

# Perovskite Solar Cells

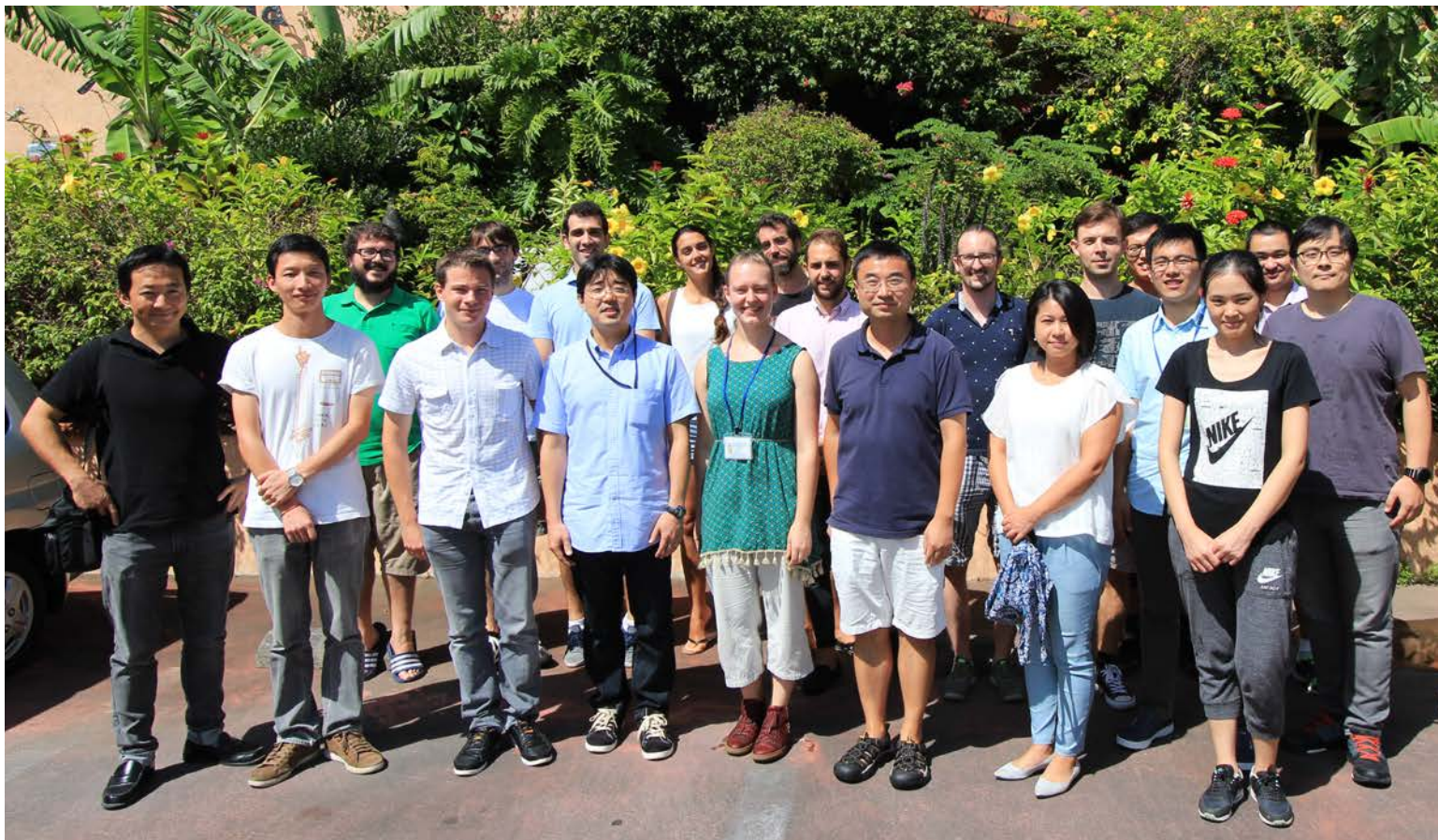
Yabing Qi

*Energy Materials and Surface Sciences Unit (EMSSU)*

Okinawa Institute of Science and Technology Graduate University (OIST)



# Acknowledgement



## Funding Support



科研費  
KAKENHI

## Coral Bleaching

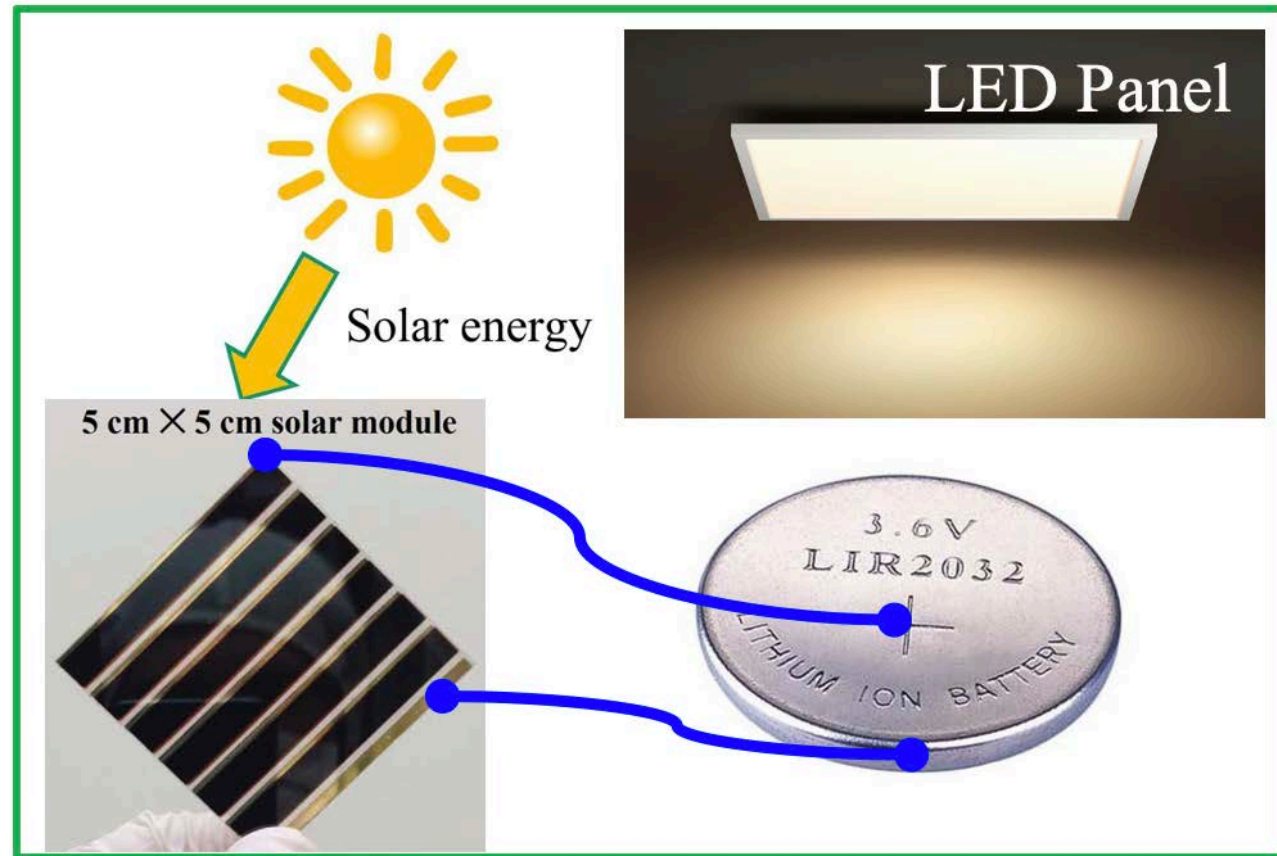


The Guardian: “...70% of the Sekisei lagoon in Okinawa had been killed by a phenomenon known as bleaching...”

“Coral bleaching occurs when unusually warm water causes coral to expel algae, turning it white.”

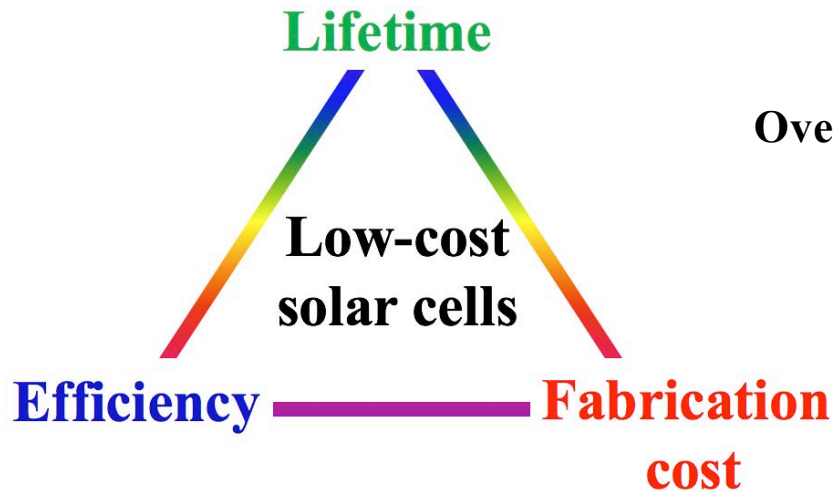
# A Clean Sustainable Future

**Novel Low-Cost High Efficiency**  
**(1) Solar Cells**  
**(2) Li-Ion Batteries**  
**(3) LED Lighting**



**Zero Net Energy Building**  
**(100% self-sustainability, zero CO<sub>2</sub> emission)**

# Advantages of Perovskite Solar Cells



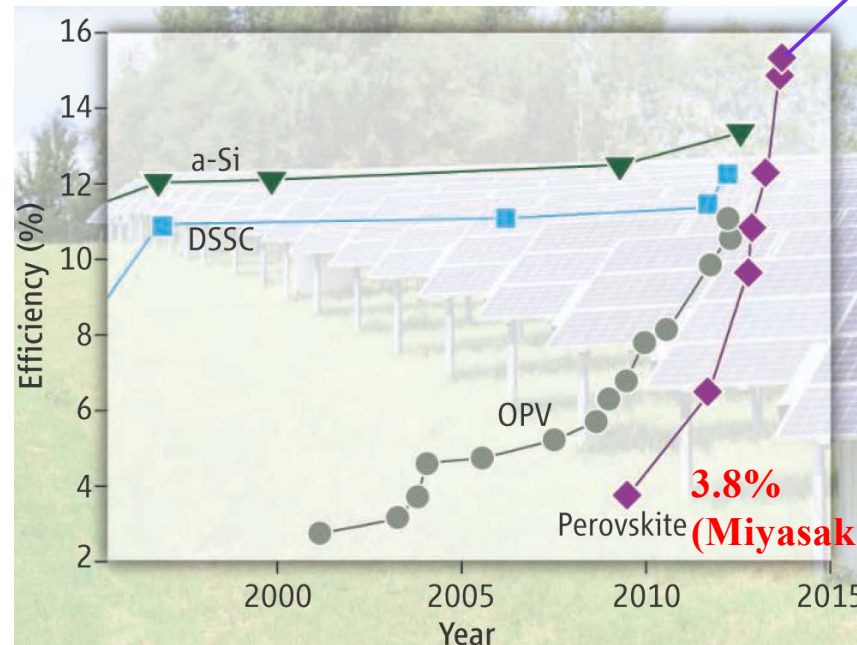
$$\text{Overall cost} = \text{fabrication cost} / (\text{efficiency} \times \text{lifetime})$$

- **Efficiency:** 25.5%  
(state of the art single-junction crystalline Si cells: ~26%)

- **Cost:** cheap raw materials + low cost processes.

- **Lifetime:** a key issue under intensive investigation.

Hodes, *Science* **342**, 317 (2013)



25.5% (NIST, Korea)

3.8% (Miyasaka\* *et al.*, JACS 2009)

# Determination of real-space atomic structures of perovskites

**J | A | C | S**  
JOURNAL OF THE AMERICAN CHEMICAL SOCIETY

*J. Am. Chem. Soc.* **137**, 16049 (2015)

Article

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## Real-Space Imaging of the Atomic Structure of Organic–Inorganic Perovskite

Robin Ohmann,<sup>†</sup> Luis K. Ono,<sup>†</sup> Hui-Seon Kim,<sup>‡</sup> Haiping Lin,<sup>§</sup> Michael V. Lee,<sup>†,⊥</sup> Youyong Li,<sup>\*,§</sup> Nam-Gyu Park,<sup>\*,‡</sup> and Yabing Qi<sup>\*,†</sup>

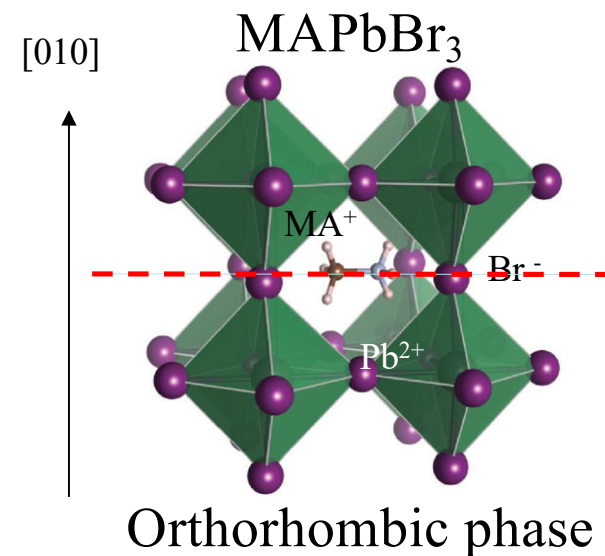
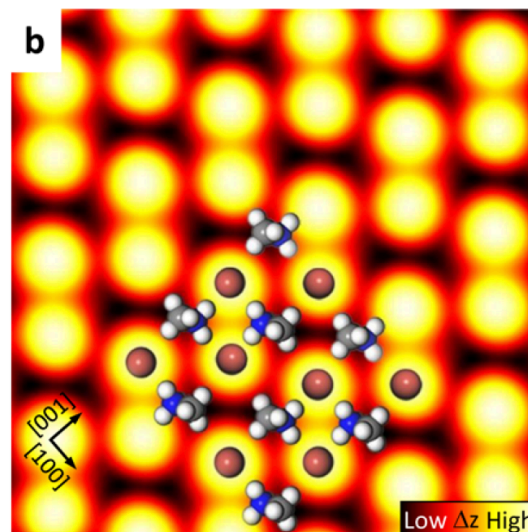
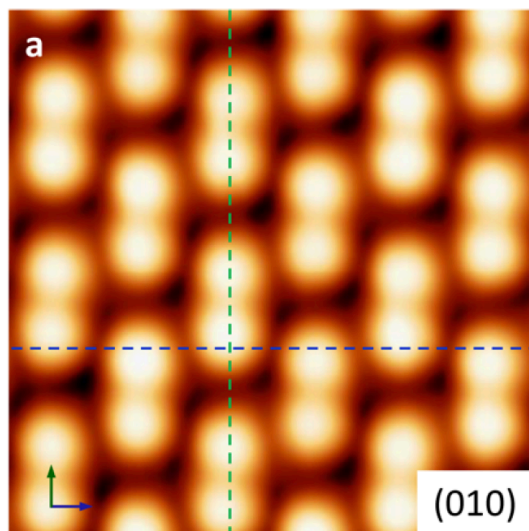
In collaboration with:

The group of **Prof. Nam-Gyu Park** (SKKU, South Korea)

The group of **Prof. Youyong Li** (Soochow University, China)

STM image

DFT simulation



Dr. Robin Ohmann



Dr. Luis Ono

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Dr. Robin Ohmann

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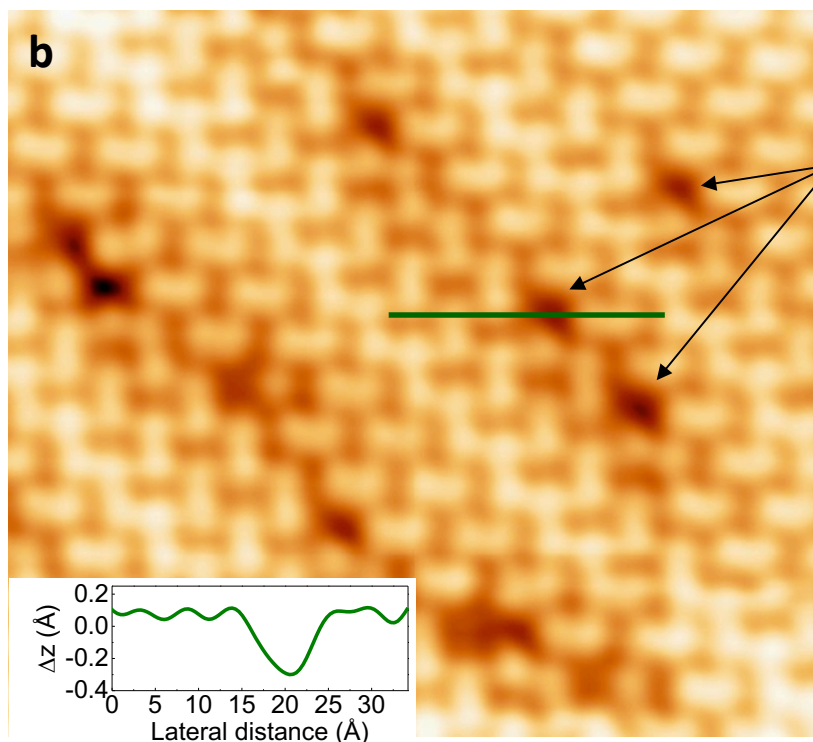
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Dr. Luis Ono



**Point defects**

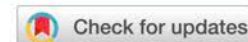
On average the density of point defects is below 1% (with respect to the number of Br surface ions).

# High efficiency stable perovskite solar modules

nature  
energy



ARTICLES

<https://doi.org/10.1038/s41560-020-0653-2>



In collaboration with **Dr. Said Kazaoui** (AIST, Japan).

## A holistic approach to interface stabilization for efficient perovskite solar modules with over 2,000-hour operational stability

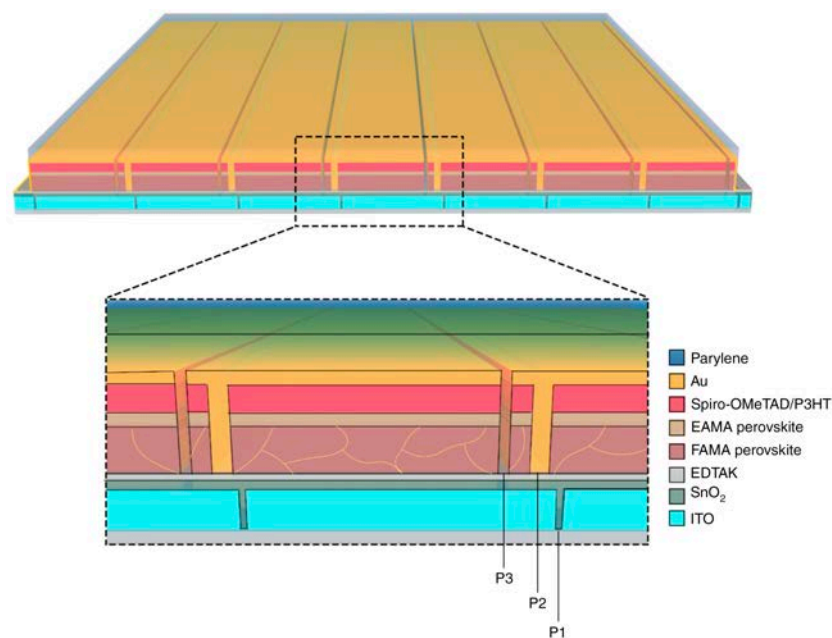
Zonghao Liu <sup>1,2,5</sup>, Longbin Qiu <sup>1,3,5</sup>, Luis K. Ono <sup>1</sup>, Sisi He <sup>1</sup>, Zhanhao Hu<sup>1</sup>, Maowei Jiang<sup>1</sup>, Guoqing Tong<sup>1</sup>, Zhifang Wu<sup>1</sup>, Yan Jiang <sup>1</sup>, Dae-Yong Son<sup>1</sup>, Yangyang Dang<sup>1</sup>, Said Kazaoui <sup>4</sup> and Yabing Qi <sup>1</sup>✉



Dr. Zonghao Liu

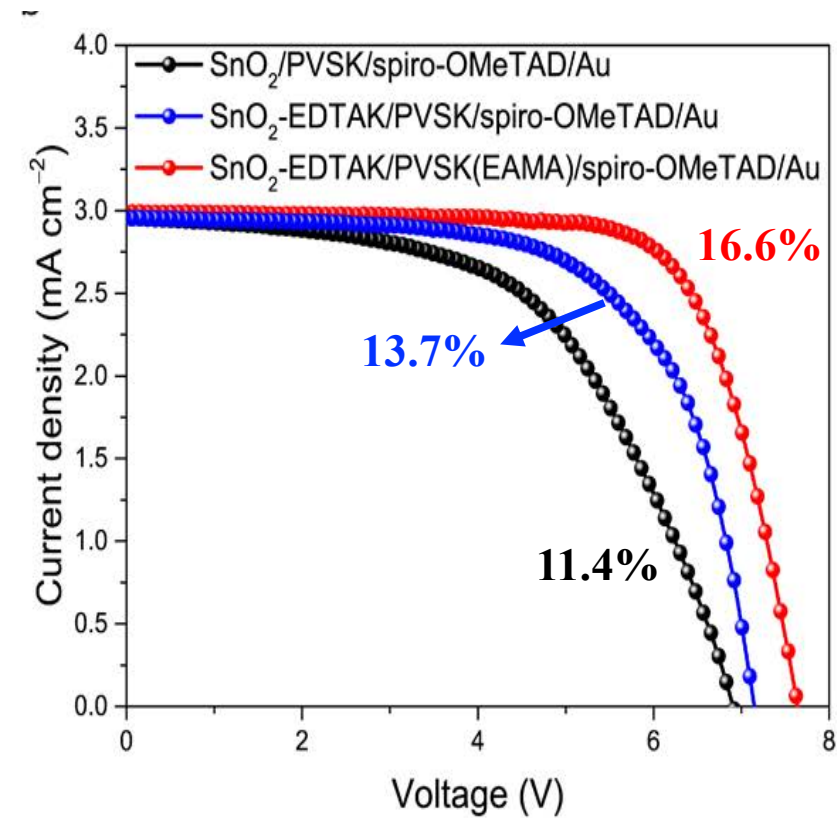
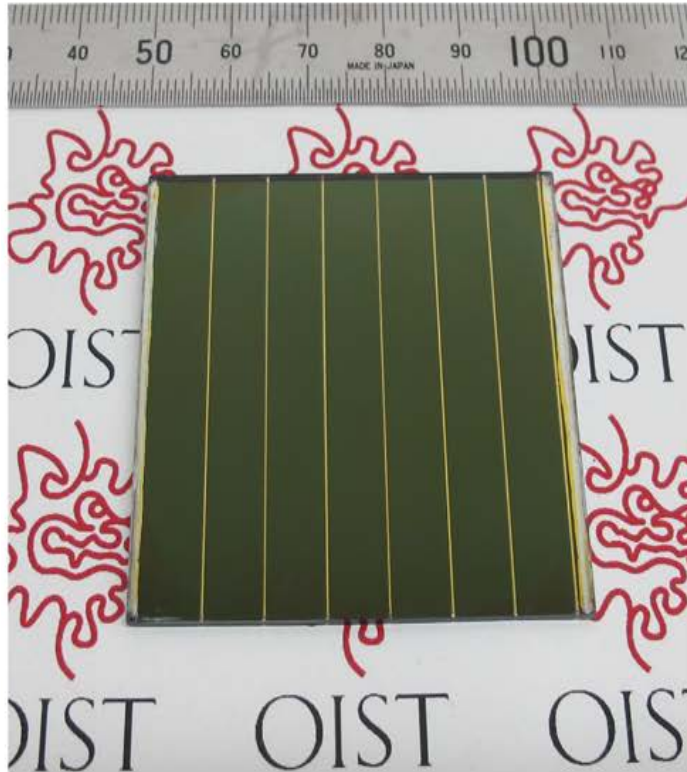


Dr. Longbin Qiu



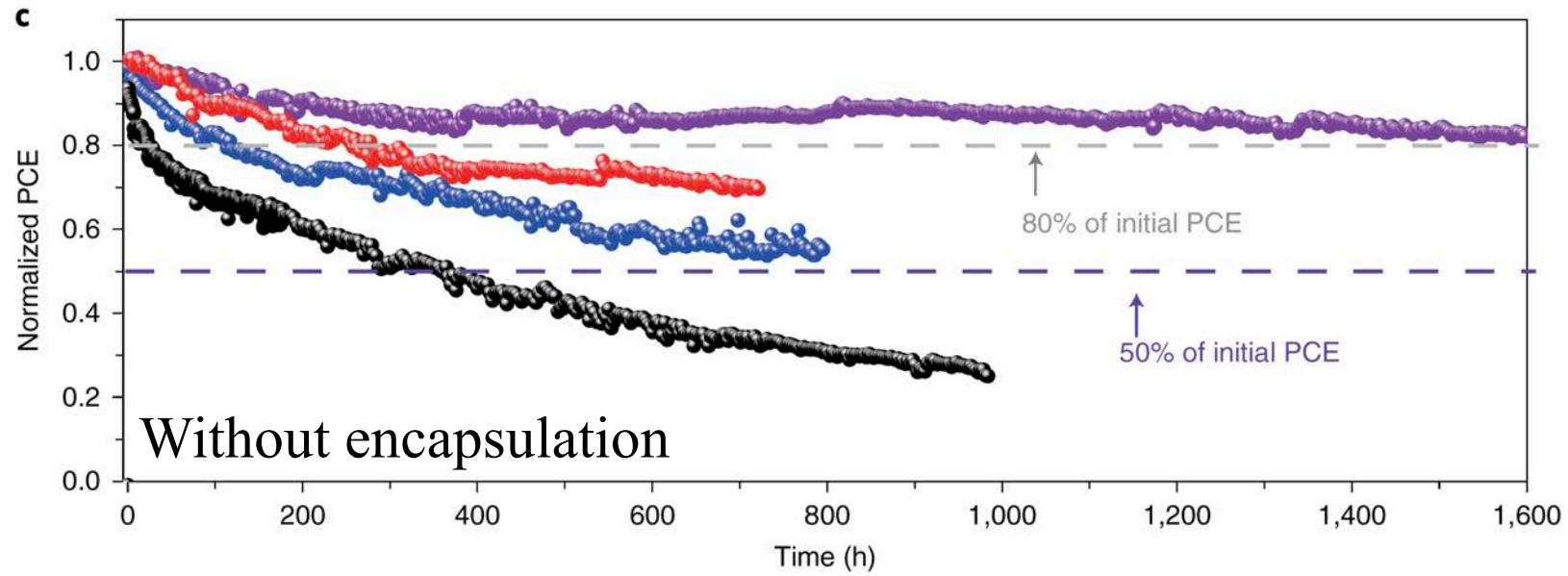


# High efficiency stable perovskite solar modules

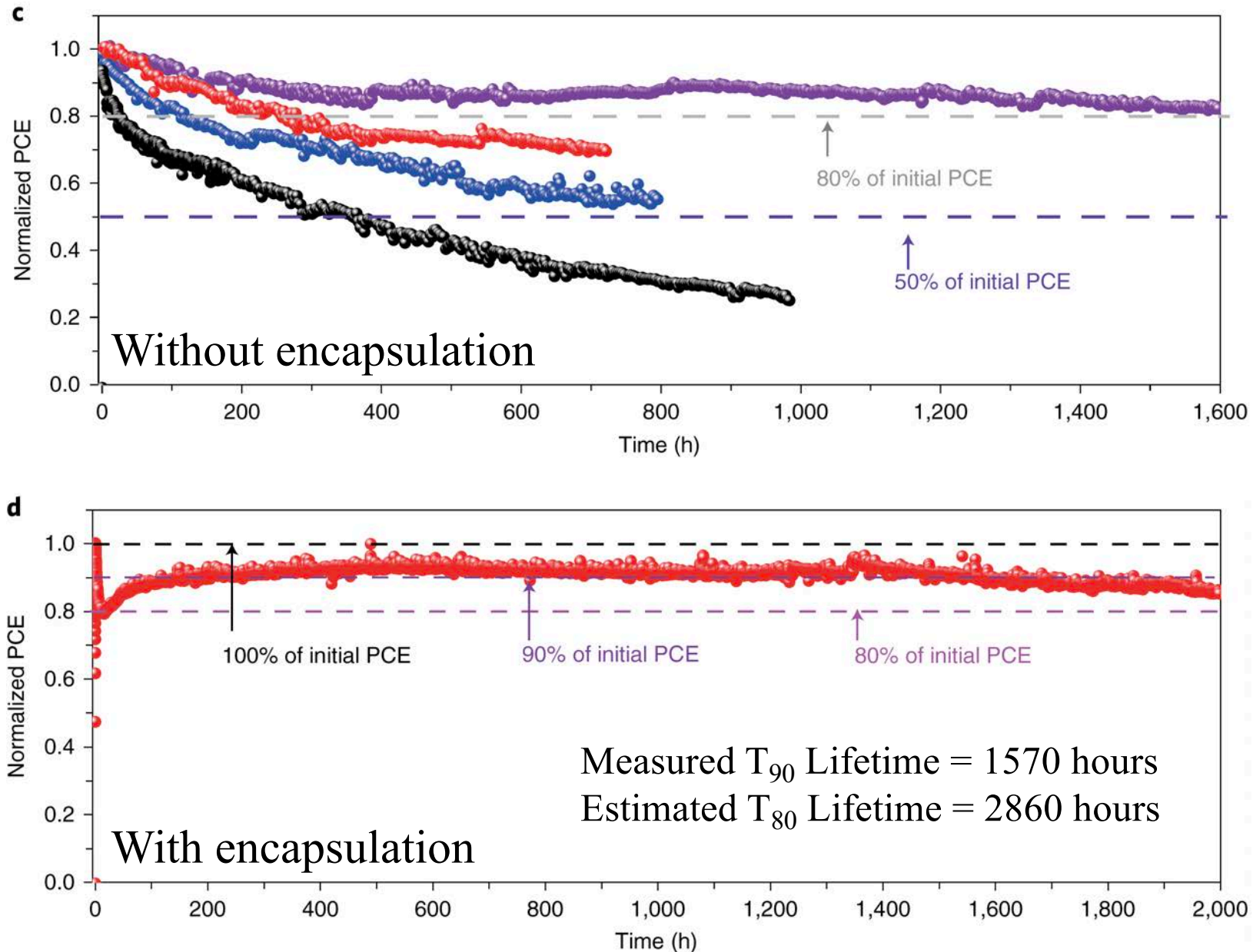


22.4 cm<sup>2</sup> - solar module:  
Efficiency = 16.6%

# High efficiency stable perovskite solar modules



# High efficiency stable perovskite solar modules



Thank you!