CLOSED STACKS

COMPARATIVE ANALYSIS OF HYDROGEN CONTENT IN HYDROGENATED AMORPHOUS SILICON(a-Si:H) USING FOURIER TRANSFORM INFRA-RED SPECTROSCOPY AND OPTICAL VISIBLE SPECTROSCOPY TECHNIQUES

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Abstract

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Comparative Analysis of Hydrogen Content in Hydrogenated Amorphous Silicon (a-Si:H) using Fourier Transform Infra-red Spectroscopy and Optical Visible Spectroscopy Techniques

Hydrogenated amorphous silicon (a-Si:H) films are prepared by dc plasma glow discharge of silane and also silane diluted in helium. The chemical bonding structure of the films are studied by using Fourier Transform Infra-red (FTIR) transmission spectrum while the optical energy gap of the films are deduced from the Optical Transmission Spectrum in the visible region. D.C. electrical characterization on the film enables the room temperature conductivity, activation energy for extended state conduction, activation energy for hopping conduction in the tail states and the density of states at the Fermi level to be determined. Effects of annealing on all parameters are also investigated. Samples of a-Si:H films prepared from dc plasma glow discharge of silane diluted in helium are found to have dominant Si-H bonding configurations in the films. The optoelectronic properties and homogeneity of the film is improved significantly when the deposition pressure is due to the total pressure contributed by the partial pressures of the reactant and diluent gases and also when the deposition temperature is within 200-300 °C. Variation in the helium to silane flow-rates ratio influences the energy gap and the bonding configurations of hydrogen to silicon atoms in the film .

Hydrogen content in the film is determined by analytical techniques based on the valence electron model (VEM) and the chemical bonding infra-red model (IRM). The former model is a combination of the J.C. Manifacier method to obtain the dispersion curve (refractive index versus wavelength) from optical transmission spectrum and the C. Ance method for deducing the hydrogen content from the dispersion curve. The latter model is the usual technique of determining hydrogen content from the FTIR transmission spectrum but in this work the total hydrogen content in the film is derived from the total integrated areas under the Si-H_x stretching and Si-H wagging modes The VEM is found to be associated to the hydrogen in the film only at the Si-H bonding sites irrespective of whether it is bonded or coupled to impurity atoms. The behaviour of room temperature conductivity and the density of states at the fermi level cannot be explained by the amount of hydrogen based independently on either the VEM or the IRM, but instead are found to be dependent on the ratio of the VEM hydrogen percentage to the IRM hydrogen percentage. Annealing results are used to investigate the comparative nature of the two models. This work proposes that there must be a balance between the hydrogen content at the monohydride and polyhydride bonding sites in the film to produce a-Si:H with good electronic properties.

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