KANNIKA KUNCHANA : STUDY OF NANO-SILICON DOTS THIN FILMS IN ITS OXIDE MATRIX BY USING SOL-GEL TECHNIQUE FOR PHOTOVOLTAIC APPLICATIONS. THESIS ADVISOR : ASST. PROF. THIPWAN FUNGSUWANNARAK, Ph.D., 97 PP.

NANO-SILICON DOTS/ ENERGY BAND GAP/PHOSPHOSILICATE GLASS/ SOL-GEL/SOLAR CELL

In this thesis, the thin film of nano-silicon dots (nc-Si dots) in its silicon dioxide (SiO_2) is synthesized by using a sol-gel spin coating technique to approach the low-cost emitter layer for solar cell. The prepared films do not rely on a high vacuum system and the as-deposited films were treated at low annealing temperature. The microstructural, electrical, and optoelectronic characteristics of the prepared films, were examined in this study. Fourier transform infrared spectroscopy measurement provided the results implying the quality of SiO_2 film as a medium phase of nc-Si films. FTIR peaks can be implied to Si-O-Si bonding. The nc-Si quality and chemical composition were verified by a micro-Raman spectroscopy, respectively. It was found that 511 cm^{-1} peak of Raman spectrum shifted from 521 cm^{-1} that indicated the formation of Si nanostructure. The incorporation of boron atom in Si structure associating with B-Si bonding was measured by a photoemission spectroscopy.

In addition, The conductivity of the n-type nc-Si dots film that consists of nc-Si phase embedded in phosphosilicate glass (PSG) is prepared by using phosphoric acid in the suspension. The film is higher conductivity by 5.64 times. Photocurrent is stepped up by 10^3 times as compared with the dark current. Furthermore, the film with the different nc-Si densities were fabricated by adding the amount of nc-Si

powder of 0.03g, 0.06g and 0.10g in the sol-gel solution. The film thickness increased from 0.95 μm to 1.36 μm. The spectral of transmittance (T%) and reflectance (R%) were examined in the range from UV to visible wavelength by a spectrophotometer. The density of nc-Si dots in the films increased with decreasing T% while the R% increased with increasing nc-Si density. The optical band gap was estimated from the T% and R% calculation by using the Tauc's plot technique. It was found that the value of optical band gap increased from 1.1 eV as compared with that of a c-Si and it can be extended to 1.4 eV with nc-Si density of 0.06g.

In this study, the nc-Si dots embedded in its dielectric film exhibited the low conductivity about 5.60×10^{-6} S/cm due to some small cracks in the film surface. Therefore, it is necessary to have p-n junction underneath the nc-Si dots layer forming the solar cell structure of Ag-Al/nc-Si dots/n-Si/p-Si substrate/Al. The cell efficiency is about 2.35% with the cell area of 1 cm^2 light intensity with AM1.5 standard. The efficiency of the cell with the layer of nc-Si dots in PSG phase is lower than that of the cell with single p-n junction because low T% of the nc-Si dots layer results in the low carrier generation within the p-n junction. However, this attempt has the successful synthesis for nc-Si dots film under a low-cost preparation technique. It has not only the good optical properties but also the technical obstacle with the low conductivity of the film to be revealed in order to sustainably develop nc-Si dots film for a new generation solar cell.

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