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a-SiCNH PACVD films grown from TMS/NH₃ mixtures for Silicon PV cellsLaurent Thomas¹, Isabelle Bousquet¹, José Almeida Silva¹, Sébastien Quoizola¹, Emmanuel Hernandez¹¹PROMES/CNRS, Perpignan, France

thomas@univ-perp.fr

Dielectric thin films are nowadays commonly used in photovoltaics for which both antireflective and passivation properties of silicon solar cells are needed. Silicon nitride (a-SiN:H), oxide and silicon oxynitride (SiOx and SiON:H) or amorphous silicon (a-Si) provide these functions. These films are mostly produced by Low or Radio-frequency plasma of gas mixtures containing silane or fluorinated/chlorinated derivatives that require means of security. Use of classical plasmas leads to low deposition rates (< 1 nm/s) because of low dissociation rates. This limits production costs reduction necessary for industrial development. Our studies aim at developing, i) introduction of secure liquid siliconized precursors (Tetramethylsilane in this work) to replace silane in Low Frequency (LF) classical PACVD, ii) both replacement of silane and plasma process by UHF plasma process (microwave), then make comparisons. Obtained SiCN:H film type (from SiC to SiN) can replace historical SiNx, SiOx and SiC extending to a wider area their functional properties. As revealed by deconvolution analysis of films FTIR spectra, both LF and UHF PACVD of TMS/NH₃ mixtures indicates that films vary from "nitride-like" materials, close to SiNH industrial reference, obtained at low %TMS/%NH₃ (SiN/SiNH band increase, NH_x band varying from R-NH to R-NH₂, and SiH bonds from HSi-Si to HSi-N), to "carbide-like" ones at high gas ratio (Si-C and Si-(CH₂)_n-Si, high CH/NH rate, HSi-C₃ environments). This lead to n optical index that changes from 1,70 to 2,30 (at λ=634 nm) for UHF process as it is limited in the range 1,95-to-2,07 for LF PACVD process (same range of %TMS/%NH₃ gas ratios). High growth rates are observed with UHF PACVD : up to 5 nm/s in comparison to 1,5 for Low Frequency plasma. Carrier lifetime has been measured for LF PACVD SiCNH films grown on CZ 2" Si wafers : 170 μs is attained. Such coatings have been grown 3" square n-type Si cells. Values are compared to those obtained in UHF plasmas.

Keywords

SiCN

Organosilicon

Si solar cells

PACVD