Sutasinee Kityakarn 2009: (Photo)Electrochemical Studies of Nanoporous TiO_2 and Ce-doped TiO_2 Film Electrodes Prepared by the Sol-Gel Method. Doctor of Philosophy (Chemistry), Major Field: Chemistry, Department of Chemistry. Thesis Advisor: Associate Professor Attera Worayingyong, Ph.D. 207 pages.

Nanoporous undoped TiO_2 and Ce-doped TiO_2 film electrodes were successfully prepared by a sol-gel method using high water content (a high ratio of water to alkoxide precursor of 200:1). Mixture phases of anatase and rutile were investigated by x-ray diffraction (XRD). Extended x-ray absorption fine structure (EXAFS) technique was also used to determine the mixture phases of anatase and rutile in undoped TiO_2 and Ce-doped TiO_2 powder together with the position of Ce ions in the TiO_2 structure. Results from scanning electron microscopic technique (SEM) showed that the undoped TiO_2 and Ce-doped TiO_2 electrodes were relatively compact films whereas a commercial TiO_2-P25 formed an agglomerated fine particle electrode. Electrochemical properties and photo-electrochemical properties of TiO_2 electrodes were studied by cyclic voltammetry (CV) and electrochemical impedance spectroscopy (EIS). The Ce-doped TiO_2 electrode showed a higher current in the dark compared with the undoped TiO_2 electrode due to a higher number of hydrated Ti(III) sites resulting from Ce(III) on the surface. Under irradiation, the overall impedance of the undoped TiO_2 showed a smaller value than that of the Ce doped-TiO_2 electrode, which meant that the undoped TiO_2 had higher conductivity due to fewer grain boundaries of the mixture phases of anatase and rutile. The EIS results were simulated using a transmission line model for porous film electrodes. Charge transfer processes and recombination reactions were taken into account for the simulation of irradiated EIS results. The enhancement of photocurrents depended on anodic potential, photon flux and electrolyte solution. The limitation of the overall reaction resulted from the charge transfer and recombination reactions.

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