

Large-Scale Synthesis of Carbon Nanotubes and Their Applications to the Counter Electrodes of Dye-Sensitized Solar Cells

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ABSTRACT

The ideal counter electrodes of Dye-Sensitized Solar Cells(DSSC) must meet the following requirement: (1).Good electrical conductivity to reduce the series resistance (RS), (2).Excellent chemical stability to protect from corrosive electrolytes and take part in undesired electrochemical reactions, (3).To reduce the over-potential of the redox couples (mediator, i.e. I-/I3- in typical DSSC) and (4).High surface area for mass transfer. Fullerenes family such as C60 and carbon nanotubes(CNTs) have better electron affinity for fast transfer of photocurrent(electron shuttle)., Carbon nanotubes have high porosity, large surface area with good electric conductivity and relatively easy synthesized in lab. Scale. Accordingly, in this study, we had fabricated multiwalled carbon nanotubes(MWNT) based counter electrode of DSSC in endeavor for cell performance improvement. MWNTs were synthesized by atmospheric thermal chemical vapor deposition over Co-Mo/MgO by using C2H2 as carbon source and H2/NH3 as reducing ambient at 700~900oC. The major products were multiwalled carbon nanotubes with diameter around 7~13 nm. The as-synthesized MWNTs with high carbon yield are easily purified and processed. The optimal pretreatment temperature is 800 oC. For higher nanotube density, reaction temperature of 800~900oC is desirable. As the growing temperature is increased, the diameter of MWNT is larger. One of the production yield is 0.733 g-CNT /hr whose growth rate is fastest at the very start of 10min.(0.057 g-CNT/min. g-cat). After purification of the as-grown MWNTs, finely dispersed CNTs were anchored on the ITO glasses as the counter electrode of DSSC. After fabrication of TiO2 working electrode dyed with mercurochrome. The assembled DSSC was tested for I-V character under illumination. It revealed that CNT-based counter electrode own superior VOC and ISC under identical conditions. In comparison with the traditional Pt-counter electrode(VOC=0.49 V and ISC=1.86 mA), the CNT-counter electrode possessed higher cell performance with VOC=0.65 V and ISC=3.05 mA. After keeping the [K1]/[I2] to 5/1, the influence of different electrolyte concentration were investigated. The results shows that there is optimal value of [K1]/[I2]=0.3 M/0.06 M. Under the given electrolyte value, the DSSC have VOC=0.65 V and ISC=3.05 mA. Besides, it shows that under identical [K1]/[I2] ratio, the VOC is always kept the same. By varying the [I2] and keeping [K1]=0.3 M, the ISC will increase as the [I2] is increased. The equivalent solar cells circuit analysis shows that the series resistance under best cell performance in this study is Ro=138 , with ideal factor n=0.56 in comparison to that of Pt-counter electrode with Ro=190 , n=0.4. As a conclusion, the CNTs is effective increase the electron transfer property of counter electrode of DSSC.

Keywords : MgO ; Chemical vapor deposition ; Dye-Sensitized ; Counter electrodes ; family ; after

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