Journal of Power Sources 306 (2016) 764–771

Contents lists available at ScienceDirect

Journal of Power Sources

journal homepage: www.elsevier.com/locate/jpowsour

Copper and nitrogen doping on TiO_2 photoelectrodes and their functions in dye-sensitized solar cells

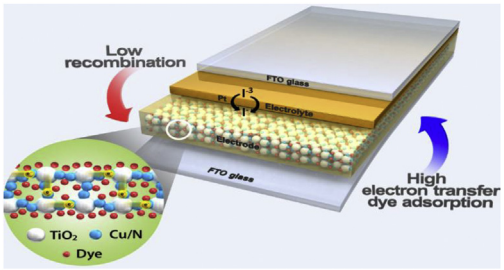
Jun-Yong Park [a], Chan-Soo Kim [b], Kikuo Okuyama [c], Hye-Moon Lee [d], Hee-Dong Jang [e, **], Sung-Eun Lee [f, ***], Tae-Oh Kim [a, *]

[a] Department of Environmental Engineering, Kumoh National Institute of Technology, Daehak-ro 61, Gumi, Gyeongbuk 730-701, Republic of Korea
[b] Marine Energy Convergence & Integration Laboratory, Jeju Global Research Center, Korea Institute of Energy Research, Republic of Korea
[c] Department of Chemical Engineering, Graduate School of Engineering, Hiroshima University, 1-4-1 Kagamiyama, Higashi Hiroshima 739-8527, Japan
[d] Principal Researcher Powder Technology Department, Korea Institute of Materials Science, Republic of Korea
[e] Rare Metals Research Division, Korea Institute of Geoscience & Mineral Resources, Daejeon 305-350, Republic of Korea
[f] School of Applied Biosciences, Kyungpook National University, Daegu 702-701, Republic of Korea

HIGHLIGHTS

- Addition of Cu provided small particle size and high specific surface area.
- Addition of Cu and N supplied low recombination rate of electrons.
- The highest power conversion efficiency was 11.35% (Jsc: 22.5 mA/cm^2).
- This efficiency was increased about 37% in comparison to Degussa P25.

GRAPHICAL ABSTRACT



ARTICLE INFO

Article history:
Received 18 August 2015
Received in revised form
2 December 2015
Accepted 17 December 2015
Available online 30 December 2015

Keywords:
Dye-sensitized solar cell
Cu/N doped TiO_2
Dye loading
Transport time
Charge recombination

ABSTRACT

The influence of Cu doping on the function of dye-sensitized solar cells (DSSCs) dependent on Cu/N-doped TiO_2 photoelectrodes was examined. Cu/N-doped TiO_2 photoelectrodes with diverse Cu concentration were synthesized using the sol–gel process. Upon adequate addition of Cu, the nanoparticles exhibited small particle sizes, high surface area, and a significant red alteration of their absorption to the visible region in relation to Degussa P25 nanomaterials. Furthermore, the traces of Cu/N-doped TiO_2 nanoparticles enhanced the charge transfer and reduced the charge recombination. The addition of sufficient Cu and N increased the surface area, elevating the dye adsorption degree, and decreasing the level of electron recombination. A DSSC fabricated with a 1 mM Cu/N-doped TiO_2 nanoparticles accomplished 11.35% of the highest power conversion efficiency, with a short-circuit current of 22.5 mA/cm^2. The energy conversion efficiency of this photoelectrode was approximately 37% greater than that of the control, Degussa P25. The increased energy efficiency can be resulted from the extension in surface area, which enabled larger dye charging amount, and the deduction in charge recombination, which accelerated the charge transfer.

1. Introduction

Todays, studies on alternatives to silicon-based solar cells or

* Corresponding author.
** Corresponding author.
*** Corresponding author.
E-mail addresses: hdjang@kigam.re.kr (H.-D. Jang), selpest@knu.ac.kr (S.-E. Lee), tokim@kumoh.ac.kr (T.-O. Kim).

http://dx.doi.org/10.1016/j.jpowsour.2015.12.087
0378-7753/