PROGRAM

PT-P003

Control of Plasma Characteristic to Suppress Production of HSRS in SiH4/H2 Discharge for Growth of a-Si: H Using Global and PIC-MCC Simulation

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In SiH4/H2 discharge for growth process of hydrogenated amorphous silicon (a-Si:H), silane polymers, produced by SiH2 + Sin-1H2n → SinH2n+2, have no reactivity on the film-growing surface. However, under the SiH2 rich condition, high silane reactive species (HSRS) can be produced by electron collision to silane polymers. HSRS, having relatively strong reactivity on the surface, can react with dangling bond and form Si-H2 networks which have a close correlation with photo-induced degradation of a-Si:H thin film solar cell [1]. To find contributions of suggested several external plasma conditions (pressure, frequency and ratio of mixture gas) [2,3] to suppressing productions of HSRS, some plasma characteristics are studied by numerical methods. For this study, a zero-dimensional global model for SiH4/H2 discharge and a one-dimensional particle-in-cell Monte-Carlo-collision model (PIC-MCC) for pure SiH4 discharge have been developed. Densities of important reactive species of SiH4/H2 discharge are observed by means of the global model, dealing 30 species and 136 reactions, and electron energy probability functions (EEPFs) of pure SiH4 discharge are obtained from the PIC-MCC model, containing 5 charged species and 15 reactions. Using global model, SiH2/SiH3 values were calculated when pressure and driving frequency vary from 0.1 Torr to 10 Torr, from 13.56 MHz to 60 MHz respectively and when the portion of hydrogen changes. Due to the limitation of global model, frequency effects can be explained by PIC-MCC model. Through PIC-MCC model for pure SiH4, EEPFs are obtained in the specific range responsible for forming SiH2 and SiH3: from 8.75 eV to 9.47 eV [4]. Through densities of reactive species and EEPFs, polymerization reactions and production of HSRS are discussed.

Keywords: Amorphous silicon, plasma enhanced chemcial vapor deposition, global model, PIC-MCC, numerical simulation