



The Optical Properties Characterization of Hydrogenated Silicon by Spectroscopic Ellipsometry for Solar Cell Applications

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Abstract

This study investigates the preparation of hydrogenated amorphous silicon films (a-Si:H) using very high frequency plasma-enhanced chemical vapor deposition (VHF-PECVD). The optical properties and crystal structure of the films were characterized using spectroscopic ellipsometer (SE) and Grazing X-ray diffractometer (GIXRD), respectively. The energy band gap of amorphous silicon was determined using the Tauc plot and compared with the energy band gap obtained from the SE parameter analysis. The results indicate that the a-Si:H on glass prepared by VHF-PECVD at a substrate temperature of 200°C with various hydrogen dilutions (RH=H₂/SiH₄) of 1.0, 2.0, 3.0, 4.0, and 5.0 were in the amorphous phase. The optical constant from the SE modeling could determine the energy band gap of the a-Si:H film, with the lowest and highest energy band gap being RH 1.0 and 3.0 eV at 1.80 and 1.86 eV, respectively. The dielectric function of the Tauc-Lorentz model included five fitting parameters, which could apply and extract the optical properties and energy band gap of amorphous silicon, including the real part of the dielectric function. The model contained three layers: the interface layer between the glass substrate and a-Si:H, the a-Si:H film, and surface roughness as the best model. The technique used for fabricating amorphous silicon, plasma-enhanced chemical vapor deposition (PECVD), enables large areas and excellent control in industrial manufacturing, and H atoms passivate defects resulting from incomplete bonding of Si atoms. Amorphous and microcrystalline silicon are important layers widely used in the solar cell market, and the absorption process layer in the solar cell is crucial for solar cell design's efficiency in converting sunlight.

Keywords: *Spectroscopic Ellipsometry, Physical Model, Tauc-Lorentz Oscillator, Very High Frequency Plasma Enhanced Chemical Vapor Deposition.*