Exploration of the Effect of $TiCl_4$ Treatment on TiO_2 Nanoporous Film Electrode

Yanjie Ren[1], Wenjian Sun[2] and Shengmin Cai[1]*

[1] College of Chemistry and Molecular Engineering,
Peking University, Beijing 100871, China
[2] Department of Chemistry and Biochemistry,
The University of Texas at Arlington,
Arlington TX 76019-0065, USA

Dye-sensitized nanoporous TiO_2 photoelectrochemical cell has attracted much attention due to its merits in scientific, technical and economic aspects [1-3]. As a matrix for attachment of sensitizer molecules and a transfer layer for injected electrons, the nanoporous film electrode plays a vital role in photoelectric conversion process. Methods of electrode modification or post-treatment have been subject to investigation aiming to achieve further improvement of cell performance [4, 5]. Post-treatment of TiO_2 electrode with $TiCl_4$ has been reported to be effective in increasing the photocurrent.

Although it is very important in the development of more efficient dye-sensitized photoelectrochemical cells, the mechanism of this improvement is not known in detail yet.

In the present work, we concentrate our attention on exploring the effect of $TiCl_4$ post-treatment on the electrode. Surface area and pore size distribution analysis of the nanostructured electrode shows that $TiCl_4$ treatment decreases BET surface area from 127m^2 g^{-1} to 119m^2 g^{-1}, and decreases average pore diameter from 13.3nm to 12.5nm. These data rule out the possibility that the surface area and the amount of absorbed dye increases by nucleation of small particles in the post-treatment process. On the other hand, photoinduced current transient for the $TiCl_4$ treated electrode decays faster and its amplitude is larger compared with that of the untreated one, suggesting that electron percolation through the film electrode is improved by $TiCl_4$ post-treatment, and thus give rise to increased photocurrent.

References:

[1] B. O'Regan, M. Grätzel, *Nature*, **1991**, *353,* 737.
[2] Hagfeldt, A.; Grätzel, M. *Chem. Rev.* **1995,** *95*, 49.
[3] Y. Ren, Z. Zhang, E. Gao, S. Fang, S. Cai, *J. Appl. Electrochem.,* **2001**, *31*, 445.
[4] M. K. Nazeerudin, A. Kay, I. Rodicio, B. R. Humphury, E. Mueller, P. Liska, N. Vlachopoulos, M. Grätzel, *J. Am. Chem. Soc.,* **1993**, *115*, 6382.
[5] S. Lee, Y. Jun, K.J. Kim, D. Kim, *Sol. Energy Mater. Sol. Cells.* **2001**, *65,* 193.

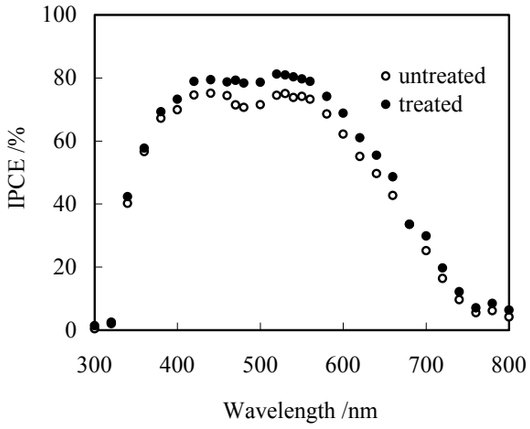

Fig. 1 Photocurrent action spectra of $RuL_2(SCN)_2$ sensitized electrodes with and without the post-treatment

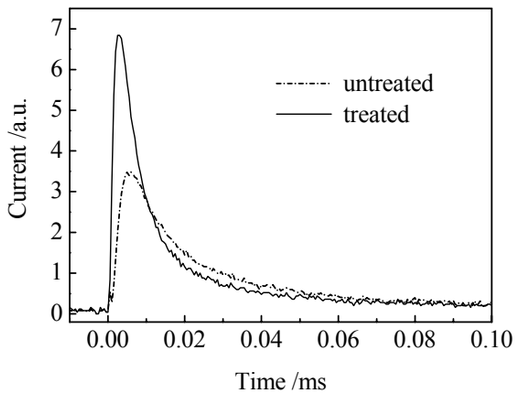

Fig. 2 Photocurrent transients of $RuL_2(SCN)_2$ sensitized electrodes with and without the post-treatment