SOLARIUM-L

- Multi-functional imaging including high-precision PL/EL intensity, emission spectroscopy, time-resolved PL, PLQE, QFLS, and quasi-J-V.
- High-resolution photocurrent/photovoltage imaging.
- Optional laser/sample scanning.
- Compatibility with high-voltage and low-temperature modules.
- Integrated control software for both data acquisition and analysis.
- Compatible Samples:Silicon/perovskite/silicon-perovskite tandem solar cells and thin-film.



Specifications

Detection Function

Single-junction Solar Cell	True J-V, Suns-PL (Pseudo-J-V), V_{OC}, J_{SC}, MPP, PL/TRPL PL intensity/lifetime, iV_{OC}, PCE, FF, R_S, PLQE, QFLS, Photovoltage/photocurrent imaging
Tandem Solar Cell	True J-V characteristics of tandem solar cells, Sub-cell Suns-PL, Pseudo-J-V, V_{OC}, J_{SC}, MPP, PL/TRPL, EL PL spectroscopy/intensity/lifetime imaging, iV_{OC}, PCE, FF, R_{SH}, PLQE, QFLS imaging

Light Source Configuration (1)

Wavelength	LED	450 nm, 532 nm, 850 nm, 900 nm (Standard configuration 450 and 850 nm)
	Picosecond laser	405 nm, 450 nm, 532 nm, 780 nm, 808 nm, 850 nm
Optical Dynamic Range	LED	0.01-1.5 suns

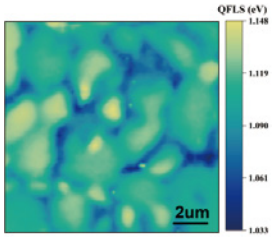
Other Parameters

Max single image size (wide-field)	≤ 2x2 cm^2	
Spectral Resolution	0.14 nm @ 300 mm focal length monochromator, @1200 grooves/mm grating, @25 μm CCD pixel size	
Spectrum Acquisition Time	5 ms (Min.)	
Tandem Solar Cell	Wide-Field Imaging	a. High-resolution mode: 1.5 μm/pixel, imaging area < 7 mm^2 b. Standard-resolution mode: 8 μm/pixel, imaging area < 80 mm^2 c. Used for PL/EL intensity, iVOC, PCE, FF, RS, RSH, etc. imaging
Spatial Resolution	CLSM imaging	a. Up to 260 nm spatial resolution (100× oil immersion) b. Objectives: 5×, 10×, 20×, 40×, 50×, 60×, 100× air/oil immersion c. Used for PL spectral imaging, PLQE, QFLS imaging
TCSPC Module	IRF	≤ 230 ps
	Spectral Range	400-1100 nm (APD)
	Laser Source	375, 405 nm Picosecond Laser

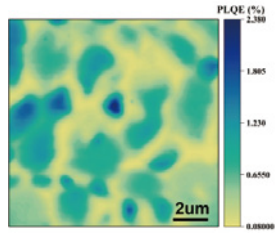
Note: 1. The size, wavelength, and power of the light source can be customized.
The LED area light source supports the integration of three types of light sources simultaneously.

Sample Data

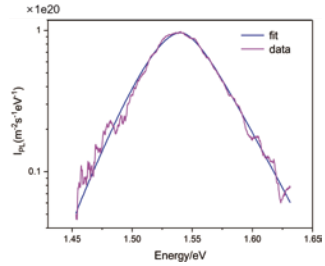
High-resolution QFLS and PLQE Mapping



Perovskite film QFLS mapping

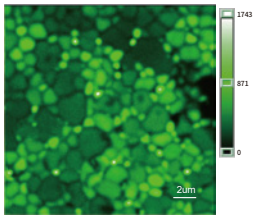


Perovskite film PLQY mapping

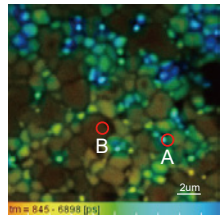


PL spectrum fitting

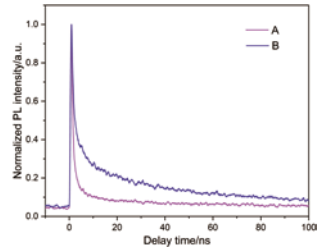
High-resolution fluorescence intensity/lifetime Mapping



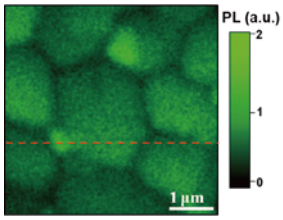
PL intensity mapping



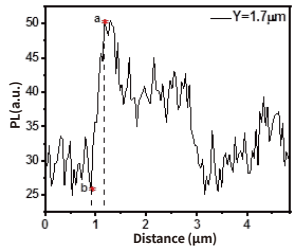
PL lifetime mapping



Comparison of decay curves at points A and B

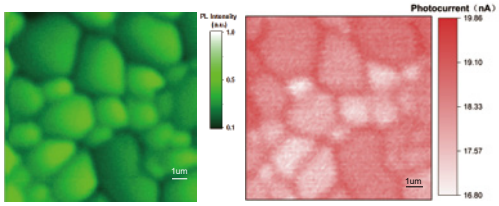


Fluorescence intensity Mapping with typical cross-sectional intensity profiles



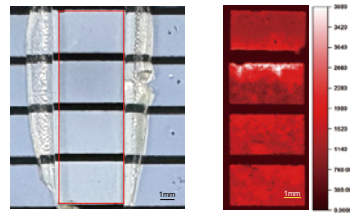
Spatial resolution up to 260 nm in fluorescence Mapping

Photocurrent Mapping



PL intensity mapping　　Photocurrent mapping

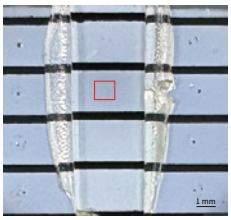
EL Intensity Mapping



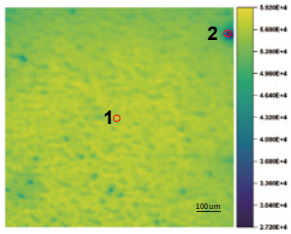
Bright-field　　EL intensity mapping

The bright field image shows the electrode surface, while the EL imaging is performed from the glass side.

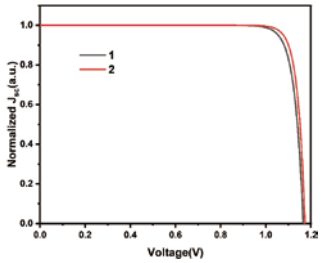
Pseudo-J-V Mapping under controlled excitation power density



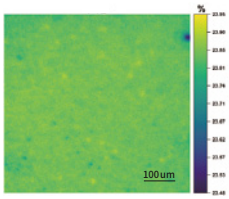
Bright-field imaging



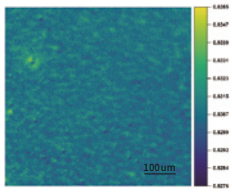
PL intensity mapping



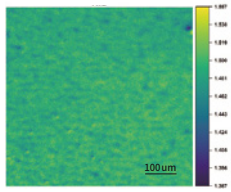
Comparison of pseudo J-V curves at different points



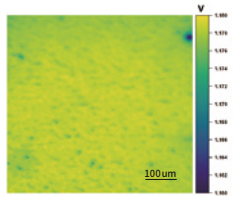
PCE



Filling Factor

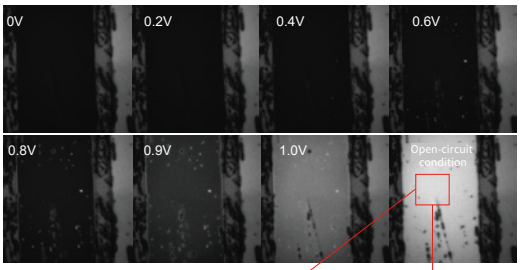


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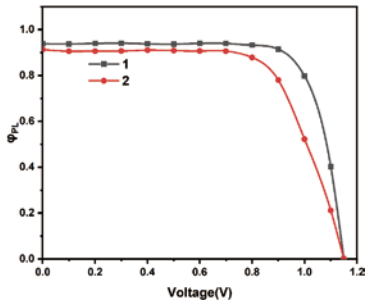


iV_{OC} mapping

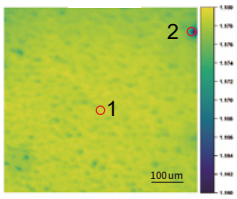
Pseudo-J-V imaging under controlled load conditions



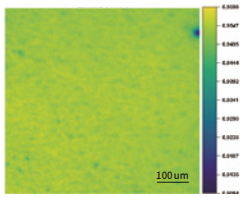
PL intensity mapping under different loads



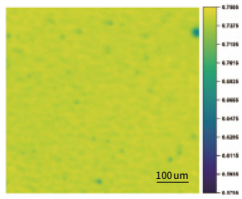
Comparison of pseudo J-V curves at different points



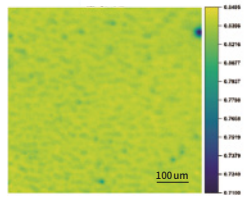
iV_{OC}



Charge collection efficiency



Filling Factor



Relative PCE

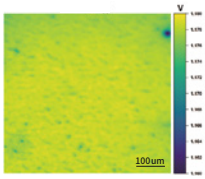
QFLS-Optical J-V imaging

Firstly, based on the generalized Planck's law, the PL intensity is converted to V_{int}(QFLS) $$QFLS_{int,xy} = vtln(\frac{PL_{xy}}{C})$$

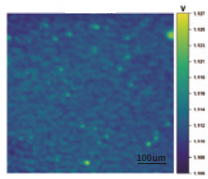
A certain voltage V_{out} is applied to the device(typically chosen near the maximum power point V_{mpp}), and it is assumed that the applied voltage is the same at different locations of the device. $(J_{in})xy$ is obtained through fitting using the pseudo J-V curve. $J_{G,xy}$。 is calculated based on the excitation light intensity. According to the simplified diode model:

$$J_{out,xy} = J_{G,xy} - J_{in,xy} \qquad R_{S,xy} = \frac{QFLS_{xy} - V_{out}}{J_{out,xy}}$$

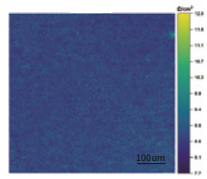
Consequently, the J-V curve and series resistance RS at each spatial point can be derived. Furthermore, the FF and PCE at each point can be obtained from the J-V curve.



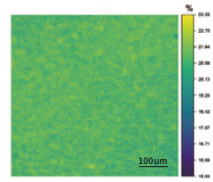
QFLS mapping



Maximum power point condition QFLS profiling



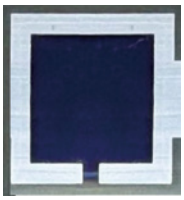
Series resistance mapping at maximum power point



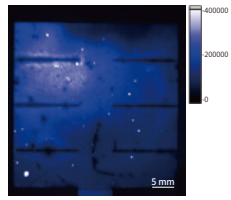
PCE imaging

PL intensity imaging of silicon/perovskite tandem solar cells

Multi-wavelength integrated light source enables independent PL intensity imaging of sub-cells.

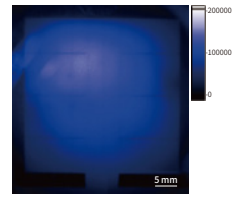


Bright-field image



Perovskite layer PL intensity mapping

Excitation wavelength	450 nm
Collection condition	630 nm long-pass

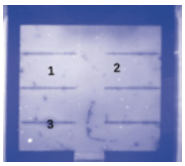


Si layer PL intensity mapping

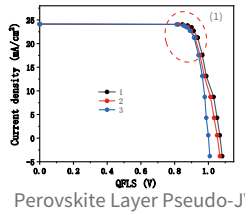
Excitation wavelength	825 nm
Collection condition	850 nm long-pass

Pseudo J-V testing of silicon/perovskite tandem solar cells

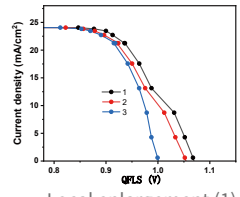
Enables independent pseudo J-V imaging of silicon and perovskite sub-cells.



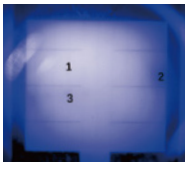
Perovskite Layer QFLS Imaging



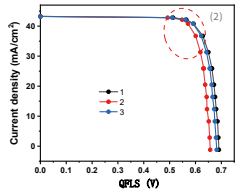
Perovskite Layer Pseudo-JV



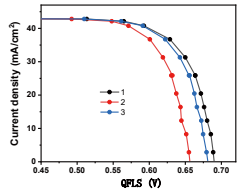
Local enlargement (1)



Si Layer QFLS Imaging



Si Layer Pseudo-JV



Local enlargement (2)