Modified Sol-gel/Impregnation Synthesis of Titanium Dioxide Nanoparticles and Ag-loaded Titanium Dioxide Nanoparticles for Dye-Sensitized Solar Cells Application

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TiO_2 nanoparticles and Ag-loaded TiO_2 nanoparticles were synthesized by the modified sol-gel method together with the impregnation method using titanium tetraisopropoxide (TTIP), ethanol(EtOH), ammonia (NH_3) and deionized water as the starting materials. The cellophane membrane was used to control the rate of hydrolysis during sol-gel process. The slow reaction of hydrolysis could produce the small size of TiO_2 nanoparticles. $AgNO_3$ was use as the Ag precursor for Ag-loaded TiO_2 nanoparticles synthesis. The amount of Ag-loaded was in the range of 0.50–3.00 mol%. The crystal structure and crystallinity of TiO_2 and Ag-loaded TiO_2 nanoparticles were examined by an X-ray diffractometry (XRD). Morphologies and particle sizes of TiO_2 and Ag-loaded TiO_2 nanoparticles were investigated by scanning electron microscopy (SEM) and Transmission electron microscopy (TEM). The chemical composition of TiO_2 and Ag-loaded TiO_2 nanoparticles were examined by energy dispersive X-ray spectrophotometry (EDXS). Specific surface area (SSA_{BET}) of the samples was investigated by the Brunauer-Emmett-Teller (BET). Anatase phase of TiO_2 was obtained in all samples with an average particle size of 20 nm. The TiO_2 nanoparticles and Ag-loaded TiO_2 nanoparticles have spherical shape. The specific surface area was found to be in the range of 60–100 m^2/g. For the enhancement of DSSCs, the dye-sensitized solar cells composed of the ITO/TiO_2/N-719/ electrolyte/Pt and the dye-sensitized solar cells composed of the ITO/Ag-loaded TiO_2/N-719/ electrolyte/Pt were fabricated. TiO_2 films and Ag-loaded TiO_2 films were deposited by using squeegee method using EtOH as a solvent and the films were sinterd at 450°C for 30 min before preparation of the cells. Finally, the fabricated cells were studied upon an irradiation of solar light to study the performance and compare the enhancement with the cell fabricated with unloaded TiO_2. The fabricated cell with 1.0 mol% Ag-loaded TiO_2 could enhance the conversion efficiency more than 60% when compare to the fabricated cell with unloaded TiO_2. The performance of the fabricated cells could be enhanced by localized surface plasmon effect and scattering property.