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Optical and electrical properties of silicon carbonitride thin films deposited by sputtering on Si (100) and nitrated Si (100): Effect of the interface

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Improving the efficiency of photovoltaic cells, especially those of the 1st generation and decreasing the production costs are more than ever required regarding the world's energy demand. In this context, thin coatings such as hydrogenated silicon carbonitride ($\text{SiC}_x\text{N}_y\text{:H}$) have attracted lot of attention. In this work, we elaborated $\text{SiC}_x\text{N}_y\text{:H}$ thin films on silicon using a process combining RF sputtering and ECR plasma excitations, by sputtering a Si target under an Argon- N_2 - CH_4 gas mixture, and four coaxial microwave sources while the reactive gas flow ratio $R = [\text{F}_{\text{N}_2}] / ([\text{F}_{\text{N}_2}] + [\text{F}_{\text{CH}_4}])$ was varied. On one hand, we proved that $\text{SiC}_x\text{N}_y\text{:H}$ are an interesting candidate as antireflective coating for silicon PV devices thanks to their optical properties. Indeed, their band gap and refractive index could be easily tailored as a function of the reactive gas ratio. On the other hand, high defects level and interface state density are one of the main causes of PV cells efficiency decrease. One of the known methods to reduce the recombination of charge carriers at the interface between $\text{SiC}_x\text{N}_y\text{:H}$ and the Si substrate is surface passivation. A passivating treatment of the silicon has been performed. These Si_xN_y passivated films were elaborated in UHV chamber by two N_2 plasma sources (ECR and GDS at 10^{-4} Pa) and monitored by XPS. To perform electrical capacitance-voltage (C-V) measurements, a metal insulator semiconductor (MIS) structure was elaborated by sputtering Al on the front and back side of the $\text{SiC}_x\text{N}_y\text{:H}/\text{Si}$ films. The effect of the interface preparation on optical and electrical properties has been pointed out.

Keywords

$\text{SiC}_x\text{N}_y\text{:H}$

Sputtering

Passivation

Electrical properties

Nitridation