104 學年

材料工程系專題製作成果報告

題目：Fabrication of inverse opal nanostructure of platinum nanoshells as a highly porous counter electrode of Dye-sensitized solar cells

班級/學生: U01187023 陳怡靜、U01187038 楊壹証

指導教授: 謝建國 副教授

Introduction

In this study, the polystyrene nanospheres (PS NSs) were used as the sacrificial layers onto the FTO glass substrate. Subsequently, Platinum (Pt) films were deposited onto the PS NSs via the electrochemical deposition method. After removing the PS NSs, the highly porous inverse opal nanostructure of platinum nanoshells (Pt NSLs) were obtained. The synthesized Pt NSLs was used as a stereoscopic counter electrode (CE) for dye-sensitized solar cells (DSSCs).Due to the superb porosity and the stereoscopic nanostructure of the Pt NSLs, the specific surface area could be highly increased while the electrolyte filled into the inverse opal nanostructure. The outstanding specific surface area of the stereoscopic Pt NSLs CE enhanced the catalytic ability which promoted the power conversion efficiency (PCE) of DSSCs. In combination with an N719 dye-sensitized TiO_2 working electrode and an iodine-based electrolyte, the DSSCs with the stereoscopic Pt NSLs CE showed a PCE of 7.59% under AM 1.5 (100 $mWcm^{-2}$) illumination to achieve the high performance in DSSCs.

Process Flow

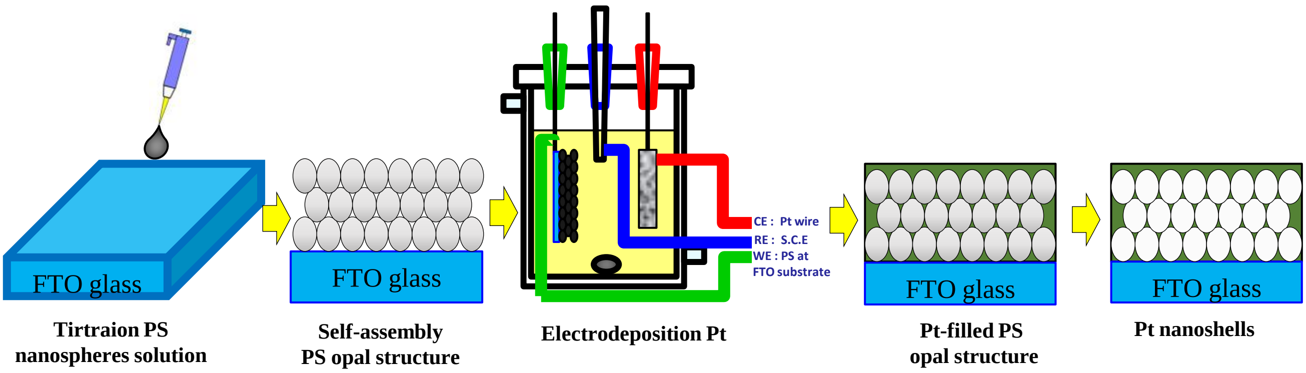

Fig. 1 Schematic diagram of the fabrication of the Pt NSLs. We used the pipette to set the stable capacity the solution of the PS NSs. The solution of the PS NSs self-assembly arrayed in an opal nanostructure. Platinum (Pt) films were deposited onto the PS NSs via the electrochemical deposition method. Toluene can dissolve PS NSs, therefore Pt NSLs will stay .

Result and Discussion

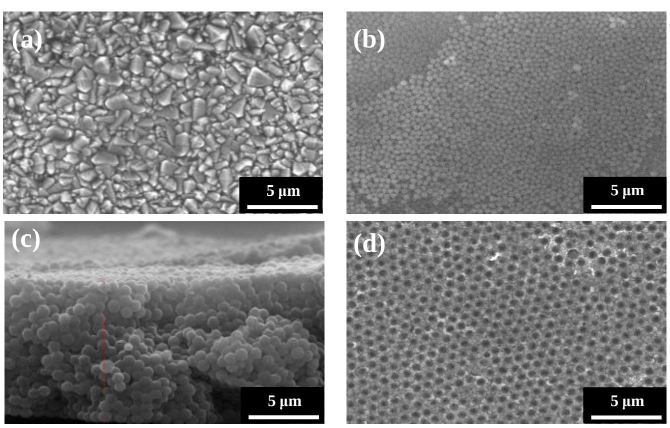

Fig. 2 SEM images of (a) FTO glass; (b) self-assembly polystyrene nanospheres with diameter of 500 nm on FTO glass; (c) electrodeposition platinum on polystyrene nanospheres(side view); (d) platinum nanoshells after polystyrene nanospheres removal.

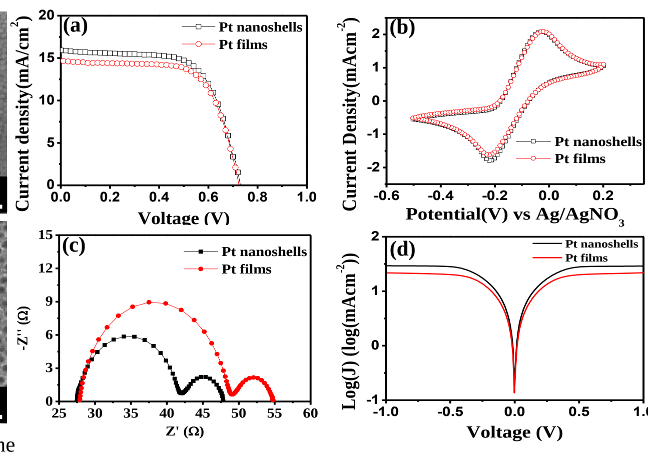

Fig. 3 (a) Photocurrent-voltage(I-V) curves; (b) Cyclic voltammetry; (c) Electrochemical impedance spectra ; (d) Tafel curves of the DSSCs with Pt nanoshlls and with Pt films.

Table. 1 Summary of PCE and electrochemical results in different CEs.

CEs	R_s (Ω)	R_{ct} (Ω)	J_o (mA cm^{-2})	I_{pa} ($mAcm^{-2}$)	V_{pa} (V)	I_{pc} ($mAcm^{-2}$)	V_{pc} (V)	Over potential	V_{OC} (V)	J_{SC} (mA cm^{-2})	FF	η (%)
Pt nanoshells	27.46	7.24	6.56	2.08	-0.03	-1.79	-0.22	0.19	0.73	15.92	0.68	7.59
Pt films	27.86	10.56	5.98	2.09	-0.02	-1.61	-0.22	0.20	0.72	14.69	0.63	7.16

Summary

We successfully fabricated superb porosity and the stereoscopic nanostructure of the Pt NSLs. The outstanding specific surface area of the stereoscopic Pt NSLs CE enhanced the catalytic ability which promoted the power conversion efficiency (PCE) of DSSCs. The PCE of the complete DSSCs was measured to be 7.59%. We demonstrated that inverse opal porous nanostructure of Pt NSLs can play a good candidate for DSSCs.