Research Center for Photovoltaics

Efficiency and Stability of Perovskite Solar Cells

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Introduction

The demand for new material in order to increase the power conversion efficiency and to reduce the cost has triggered our interest to study the $CH_3NH_3PbI_3$ organolead halide Perovskite-based solar cells.

1) Relatively high power conversion efficiency (PCE) is expected:
PV cell based on CH3NH3PbI3 exhibits relatively high efficiency PCE~22% and 24% are expected due to their unique properties high Voc ~1.1V (vs Eg=1.5eV), Jsc~22mA/ cm^2 high carrier mobility ~10 cm^2 V^{-1} s^{-1} , diffusion length ~100nm, long lifetime of both e and h.

2) Relatively low production cost is expected:
Low-cost and low-temperature processing technologies such as printing are possible, but the long term stability of the PV and the toxicity of the materials are crucial issues.

Experimental

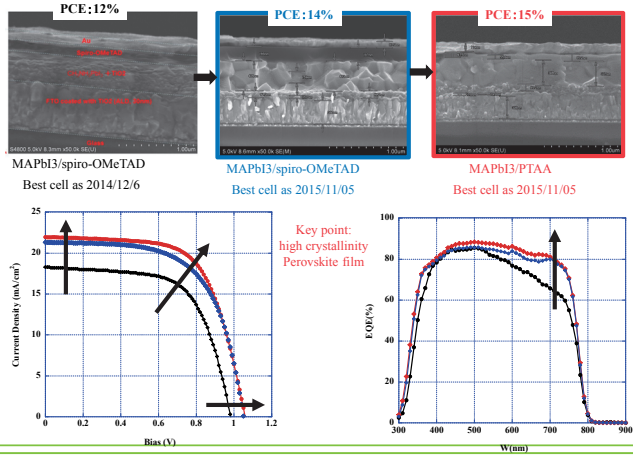
In this study:

We have developed a technique to control the crystallinity and the uniformity of the films of $CH_3NH_3PbI_3$ Perovskite, by selecting different combination of solvent and an-solvent. The power conversion efficiency was improved from 12 to 15% at 1 sun.

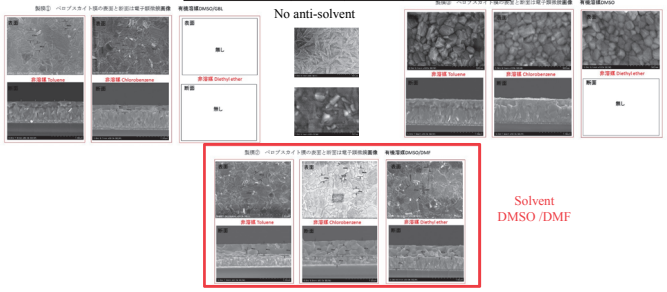
We address the stability of the solar cell (encapsulated in Ar atmosphere but not hermitically sealed) under continuous illumination (1 sun) or under light/dark cycles (illuminated at 1 sun, but store in dark/room light in Glove Box) at constant temperature and relative humidity.

Materials are characterized by x-ray diffraction techniques, and the solar cells are characterized by recording I-V curves and EQE.

Efficiency



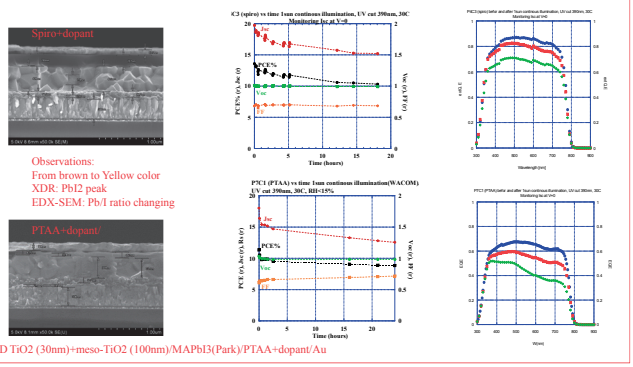
Anti-solvent \ Solvent	DMSO /GBL	DMSO /DMF	DMSO Too slow	DMF Too fast
Toluene	○	△	○	○
Chlorobenzene	○	△	○	○
Diethyl Ether	△	○	△	?
No anti-solvent	X	X	X	X



Stability

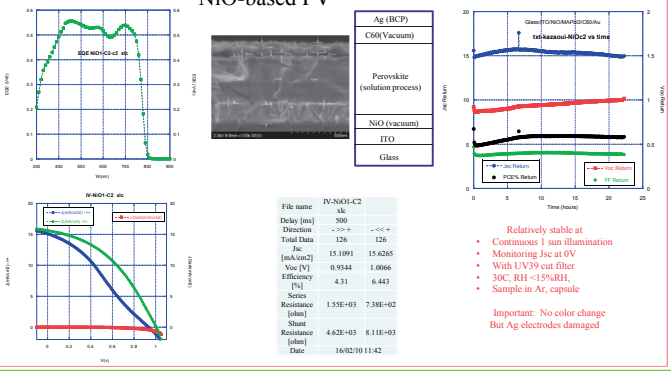
Glass/FTO/ALD TiO2 (30nm)+meso-TiO2 (100nm)/MAPbI3(Park)/Spiro+dopant/Au

TiO_2-based PV



Glass/FTO/ALD TiO2 (30nm)+meso-TiO2 (100nm)/MAPbI3(Park)/PTAA+dopant/Au

NiO-based PV

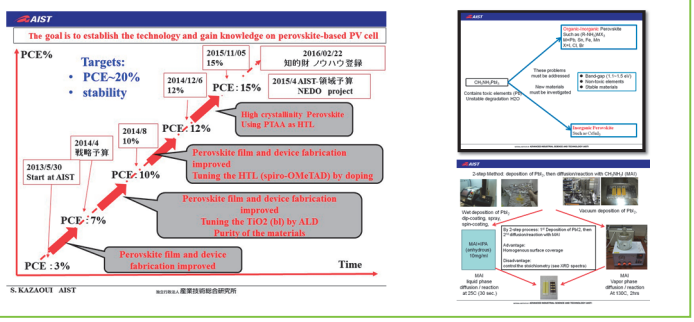


File name	IV-NiO1-C2 ak
Delay [ms]	500
Direction	-->> +
Total Data	126
Jsc [mA/cm2]	15.1091
Voc [V]	0.9344
Efficiency [%]	4.31
Series Resistance [ohm]	1.55E+03
Shunt Resistance [ohm]	4.62E+03
Date	16/02/10 11:42

Relatively stable at
- Continuous 1 sun illumination
- Monitoring Jsc at 0V
- With UV39 cut filter
- 30C, RH <15%RH,
- Sample in Ar, capsule

Important: No color change
But Ag electrodes damaged

Conclusions / perspectives



References / Acknowledgements

(1) "Efficient Hybrid Solar Cells Based on Meso-Superstructured Organometal Halide Perovskites", M. Lee, J. Teuscher, T. Miyasaka, T. N. Murakami, H. Snaith、Science、vol 338、pp 643 (2 Nov. 2012).
(2) " Solvent engineering for high-performance inorganic–organic hybrid perovskite solar cells", Nam Joong Jeon, Jun Hong Noh, Young Chan Kim, Woon Seok Yang, Seungchan Ryu, Sang Il Seok, Nature Materials 13, 897–903 (2014)

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