1 Spatial distributions of the most important negative ion($SiH_3^-$) and the electron at the thickness of dielectric layer of 0mm(a), 3mm(b) and 6mm(c) in a radio frequency capacitively coupled $SiH_4/N_2/O_2$ plasma

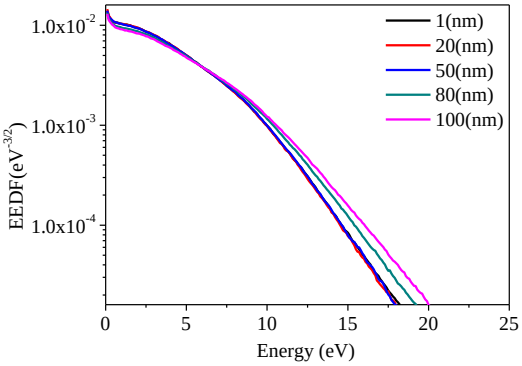


Fig.2 Time-averaged electron energy distribution function averaged over the plasma for different dust particles radius of 1nm, 20nm, 50nm, 80nm and 100nm in a silane dust plasma