Simulation of the Effect of SiH$_4$ Concentration on Silicon Film Deposition at Atmospheric Pressure

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The homogeneous plasma can be generated under atmospheric pressure by radio frequency plasma enhanced chemical vapor deposition (RF-PECVD) technology, which is suitable for the manufacture of microcrystalline silicon thin film. The mixed gas Ar/SiH$_4$/H$_2$ is a potentially interesting reactive gas for deposition silicon film due to economy considerations. The SiH$_4$ concentration is a very important parameter during deposition process, which is closely related to silicon film deposition speed and quality.

Since the reactive products of e, SiH$_3$ and H are the dominating particles for crystallization and deposition processes of microcrystalline silicon, two-dimensional fluid model based on the continuity equation, momentum equation and the current balance equation was established to study the effects of e, SiH$_3$, H on the deposition of microcrystalline silicon particles with different silane concentrations. The simulation results show that maximum particle densities (e, SiH$_3$ and H) exist under certain silane concentration. As SiH$_4$ concentration rises from 0.005% to 0.1%, the densities of SiH$_3$, e and H increase correspondingly from 9.08×10$^{11}$ to 9.73×10$^{13}$ cm$^{-3}$, from 7.0×10$^{11}$ to 3.5×10$^{12}$ cm$^{-3}$ and from 2.82×10$^{12}$ to 3.69×10$^{13}$ cm$^{-3}$, respectively. Taking into account the chemical reaction mechanism of mixed gas Ar/SiH$_4$/H$_2$, the results reveal the effect of SiH$_4$ concentration on the dominating particle (e, SiH$_3$ and H) densities distribution and further microcrystalline silicon deposition process.