Republic of Iraq
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University of Technology
Laser and Optoelectronic Engineering Department

Preparation and Characterization of Nano TCO Materials for Solar Cells

A Thesis

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Abstract

In this work, a Q-switched Nd:YAG laser (pulse repetition rate 6 Hz, 10nm pulse duration, 532 nm wavelength, and 237.47 J/cm^2 laser fluence) was used to deposit high crystalline TiO_2 nano-films of 3.24 eV energy band gap, and good surface morphology with 2.38 nm roughness.A solar cell device with a conversion efficiency reaching 8.733% was prepared by fabricating porous silicon (PSi) and depositing titanium dioxide films on PSi.Various laser fluences (from 131.93 to 263.85 J/cm^2) and three laser wavelengths (1064 nm, 532 nm, and 355 nm) of pulsed laser deposition (PLD) were used to grow nano TiO_2 films on quartz and silicon (Si) substrates in order to study the effect of changing these parameters on the prepared TiO_2 nano-films. The structural properties of TiO_2 nano-films were investigated utilizing X-ray diffraction (XRD) and Raman spectroscopy. As a result, it has been found that the film structure and material crystallization are affected by fluence and wavelength changes. XRD showed that as the laser fluence increases, rutile crystals start to appear due to the temperature increase, lower deposition laser wavelength resulted in better crystallization with rutile peaks also The UV-Vis transmittance measurements have shown that the prepared films are highly transparent in the visible region and have high UV absorbance; decreasing the deposition wavelength resulted in reducing the visible transmission values by nearly 20%.The surface morphology of the deposited films has been studied using Field Emission Scanning Electron Microscopy (FESEM) and Atomic Force Microscopy (AFM). The surface of the nanoparticles observed depended on the deposition laser fluence, where 237.47 J/cm^2 fluence resulted in the highest roughness value of 2.38 nm. The laser wavelength change also affected the morphology of the films, where the FESEM images showed clearer particles on the

532 and 355 nm deposition wavelength, and the largest average grain size was observed at the 532 nm film.