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Quantum-dot-sensitized Solar Cells

INTRODUCTION

Poor absorption of low-energy photons by available dyes are one of major factors limiting further improvement in the photo-conversion efficiencies achievable using nanocrystalline Dye-sensitized solar cells (DSSCs). Quantum dots (QDs) provide the ability to match the solar spectrum better and can generate multiple electron-hole pairs per photon, which could improve the efficiency of the device.[1] In this project, quantum-dot-sensitized solar cell (QDSC) will be fabricated.

METHODOLOGY

1. Preparation of TiO₂ film and TiO₂ nanorod
   (a) Nanocrystalline TiO₂ film Preparation
   A method called screen-printing was used in the experiment. Screen shape shown in Figure.1a. The printed nanocrystalline TiO₂ shown in Figure.1b.
   (b) Nanorod TiO₂ Preparation
   TiO₂ nanorods were obtained by hydrothermal treatment.[2] The after treatment glass is shown in Figure.1c. The TEM is shown in Figure.1d.

2. CdSe QDs’ deposition onto the TiO₂ layer.
   CdSe was deposited on the electrodes by the SILAR method. The same procedure was repeated 6 times to obtain suitable CdSe loading on electrodes.[3] The microscopic image shown in Figure.2a,b and c.

3. Fabrication of the QDSC
   The finalized solar cell is shown in Figure.3.

4. Testing of the Solar Cell
   The testing apparatus is shown in Figure.4.

RESULTS AND DISCUSSION

Figure.5a Solar cell with QDs
Figure.5b Solar cell without QDs
Figure.5c Spectrum absorption rate under different times of CdSe treatment
Figure.5d J-V characteristics of two cells

Figure.5a and 5b show the schematic graph of the finalized solar cells with and without QDs on it.

Figure.5c shows the absorption spectra of the QDSC, the result was obvious that more cycles of deposition led to more intensified absorption ability. However, the optimum times of SILAR method is still unknown to me. More research need to be done on it.

Figure.5d are the graphs made from the raw data of the two QDSCs. It shows that the efficiencies of QDSCs with TiO₂ nanocrystals and nanorods reached a level of 0.99% and 0.67%, respectively. The QDSCs with TiO₂ nanocrystals shows higher efficiency due to the high surface area for more QDs loading. The QDSCs with TiO₂ nanorods shows lower efficiency with low fill factor due to the higher resistance after growth of the TiO₂ nanorods.

CONCLUSION

QDSCs have been fabricated and the QDSCs with TiO₂ nanocrystals and nanorods have comparable efficiency of 0.99% and 0.67% respectively.

In the future works, Deposition methods will be modified to maximize the quantum-dot adherence and performance, and the performance of the QDSCs will be optimized.

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REFERENCES