明志科技大學材料工程系106學年四技專題製作競賽

題　　目：**高效率非富勒烯及非鹵素溶劑有機太陽能電池**

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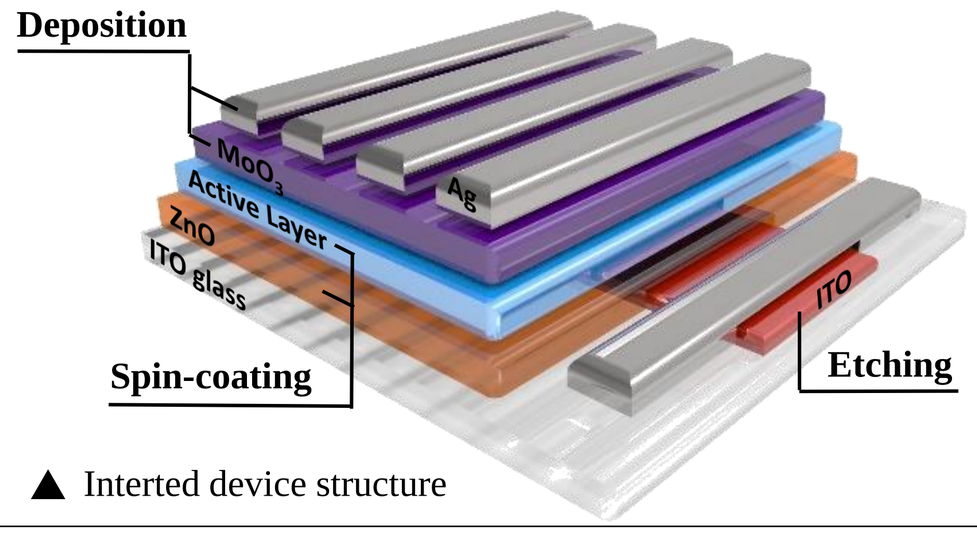
Introduction

Current organic solar cells, the active layer contains halogen solvents, the solvents containing F, Cl, Br, and I are higand the use of non-halogen solvents as components is thought to reduce the harm caused by the human body.
In this study, the difference between halogen and non-halogen solvents in the active layer was explored, and then active layers were made using non-fullerene and non-halogen solvents to prepare high-efficiency solar cells.

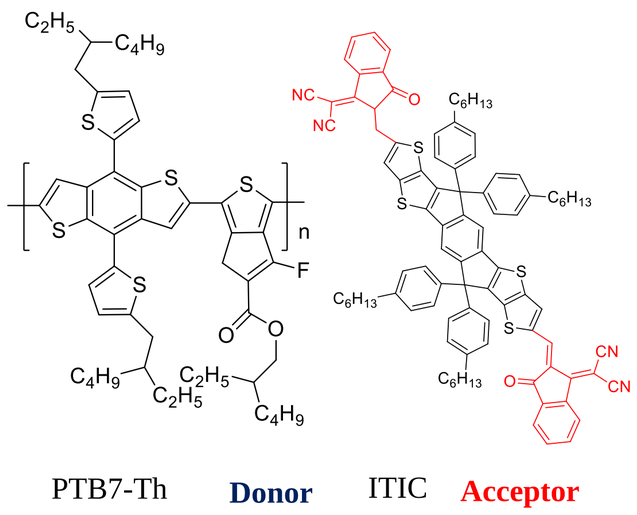
Experiment

Etching ITO → **Spin-coating** → **Deposition**

Component Analysis: UV、PL、AFM、PCE

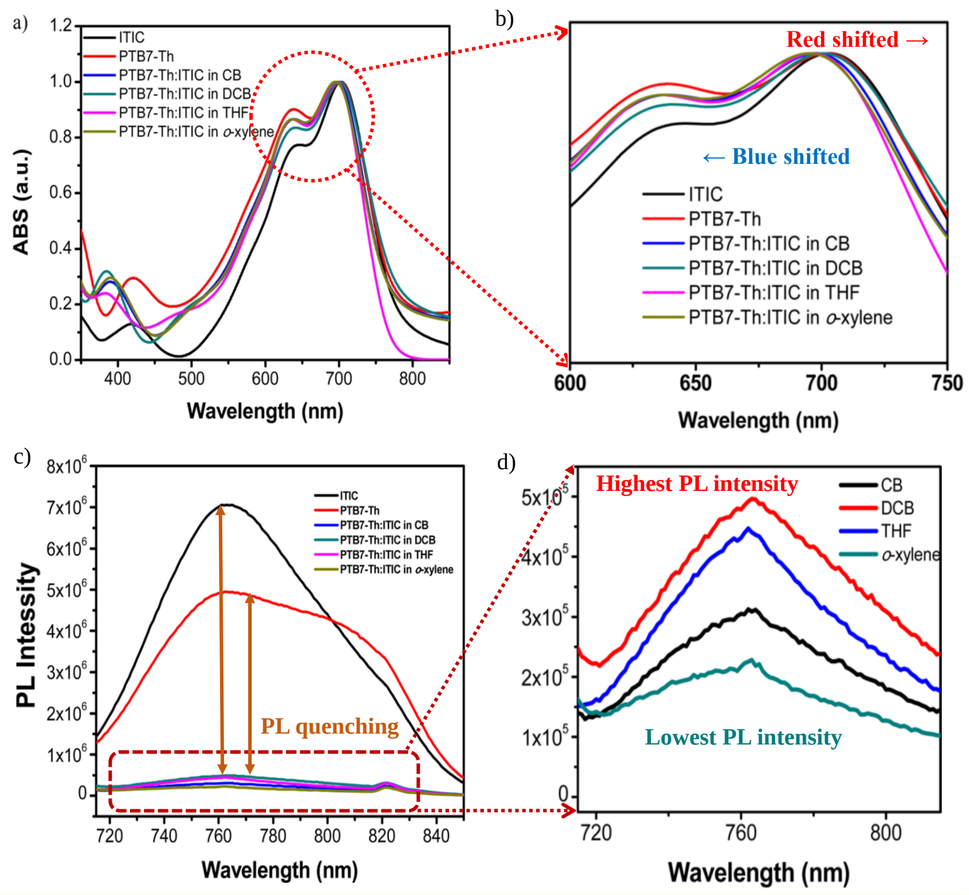


▲ Interted device structure

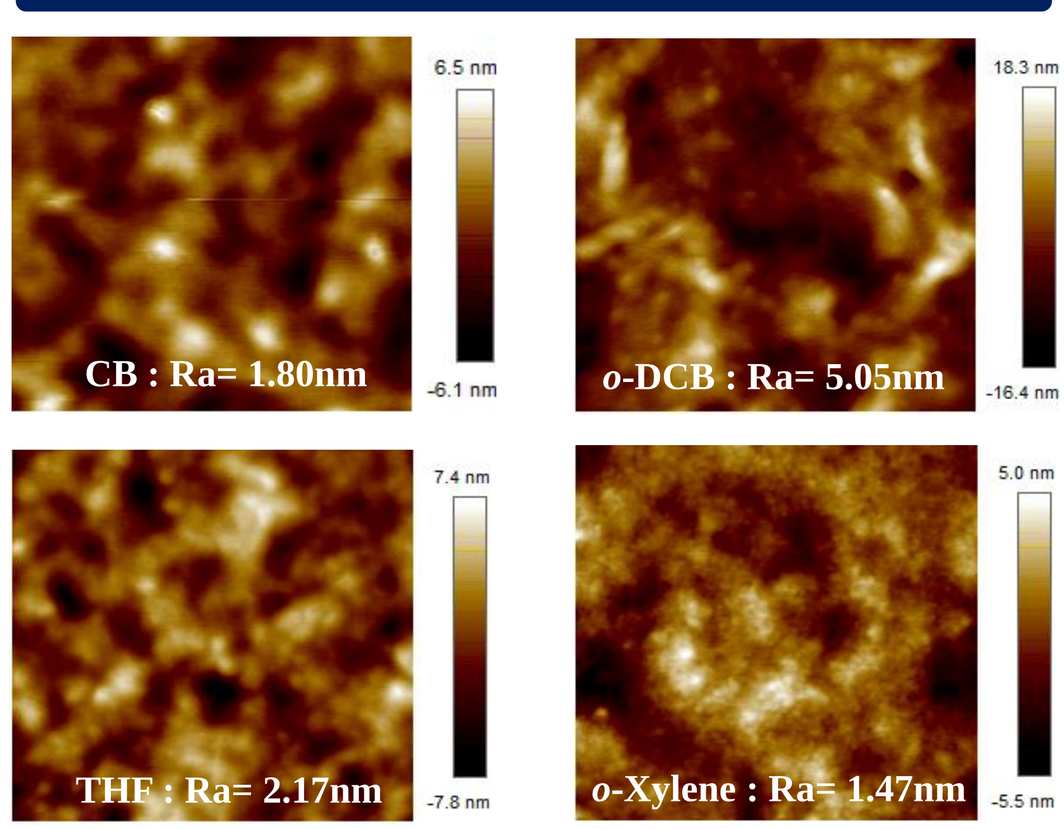


- **Materials**
  - Active Layer
- **Solvents**
  - Halogen Non-Fullerene
    - Chlorobenzene (CB)
    - 1,2-Dichlorobenzene (*o*-DCB)
  - Non-Halogen Non-Fullerene
    - Tetrahydrofuran (THF)
    - 1,2-Dimethylbenzene (*o*-Xylene)

UV−vis and PL spectra of blend films deposited from various solvents



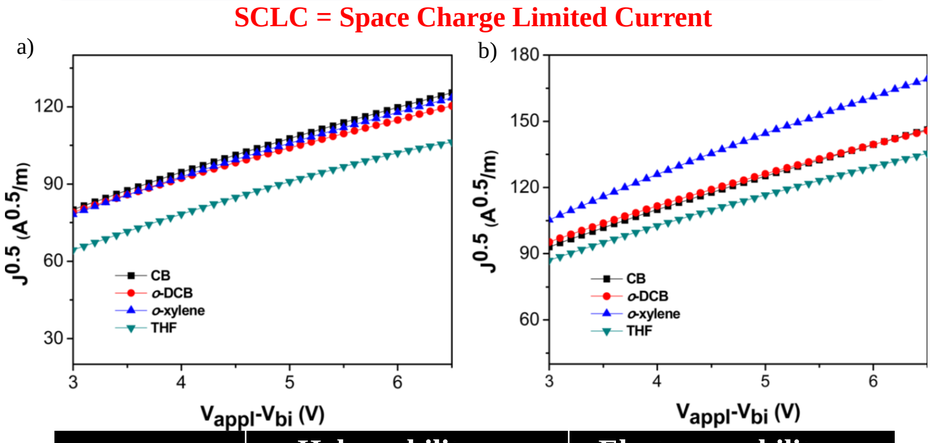
Tapping-mode AFM images of blend films with various solvents



Ra = average surface roughness

The SCLC electron mobility (μ_e) and hole mobility (μ_h)

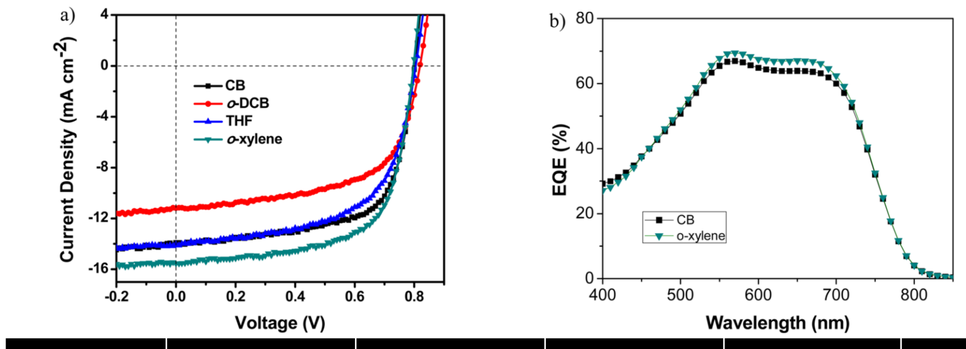
SCLC = Space Charge Limited Current



	Hole mobility, μ_h ($cm^2\ V^{-1}\ s^{-1}$)	Electron mobility, μ_e ($cm^2\ V^{-1}\ s^{-1}$)
CB	8.1×10^{-5}	1.1×10^{-4}
o-DCB	5.9×10^{-5}	8.8×10^{-5}
o-Xylene	9.0×10^{-5}	1.7×10^{-4}
THF	5.1×10^{-5}	7.1×10^{-5}

a) $J^{0.5}$–V plots for hole-only
b) $J^{0.5}$–V plots for electron-only devices derived from different solvents.

Photovoltaic performance of the polymer solar cells based on PTB7-Th:ITIC blends films with different solvents



	J_{SC} (mA/cm^2)	V_{oc} (V)	FF	$PCE_{avg.}$ (%)	PCE_{best} (%)
CB	13.88 ± 0.14	0.80 ± 0.01	0.66 ± 0.01	7.30 ± 0.14	7.41
o-DCB	11.31 ± 0.27	0.83 ± 0.01	0.60 ± 0.00	5.65 ± 0.10	5.78
o-Xylene	14.97 ± 0.45	0.795 ± 0.01	0.65 ± 0.02	7.76 ± 0.21	8.11
THF	14.14 ± 0.17	0.81 ± 0.00	0.59 ± 0.01	6.64 ± 0.15	6.79

a) J-V cures of the polymer solar cells under the illumination of AM1.5G (1000 W/m^2)
b) EQE spectra of organic photovolaic devices

Conclusion

- The highest power conversion efficiency 8.1% was obtained for the *o*-Xylene-derived device without any post treatment or additives.
- Because of the high solubility of ITIC in the solvents *o*-Xylene and THF, the PCE of the THF-based device exceeded 6.7%.
- This value is among the highest values reported to date for OPVs by using non-halogenated solvents.

Acknowledgement

Thanks Professor Yang-Yen, Yu and laboratory chiefs for their guidance and help.