Fabrication and Characterization of Porous DSC Counter Electrodes

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Introduction
Cobalt redox electrolytes have attracted great interests for increasing the open circuit voltage ($V_{oc}$) of DSCs, but its performance on typical plantium counter electrodes (CEs) is limited by high charge transfer resistance ($R_{ct}$). This project focuses on fabrication of high surface area catalysts supported on conducting substrates to reduce $R_{ct}$.

Fabrication Procedures
Niobium doped tin oxide (NTO) with good electronic conductivity and thermal stability is used as conducting scaffold material. Three different methods were employed for fabrication of NTO porous structures:
- SiO2 colloidal template approach
- PMMA colloidal template approach
- TiO2 colloidal template approach
Pt is deposited by thermal decomposition of H2PtCl6 with drop casting and by electrochemical deposition of H2PtCl6 in water solution.

Results and Discussion
The measurement of electrochemical impedance spectroscopy (EIS) shows that the value of $R_{ct}$ of Pt CEs decreases with increasing of roughness factor of catalyst supports, indicating an improvement of active surface area for charge transfer reaction by incorporating NTO porous substrates.

Figure 4. Nyquist plots of symmetric cells with Pt CEs on FTO and NTO substrates with different RF. NTO substrates are from left: SiO2 method; center: PMMA method; right: TiO2 method.

A linear relationship between $1/R_{ct}$ and RF was achieved at low roughness factor range with K=6.18, indicating that the active surface area of Pt catalyst in six times higher than surface area of NTO substrates. The data points, however, at high RF range is deviated from the line, which is attributed to uniformity problem of Pt deposition.

Conclusions
In this project, NTO conducting catalyst scaffolds with a series of roughness factor were successfully fabricated by three different methods. EIS data show that the charge transfer resistance of Pt porous counter electrodes based on NTO substrates are improved with increasing of RF. A linear relationship between $R_{ct}$ and RF was achieved. The fill factor and efficiency of dye sensitized solar cells with Pt CEs on NTO substrates are higher than those of DSCs on FTO substrates.