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Abstract
This research studied the titanium dioxide (TiO2) thin film, at thickness of 500nm, on ITO glass substrate, prepared by radio frequency magnetron sputtering from TiO2 target and analyzes the optical characteristics and surface morphology. The thin films were prepared at different temperatures and at two kinds of heat treatment process: (1) deposited in vacuum condition with substrate heating at temperature ranging from 100 to 400oC, (2) deposited in vacuum condition at RT and then post annealed at 100oC to 400oC in atmospheric furnace. The crystallization state of films was studied by X-ray Diffraction (XRD) and Field Emission Scanning Electron Microscopy (FESEM). The surface morphology was evaluated with Atomic Force Microscopy (AFM), and the optical characteristics were analyzed by UV-VIS spectrometer and contact angle measurement. Analysis of the temperature and crystallization of different films were summarized as following: (1) at substrate heating below 150oC or post annealed below 250oC were amorphous. (2) at substrate heating at 150 to 300oC or post annealed at 250oC to 400oC were anatase crystalline. (3) at substrate heating from 350 to 400oC was at transitional state from anatase to rutile, above 400oC was rutile crystalline. According to the results of the SEM and XRD, the largest grain size in the film was observed on substrate heating condition at 300oC, grain size decreased above 300oC due to the transformation of crystal phase. According to the results of the AFM, the surface roughness increases with prepared temperature. In the two heat treatment process, the roughest surface occurred on thin films in anatase crystalline at 300oC. From 350 to 400oC, the roughness of films prepared by post annealing did not change too much, however for those prepared by substrate heating, the roughness decreases because of crystalline transformation.
The absorptive performance was related with crystalline phase and grain size. As prepared temperature increases, the grain size increases and the band gap decreases that causes the films to absorb smaller frequency light. In the other words, the absorptive ability is red shifted to larger light wavelength. Besides, rutile phase has smaller band gap the anatase phase that resulted in red shift of absorption too. All these trends were confirmed by examining the transparency and absorptive performance of thin films between 200 nm ~600 nm on UV-VIS spectrometer. All films have good transparency about 70% above 400 nm. The hydrauphilic ability was related with crystalline phase and roughness. Better hydrauphilic ability was observed on anatase surface, however at the same temperature of different heat treatment process, the rougher surface possessed the poor hydrauphilic ability.
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