Sustainable Energy Solutions for IoT: Low-Temperature, Low-Cost Thin-Film Organic Solar Cells

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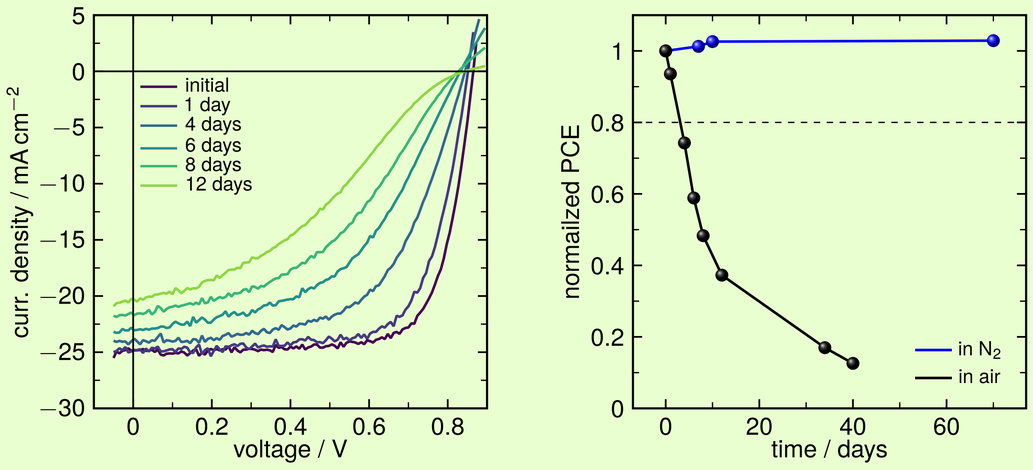
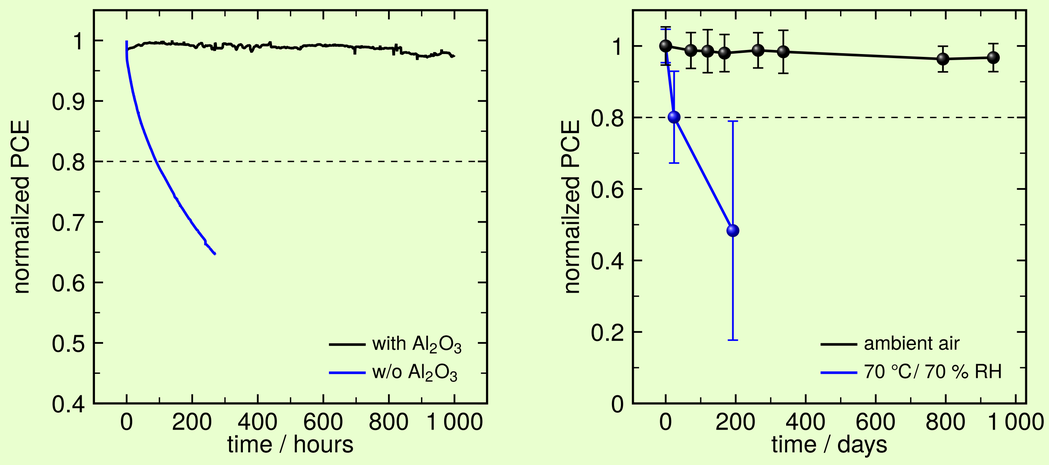
Enabling Air Stability

Without additional protection the organic solar cell degrades in air within 100 hours:

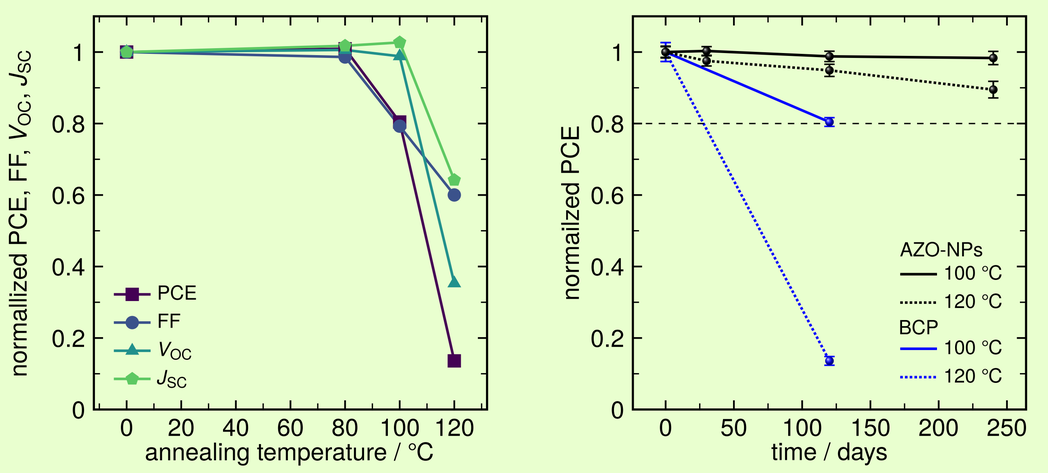


atomic layer deposition (ALD) grown metal oxide **gas barrier**

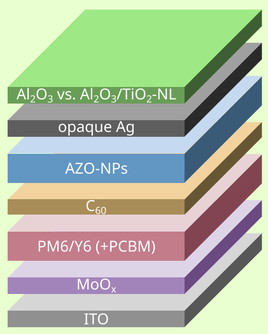
→ protect organic cell from moisture and oxygen

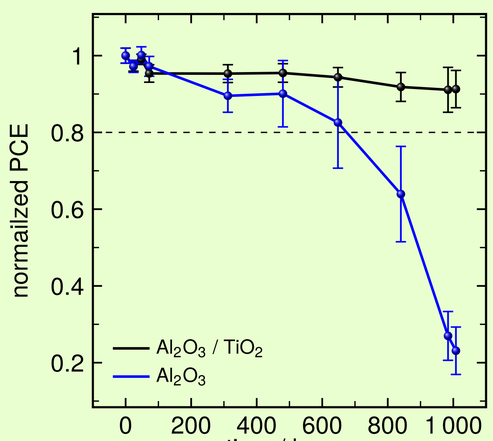


for damp heat (70 °C, 70 % RH) even better barrier needed → higher ALD deposition temperature



Replaced instable BCP with more temperature robust AZO-NP layer:





Motivation

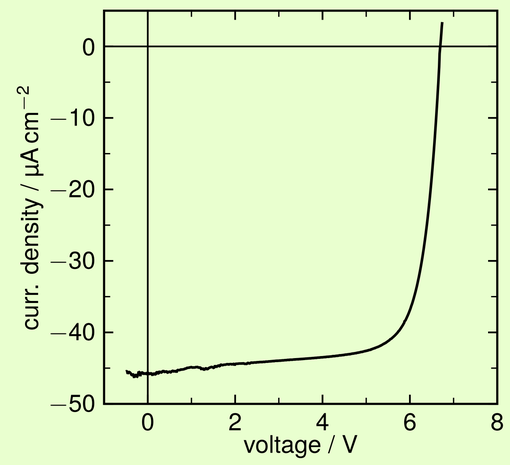
- independant USB-power
- self powering IoT devices
- non-toxic materials
- indoor usable, high efficiency
- high stability, low cost
- robust production process

Design of Organic Solar Cell Mini-Module

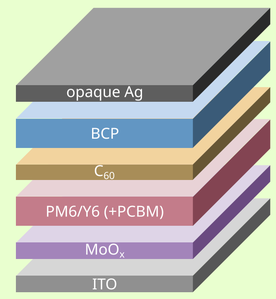
- high output voltage → series connection
- 10 cells connected to a mini-module
- 4 cm^2 mini-module with patterned ITO and silver electrode

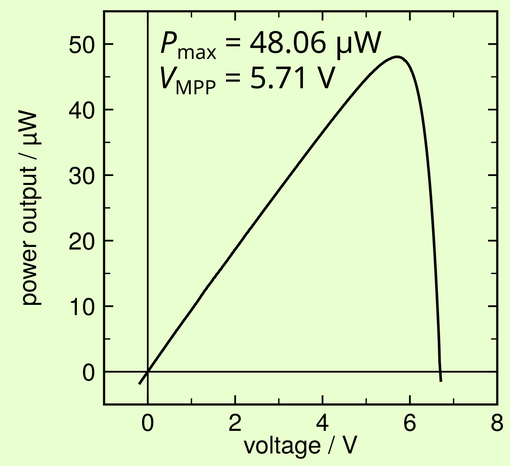
ITO electrode structuring | silver electrode structuring | explosion view | PCB for connection

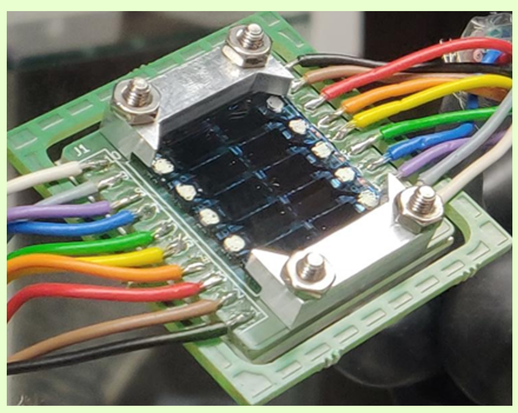
J-V characteristics under 400 lux LED indoor illumination



PCE / %	FF / %	V_{OC} / V	J_{SC} / mA/cm²
19.1	75	6.7	46







Conclusion

- lead-free oragnic solar cell
- energy efficiency > 10 %
- output voltage > 4 V
- power density > 6 µW / cm2

- organic solar mini-module with life time t_{90} **> 1000 h at damp heat conditions**
- enabled by external ALD grown oxide barrier

TEC2ZERO
1st symposium
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