新穎染敏太陽電池添加奈米碳管組成結構與電化學特性分析

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摘 要

本研究以二氧化鈦(TiO_2)添加不同比例的奈米碳管(carbon nanotubes, CNTs)作為染料敏化太陽電池（Dye-Sensitized Solar Cells, DSSC）的工作電極，使得工作電極具有碳奈米管與二氧化鈦的雙重特性優點，進而探討電性的特性。此外，還增加以異質結構的改變，研究製程參數對染料敏化太陽電池光電效率的影響。
本實驗是以商用奈米二氧化鈦(Degussa P25)作為染料敏化太陽電池之工作電極材料，在其結構中添加奈米碳管，以旋轉塗佈法的方式生成TiO_2/CNTs薄膜，同時比較以Sol-gel SnO_2與Sol-gel TiO_2等所形成的underlayer結構，在不同工作電極膜厚和添加不同比例的奈米碳管等條件下，所製作之染料敏化太陽電池，其光電轉換效率之特性。在材料鑑定方面，以XRD、SEM、UV-VIS等分析膜的結晶特性、表面型態以及光學穿透度。
實驗結果顯示：未添加奈米碳管之工作電極，當其膜厚為9μm時，所測量的光電轉換效率最高，其V_{oc}=0.74V、J_{sc}=14.1 mA/cm2、FF=0.56、η=5.93%。持續增加膜厚，無法明顯的提昇整體光電轉換效率。添加奈米碳管之工作電極，有助於染料敏化太陽電池效率的提昇，其中以0.025wt%比例的奈米碳管效果最好。其V_{oc}=0.74V、J_{sc}=13.96 mA/cm2、FF=58.77、η=6.04%。如果奈米碳管添加比例太多，會造成染料敏化太陽電池效率下降。最後，以Sol-gel SnO_2堆疊Sol-gel TiO_2作為underlayer的結構，所形成的新穎染料敏化電池結構：ITO/SnO_2/SG-TiO_2/TiO_2-CNT，可以增加工作電極染料的吸附量與提升工作電極可見光吸收效率。其V_{oc}=0.74V、J_{sc}=16.22 mA/cm2、FF=57.59、η=6.89%。由此可知：以奈米碳管修飾之二氧化鈦工作電極，有助於染料敏化太陽電池光電轉換效率的提升。

關鍵詞 : 二氧化鈦、奈米碳管、染料敏化太陽電池

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