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Electrical and optical properties of thin film of amorphous silicon nanoparticles

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Abstract
Electrical and optical properties of thin film of amorphous silicon nanoparticles (a-Si) are studied. Thin film of silicon is synthesized on glass substrate under an ambient gas (Ar) atmosphere using physical vapour condensation system. We have employed Field Emission Scanning Electron Microscopy (FESEM), Transmission Electron Microscopy (TEM) and Atomic Force Microscopy (AFM) to study the morphology and microstructure of this film. It is observed that this silicon film contains almost spherical nanoparticles with size varying between 10 and 40 nm. The average surface roughness is about 140 nm as evident from the AFM image. X-ray diffraction analysis is also performed. The XRD spectrum does not show any significant peak which indicates the amorphous nature of the film. To understand the electrical transport phenomena, the temperature dependence of dc conductivity for this film is studied over a temperature range of (300-100 K). On the basis of temperature dependence of dc conductivity, it is suggested that the conduction takes place via variable range hopping (VRH). Three-dimensional Mott's variable range hopping (3D VRH) is applied to explain the conduction mechanism for the transport of charge carriers in this system. Various Mott's parameters such as density of states, degree of disorder, hopping distance, hopping energy are estimated. In optical properties, we have studied Fourier transform infra-red spectra and the photoluminescence of this amorphous silicon thin film. It is found that these amorphous silicon nanoparticles exhibits strong Si-O-Si stretching mode at 1060 cm-1, which suggests that the large amount of oxygen is adsorbed on the surface of these a-Si nanoparticles. The photoluminescence observed from these amorphous silicon nanoparticles has been explained with the help of oxygen related surface state mechanism. © 2009 Elsevier B.V. All rights reserved.

Author Keywords
AFM; Electrical properties; Fourier transform spectrum; Mott's parameters; Optical properties; Photoluminescence; Physical Vapour Condensation Technique; SEM; Silicon nanoparticles; TEM; Variable range hopping

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