2015 中技社科技研究獎學金

CTCI Science and Technology Research Scholarship

染料敏化太陽能電池：
無白金對電極與無碘電解質之研究
Dye-sensitized Solar Cells:
Study of Pt-free Counter Electrodes and Iodide-free Electrolytes

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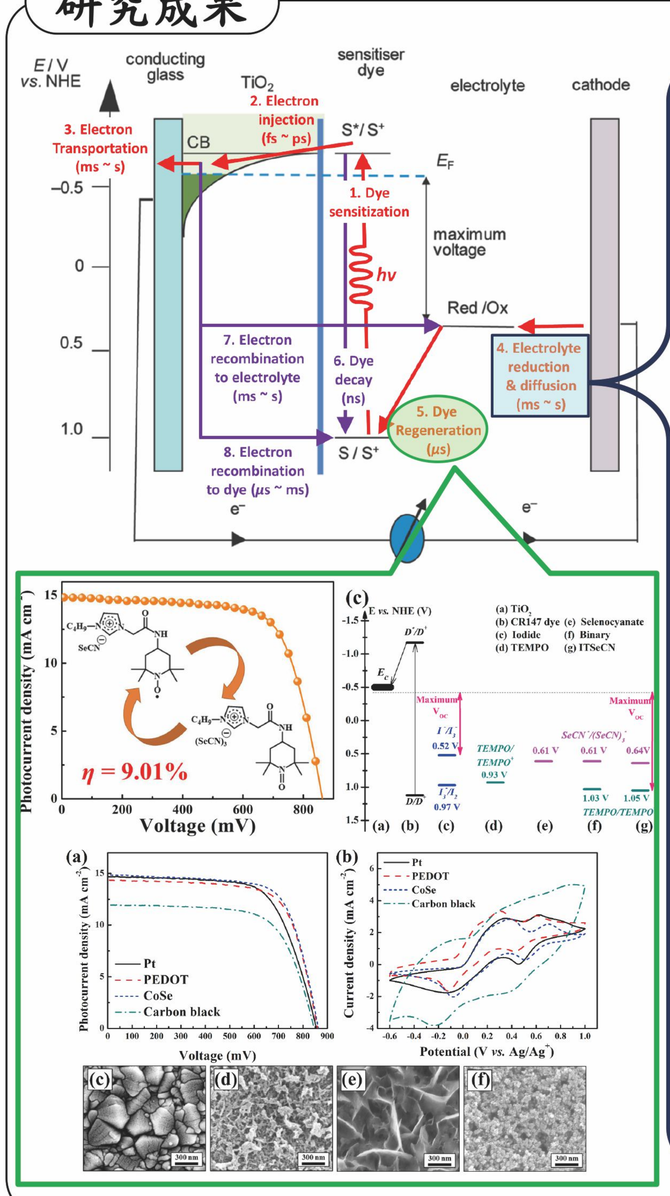
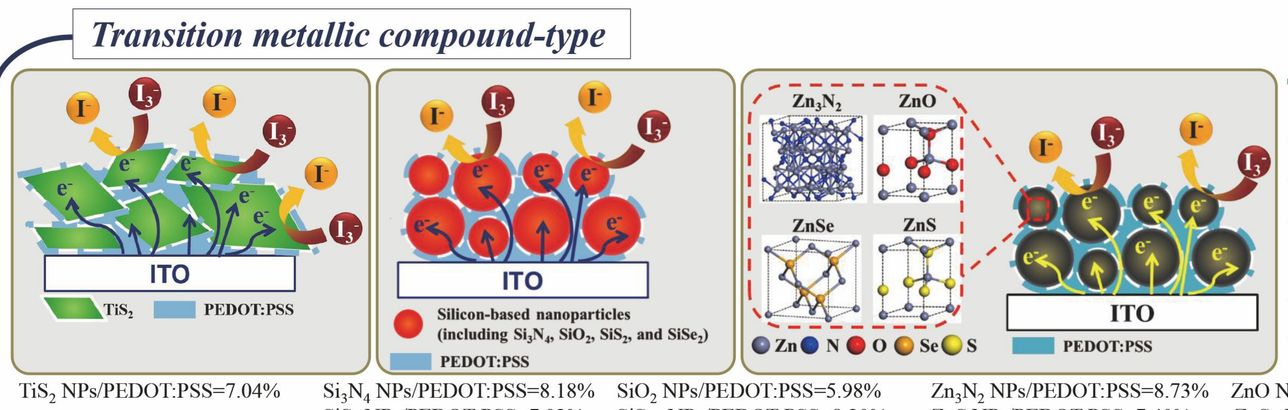
研究重點

This dissertation aimed to systematically develop Pt-free counter electrodes (CEs) and to design a novel iodide-free electrolyte for the dye-sensitized solar cells (DSSCs) with low-costs and highly cell efficiencies (η's). We systematically explored various low-cost and outstanding electro-catalysts, including transition metallic compound-type (Zn_3N_2/PEDOT:PSS, 8.73%), carbonaceous-type (carbon black/sulfonated-polythiophene, 9.02%), and conducting polymer-type (HMITFSI-doped PEDOT, 8.87%) materials, for completely replacing the expensive Pt. Moreover, we designed a novel ionic liquid (ITSeCN) containing dual redox channels of imidazolium-functionalized TEMPO (cationic redox mediator) and selenocyanate (anionic mediator). By coupling with a CoSe CE, the DSSC with ITSeCN electrolyte shows an η of 9.01%, revealing a promising approach to derive highly efficient DSSCs.

研究成果



Transition metallic compound-type

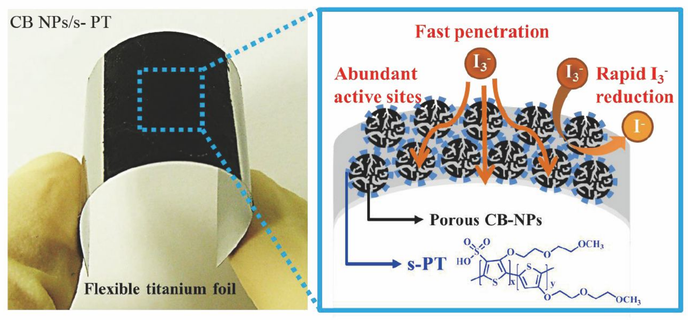


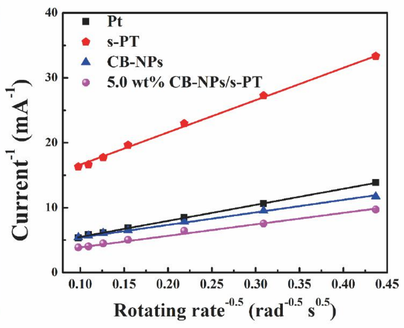
TMC NPs/PEDOT:PSS

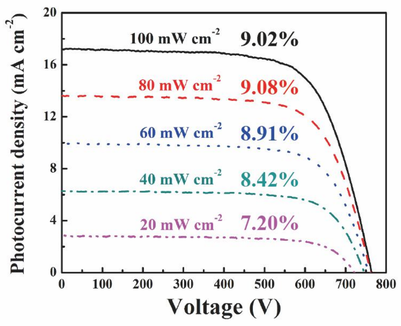
- ✓Good electro-catalytic ability
- ✓Large active surface area
- ✓Multiple electron transfer pathways
- ✓Good adhesion to ITO
- ✓Good linkage between NPs

TiS_2 NPs/PEDOT:PSS=7.04%　Si_3N_4 NPs/PEDOT:PSS=8.18%　SiO_2 NPs/PEDOT:PSS=5.98%　Zn_3N_2 NPs/PEDOT:PSS=8.73%　ZnO NPs/PEDOT:PSS=7.43%
SiS_2 NPs/PEDOT:PSS=7.02%　$SiSe_2$ NPs/PEDOT:PSS=8.20%　ZnS NPs/PEDOT:PSS=7.40%　ZnSe NPs/PEDOT:PSS=8.13%

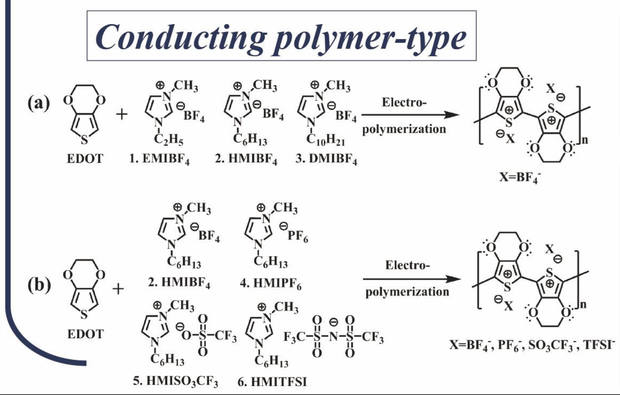
Carbonaceous-type

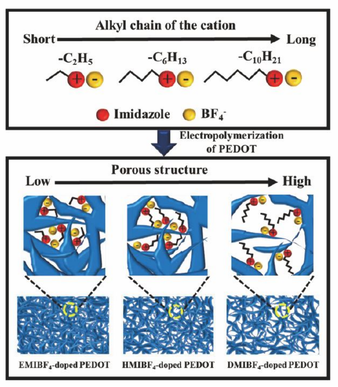






Conducting polymer-type





$EMIBF_4$-doped PEDOT=6.69%　$HMIBF_4$-doped PEDOT=7.78%
$DMIBF_4$-doped PEDOT=7.20%　$HMIPF_6$-doped PEDOT=8.28%
$HMISO_3CF_3$-doped PEDOT=7.82%　HMITFSI-doped PEDOT=8.87%

- ✓An increase in the length of the alkyl chain of an imidazolium cation ($-C_{10}H_{21}$ > $-C_6H_{13}$ > $-C_2H_5$) enables an increase in the porosity , hydrophobicity, resonant ability, and effective surface area of its ionic liquid-doped PEDOT film, but decreases the diffusion of I^-/I_3^- in the film.
- ✓An increase in the number of lone pair electrons in an anion ($TFSI^-$ > PF_6^- > $SO_3CF_3^-$ > BF_4^-) leads to the increase in the conductivity, hydrophobicity, resonant ability, and intrinsic heterogeneous rate constant of its ionic liquid doped-PEDOT film.

研究生活及心得

經過博士班四年訓練，我獲得很多寶貴的經驗與知識，非常感謝何教授的教導與提攜，讓我能夠站在巨人的肩膀上持續向前邁進，感謝中技社給予我莫大的鼓勵與肯定，讓我有動力與能量持續在學術研究領域培養更多專長，學到更多不同領域的專業知識，多多與國際學者交流，使未來的研究更具創新性、衝擊性，並期許能將自己培養成獨立、具競爭力、領導能力、優秀的學者。中技社秉持著培育科技人才、鼓勵創新科技技術、協助國內外科技與經濟建設等宗旨。令我極為嚮往，盼望我未來可以將所學回饋給台灣社會，帶領台灣的研究人才，發揮創意與想像力，提升台灣的競爭力。

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