



Efficient, High Yield Perovskite Photovoltaic Devices Grown by Interdiffusion of Solution-Processed Precursor Stacking Layers.

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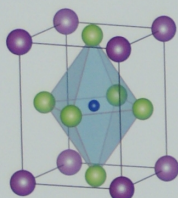
BACKGROUND

Organometal trihalide perovskites

- Material formula: $\text{CH}_3\text{NH}_3\text{PbX}_3$ (X: halide)
- High carrier mobility: the order of $\sim 10 \text{ cm}^2/\text{Vs}$
- Balance electron and hole transportation
- Low electron-hole pair binding energy: $\sim 50 \text{ meV}$
- High absorption up to infrared 800 nm

Perovskite photovoltaic devices

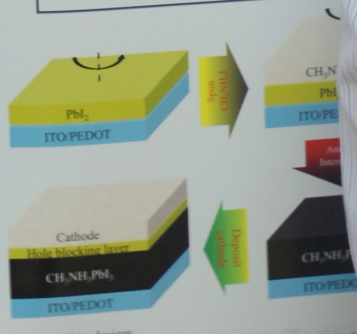
- Power conversion efficiency up to 15% using planar structure or mesoporous structure.
- Vacuum deposition (high expense)
- Solution process (the film is not continuous with many pin-holes)



Perovskite structure

PURPOSE AND HYPOTHESIS

Low temperature solution processes are particularly attractive in the fabrication of large area devices such as solar cells to reduce cost. However, it is challenging to form pinhole-free perovskite thin films by solution process. Here we show that continuous perovskite films were formed by the interdiffusion of the solution-deposited PbI_2 and $\text{CH}_3\text{NH}_3\text{I}$ stacking precursor layers. The pinhole-free perovskite film have negligible leakage-current and large shunt resistance, resulting in large fill factors close to 80%. A high efficiency of 15.4% under 1 sun, and 17.1% under 0.03 sun illumination, was achieved on devices with perovskite/fullerene double layer architectures fabricated at temperature below 105 °C. 85% of the optimized devices efficiency above 14%.



Perovskite devices



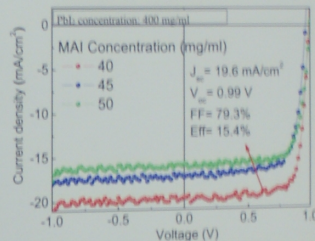
Acknowledgement

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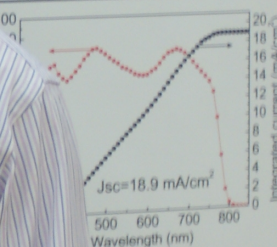
MATERIALS

Perovskite film fabrication

1. Prepare the PbI_2 and $\text{CH}_3\text{NH}_3\text{I}$ solution. $\text{CH}_3\text{NH}_3\text{I}$ was dissolved in 2-propanol and PbI_2 was dissolved in 2-propanol and baked at 130 °C for 30 min.
 2. Spin a very thin hole transport layer on ITO/PEDOT substrate.
 3. Spin PbI_2 on top of PEDOT layer.
 4. Annealing the $\text{PbI}_2/\text{CH}_3\text{NH}_3\text{I}$ stack at 105 °C for 10 min to fully reacted and increase the crystallinity.
- ### Perovskite device fabrication and testing
1. Spin coating a thin layer of PCBM on the perovskite film.
 2. The device was finished by vacuum deposition of Ag (cathode) and hole transport layer (anode).
 3. The photo generated electrons are transported from the PEDOT:PSS layer.



- This figure shows how the perovskite film was optimized to increase the power conversion efficiency.
- Highest efficiency of 15.4% was achieved.



external quantum efficiency of the device. (charge carriers to incident photons)

Wavelength (nm)	Jsc (mA/cm²)	EQE (%)	FF (%)	Eff (%)
300	0.10	0.10	0.10	0.10
400	0.10	0.10	0.10	0.10
500	0.10	0.10	0.10	0.10
600	0.10	0.10	0.10	0.10
700	0.10	0.10	0.10	0.10
800	0.10	0.10	0.10	0.10

near conversion efficiency under lower light intensity.

charge recombination.

be used to fabricate uniform perovskite films.

production techniques.

used to other perovskite materials.

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