Light Management In Mesoporous TiO2 Electrode for Dye-sensitized Solar Cells

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Nanocrystalline mesoporous materials have recently attracted much attention owing to their peculiar physical and chemical properties. Among wide-band gap metal oxides, nanocrystalline TiO_2 is a most promising material for using as an electrode in dye-sensitized solar cell (DSC). Nanocrystalline TiO_2 is normally synthesized by a sol-gel technique via hydrothermal process. Another promising method to obtain fine crystalline TiO_2 is the surfactant-assisted templating method. Mesoporous TiO_2 ($MPTiO_2$) was synthesized by a modified sol-gel with laurylamine hydrochloride surfactant in a mild condition. The obtained TiO_2 gel was coated on conducting glass by doctor blading. However, when the film thickness is increased, the thicker film tends to crack due to the film shrinkage. The large TiO_2 particles are incorporated into the $MPTiO_2$ gel to enhance the light scattering, to prevent the film cracking, and to reduce the interconnection among the particles. However, a decrease in surface area is increased by arising from the presence of large particles. The balance between light scattering and surface area is an important factor. In this work, the high crystallinity TiO_2 and P25 powder were added in $MPTiO_2$ gel. The various dyes, N719, porphyrin derivatives, and coumarin dyes, were used as sensitizer. The morphology of TiO_2 electrode was modified by repetitive coating the blended of $MPTiO_2$ gel with TiO_2 powder. From the preliminary results, the double layered electrode, which consisted of transparent $MPTiO_2$ and blended $MPTiO_2$ with TiO_2 particles, was fabricated to improve the cell performance by increasing the amount of adsorbed dye, improving light scattering, and decreasing the back-light scattering. The efficiency of double layered cell attained 9.15% with a J_{sc} of 17.1 mA/cm^2, a V_{oc} of 0.751 V, and a fill factor of 0.711, as shown in Fig. 1. However, the suitable thickness of MP-TiO_2 layer and the amount of TiO_2 powder in MP-TiO_2 gel should be optimized.

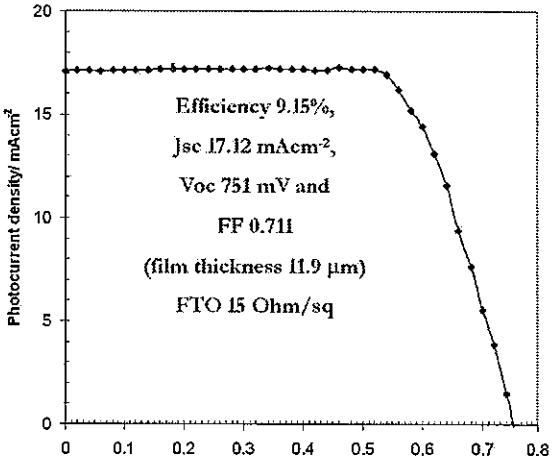

Fig. 1 Photovoltaic characteristic of double layer cell