材料工程系專題製作成果報告

105學年

題　　目： The study of perovskite solar cell performance by employing a solution processed electron transporting layer

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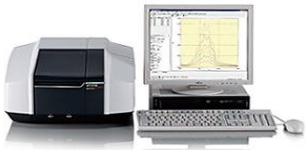
Introduction

In the study of perovskite solar cell performance by employing a solution processed electron transporting layer. We use a thin film of ZnO nanoparticles as an electron-transport layer in $CH_3NH_3PbI_3$-based solar cells; in contrast to mesoporous TiO_2, the ZnO layer is both substantially thinner and requires no sintering. ZnO is known to have an electron mobility that is substantially higher than that of TiO_2, which makes it an ideal choice for an electron-selective contact. Solar cells based on this design exhibit power-conversion efficiencies as high as 9.5% when measured under AM1.5G illumination.

Apparatus

TEM

FE-SEM

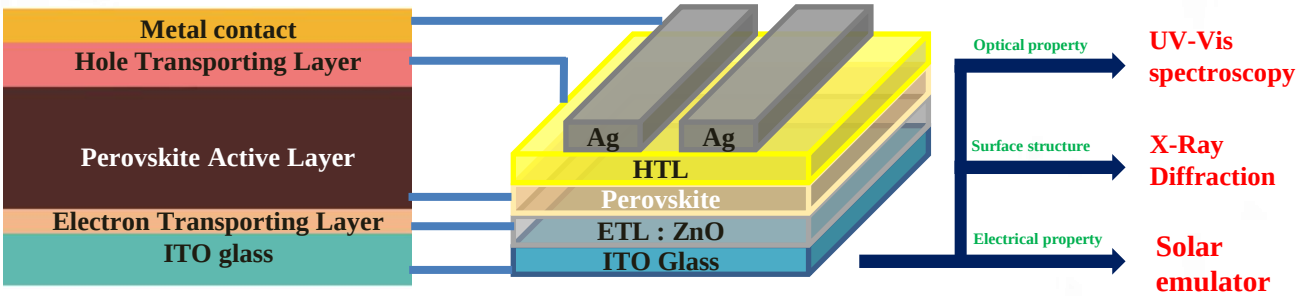


UV-Vis spectroscopy

Solar emulator

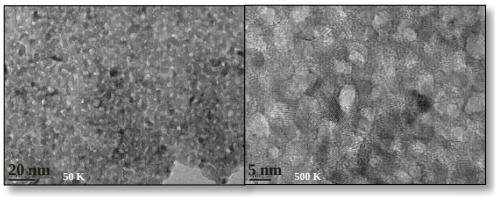
XRD

Experimental process



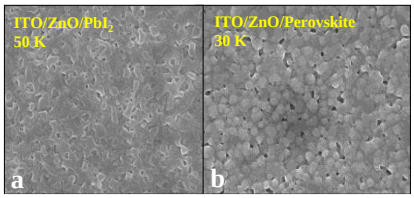
Result and Discussion

TEM



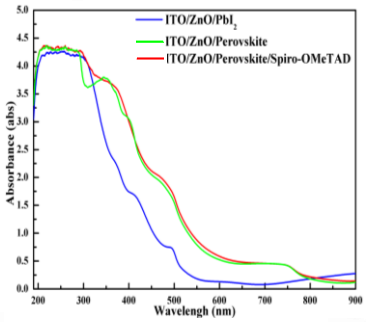
▲ Nanoparticle analysis of ZnO solution

FE-SEM



▲ a. Film surface of ITO/ZnO/PbI_2
b. Film surface of ITO/ZnO/Perovskite

UV-Vis spectroscopy



▲ Absorbance spectra of devices

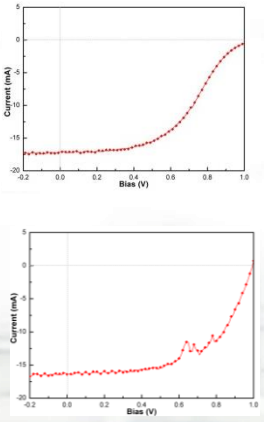
Solar emulator

1. Thickness — Heating at 90°C for 10min

Spin coating (rpm)	J_{sc} (mA/cm²)	V_{oc} (V)	FF	PCE (%)
3000	16.881	1.050	0.443	7.8
3500	**17.068**	**1.050**	**0.464**	**8.3**
4000	15.639	1.069	0.436	7.2
4500	15.393	1.039	0.437	7.0

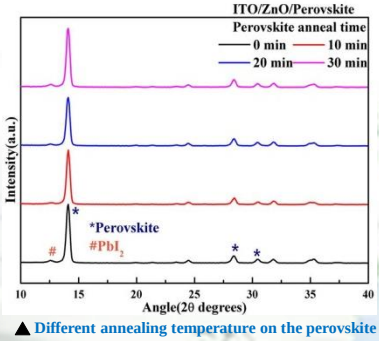
2. Crystallization — Heating at 90°C, Spin coating 3500 rpm

Annealing time (min)	J_{sc} (mA/cm²)	V_{oc} (V)	FF	PCE (%)
0	0.0083	0.760	0.164	0.001
10	**16.417**	**0.990**	**0.589**	**9.577**
20	15.492	1.040	0.450	7.244
30	16.278	0.930	0.423	6.404
60	13.169	1.020	0.416	5.587



▲ Efficiency of devices measured under AM1.5G illumination

X-Ray Diffraction



▲ Different annealing temperature on the perovskite

Conclusion

- As we can see in the thickness test, the best spin coating is 3500rpm, has the best efficiency of 8.3%.
- And we also know that in the crystallization test, the best parameter is heating at 90°C for 10 minutes, has the best efficiency of 9.5%.
- Solar cells based on this design exhibit power-conversion efficiencies as high as 9.5% when measured under AM1.5G illumination.

Acknowledgement

- First, I would like to express my special thanks of gratitude to my professors, Yu, Yang-Yen and Chen, Chi-Ping, who gave me the golden opportunity to do this wonderful project on the topic of Perovskite Solar Cells, which also helped me doing a lot of research and I came to know about so many new things.
- Secondly, I would also like to thank my seniors and my friends who helped me a lot in finishing this project within the limited time.