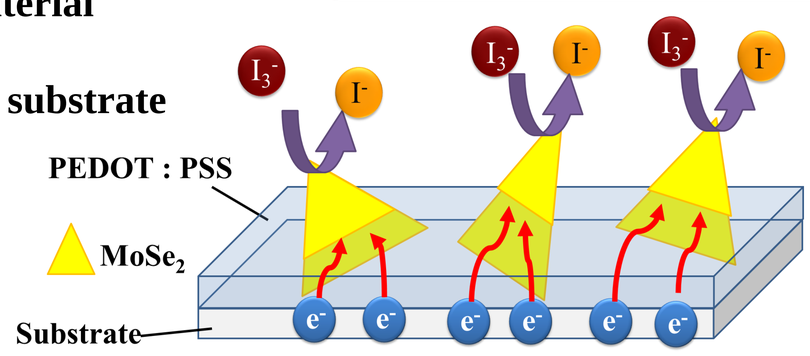
$MoSe_2$ nanosheet/poly(3,4-ethylenedioxythiophene): poly(styrenesulfonate) composite film as a Pt-free counter electrode for dye-sensitized solar cells

Yi-June Huang[1], Miao-Syuan Fan[1], Chun-Ting Li[1], Chuan-Pei Lee[1], Tai-Ying Chen[1], R. Vittal[1], Kuo-Chuan Ho[1,*]
[1] *Department of Chemical Engineering, National Taiwan University, Taipei 10617, Taiwan*
* Corresponding author: kcho@ntu.edu.tw

Motivation & Morphology

- **Two-dimensional (2D) material**
- **Good connection with the substrate**
- **Easy process & low cost**



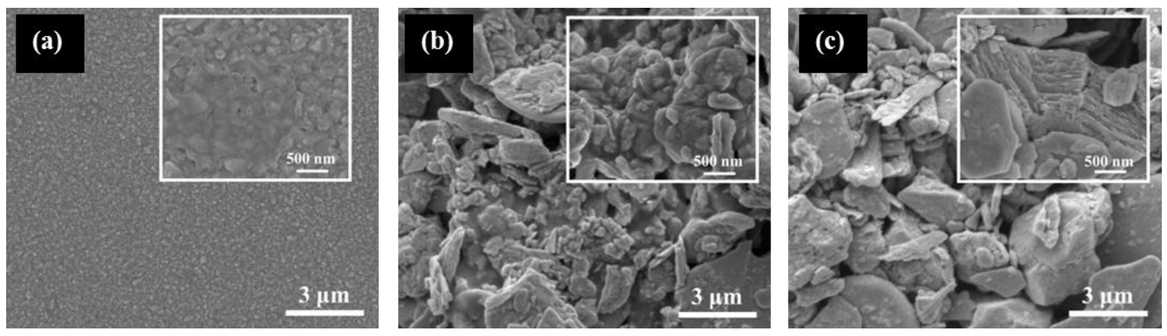


Fig 1. FE-SEM images of the CEs with (a) bare PEDOT:PSS, (b) MP-1.00, and (c) bare $MoSe_2$.

Electrochemical & Photovoltaic Analyses

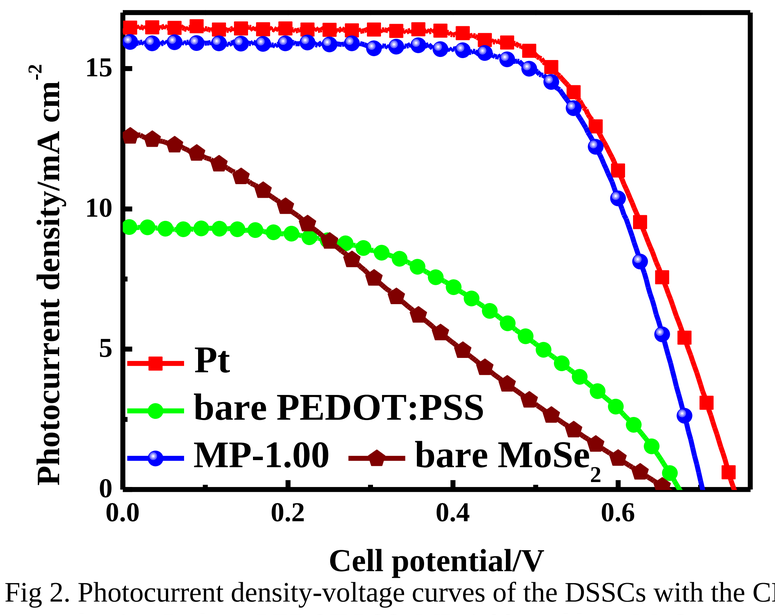


Fig 2. Photocurrent density-voltage curves of the DSSCs with the CEs having Pt, bare PEDOT:PSS, MP-1.00, and bare $MoSe_2$.

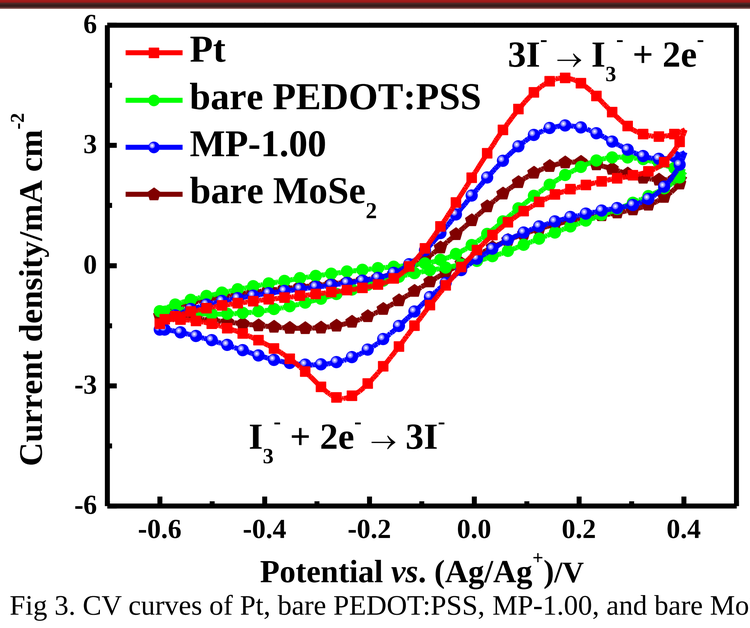


Fig 3. CV curves of Pt, bare PEDOT:PSS, MP-1.00, and bare $MoSe_2$.

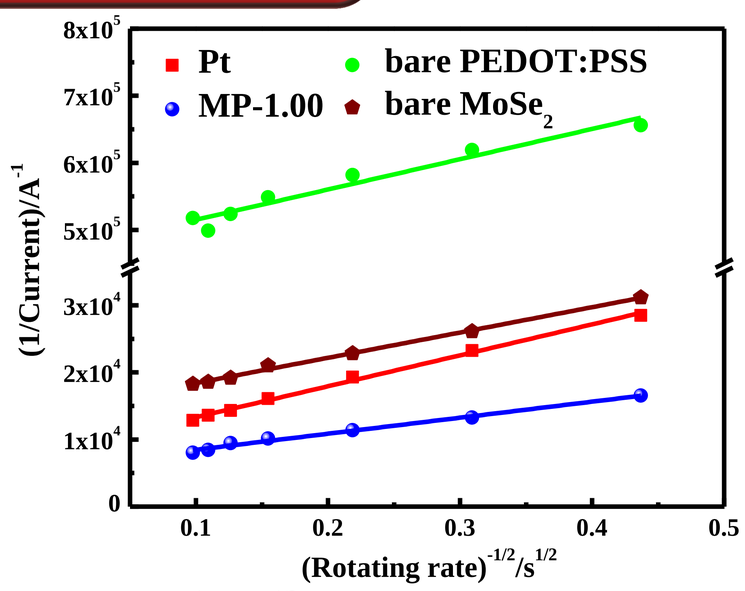


Fig 4. Plots of i^{-1} *vs.* $\omega^{-1/2}$ of Pt, bare PEDOT:PSS, MP-1.00, and bare $MoSe_2$.

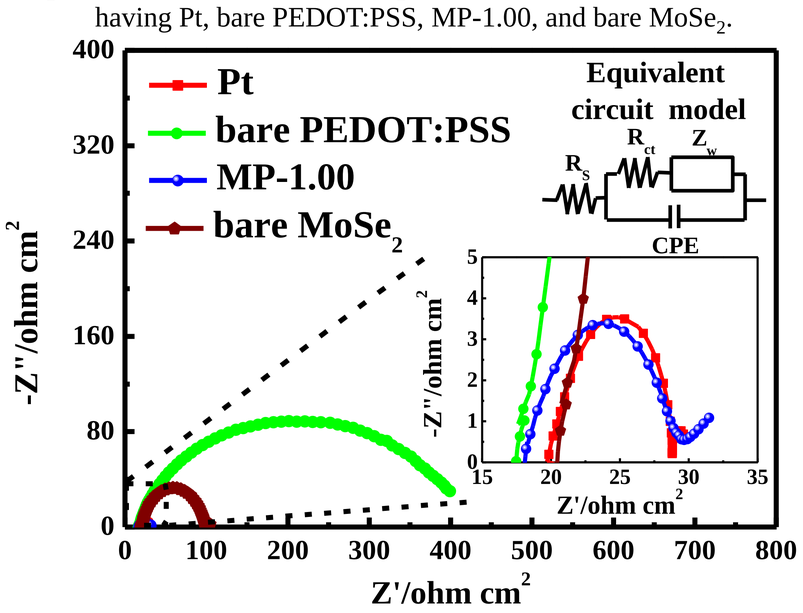


Fig 5. EIS spectra of Pt, bare PEDOT:PSS, MP-1.00, and bare $MoSe_2$.

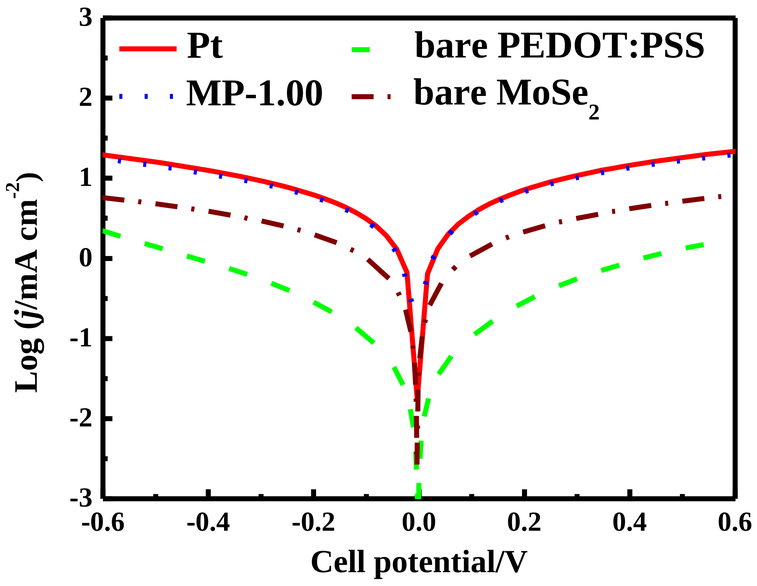


Fig 6. Tafel plots of Pt, bare PEDOT:PSS, MP-1.00, and bare $MoSe_2$.

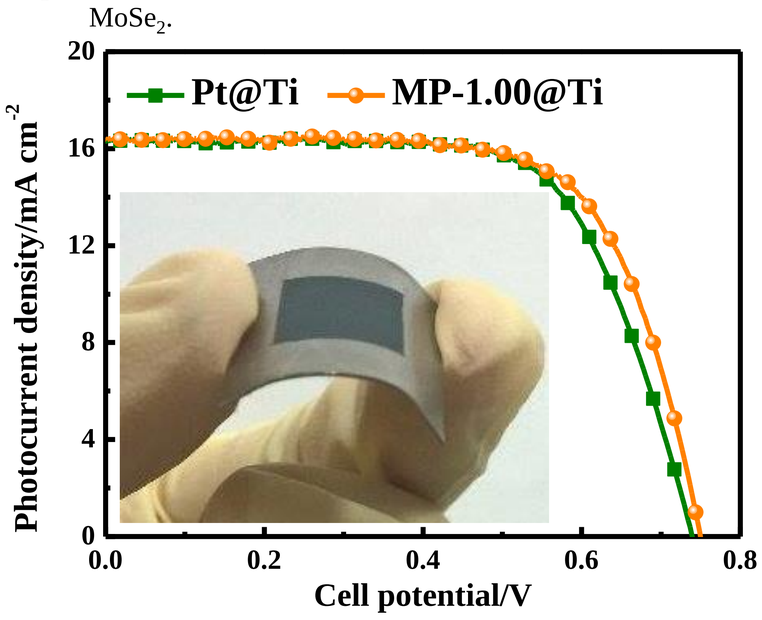


Fig 7. Photocurrent density-voltage curves of the DSSCs with the CEs of Pt, MP-1.00, and MP-1.00@Ti..

Electrochemical & Photovoltaic Parameters

Counter electrode	η (%)	V_{oc} (V)	J_{sc} (mA cm^{-2})	FF	j_{pc} (mA cm^{-2})	ΔE_p (V)	k^0 (cm s^{-1})	A_e (cm^2)	$R_{ct\text{-}Tafel}$ (Ω cm^2)	R_s (Ω cm^2)	$R_{ct\text{-}EIS}$ (Ω cm^2)
Pt	7.81±0.03	0.74±0.00	16.38±0.03	0.65±0.00	1.82	0.42	3.94×10^{-3}	0.30	3.23	20.19	4.60
Bare PEDOT:PSS	2.90±0.03	0.67±0.00	9.32±0.25	0.46±0.01	0.05	0.77	0.71×10^{-3}	0.31	181.46	17.36	190.91
MP-1.00	7.58±0.05	0.70±0.01	15.97±0.18	0.67±0.01	0.88	0.49	2.92×10^{-3}	0.58	3.77	18.08	5.43
Bare $MoSe_2$	2.29±0.04	0.66±0.01	12.65±0.31	0.28±0.01	0.29	0.52	1.92×10^{-3}	0.37	31.11	20.50	39.74

Conclusion

- The DSSC with a composite film having equal weights of $MoSe_2$ and PEDOT:PSS (denoted as MP-1.00) exhibits the highest power conversion efficiency (η) of 7.58±0.05%, which is comparable to that of the cell with a Pt CE (7.81±0.03%).
- The composite film MP-1.00 shows a much higher value of heterogeneous rate constant, k^0 (2.92×10^{-3} cm s^{-1}) and larger effective catalytic surface area, A_e (0.58 cm^2) than those of bare $MoSe_2$ and bare PEDOT:PSS.
- The DSSC with a flexible substrate of titanium foil (MP-1.00@Ti) gave an η of 8.51±0.05%, while the Pt@Ti offered its DSSC a lower η of 8.21±0.02%.

Acknowledgement

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