

## Electronic Supporting Information

**A new developed lithium cobalt oxide super hydrophilic film for large area,  
thermally stable and highly-efficient inverted perovskite solar cell**

Chien-Hung Chiang<sup>a,b</sup>, Cheng-Chiang Chen<sup>b</sup>, Mohammad Khaja Nazeeruddin<sup>c</sup>, Chun-Guey Wu<sup>a,b,\*</sup>

<sup>a</sup>*Department of Chemistry and* <sup>b</sup>*Research Center for New Generation Photovoltaics, National Central University, Zhong-Li, 32001, Taiwan, ROC.*

<sup>c</sup>Laboratory of Photonics and Interfaces, Swiss Federal Institute of Technology (EPFL), Station 6, Lausanne, CH 1015, Switzerland.

E-mail address of Professor C. G. Wu: [t610002@cc.ncu.edu.tw](mailto:t610002@cc.ncu.edu.tw)

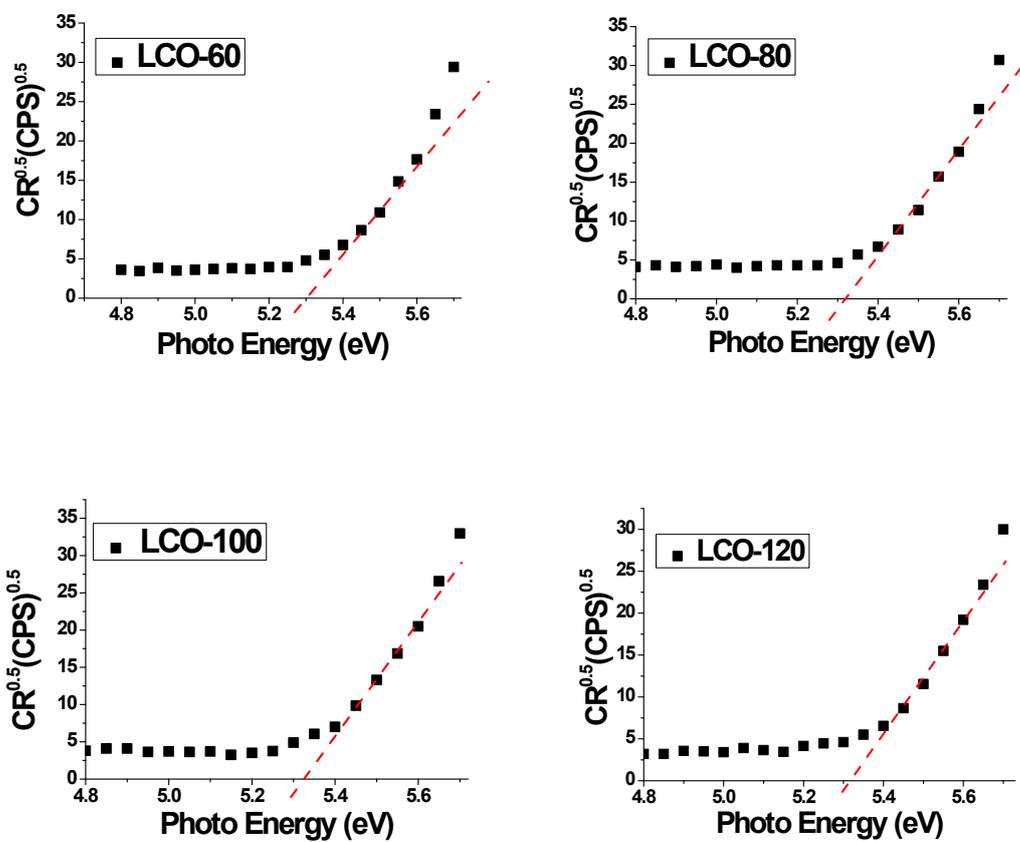


Figure S1: Photoelectron spectra of LiCoO<sub>2</sub> films prepared at various applied power.

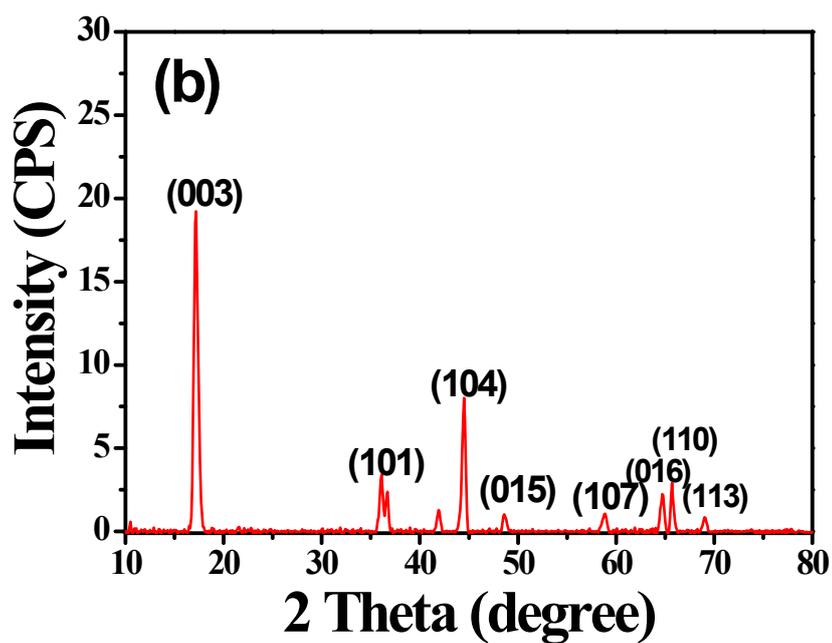
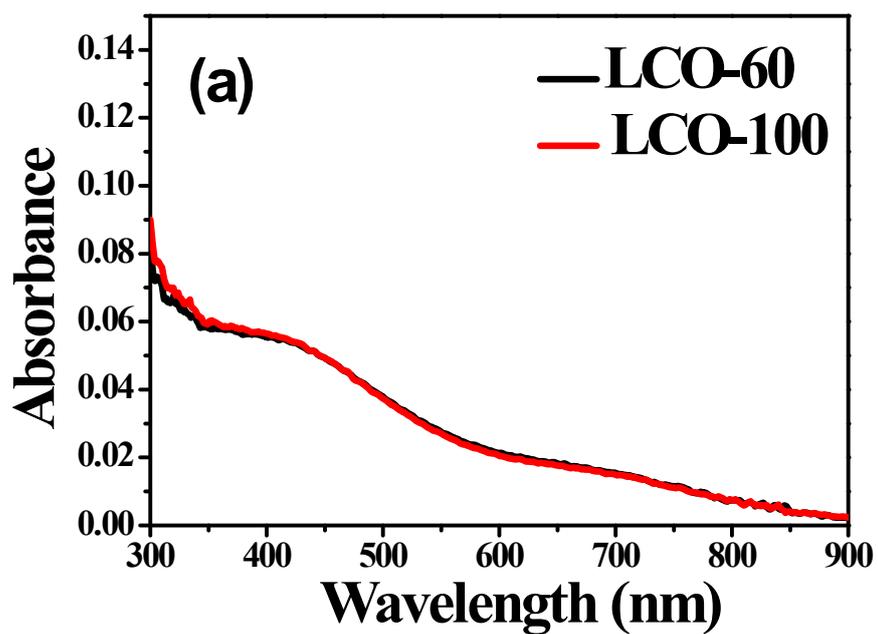


Figure S2: Representative (a) absorption spectra of LCO-60 and LCO-100 films. (b) XRD pattern of the sputtering made  $\text{LiCoO}_2$  films (the thickness of the films for absorption and XRD are 18 nm and 1  $\mu\text{m}$ , respectively).

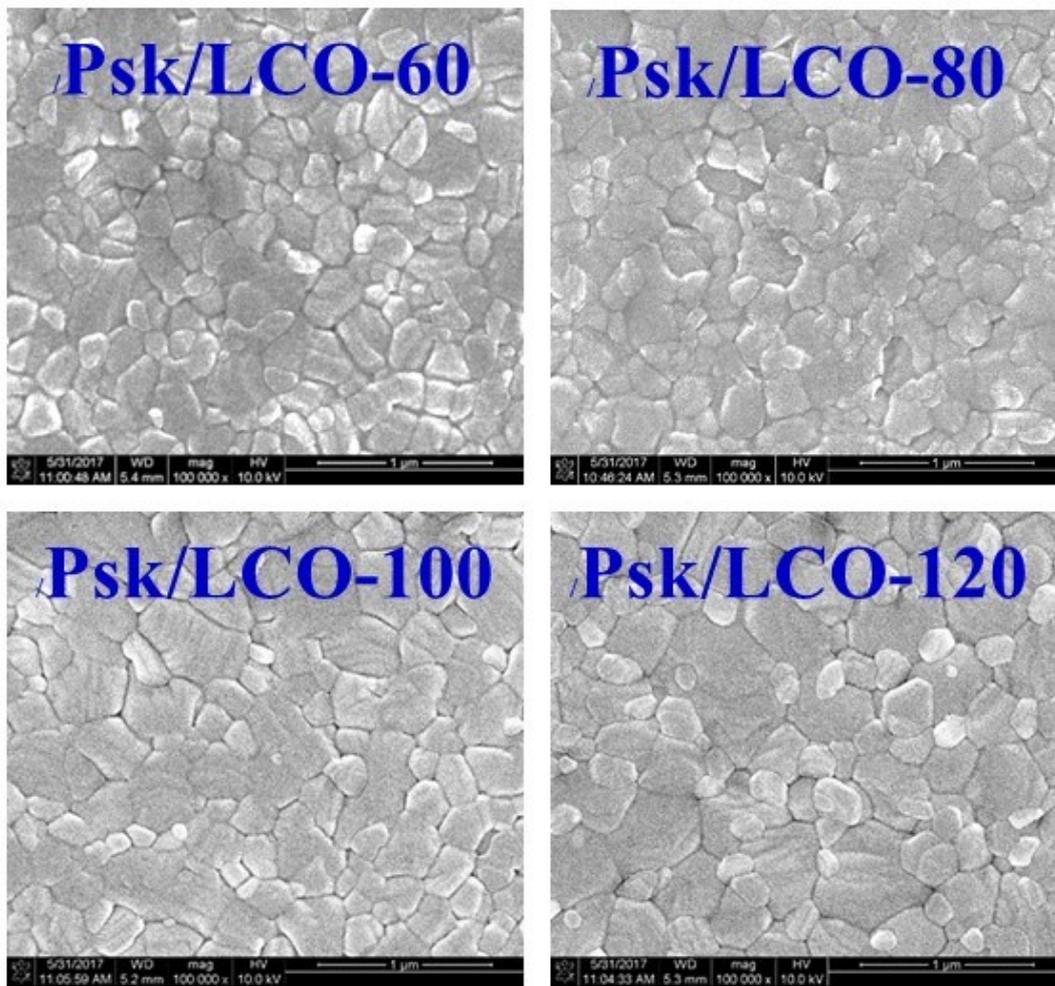


Figure S3: SEM images of the perovskite films deposited on LiCoO<sub>2</sub> prepared from various sputtering powers.

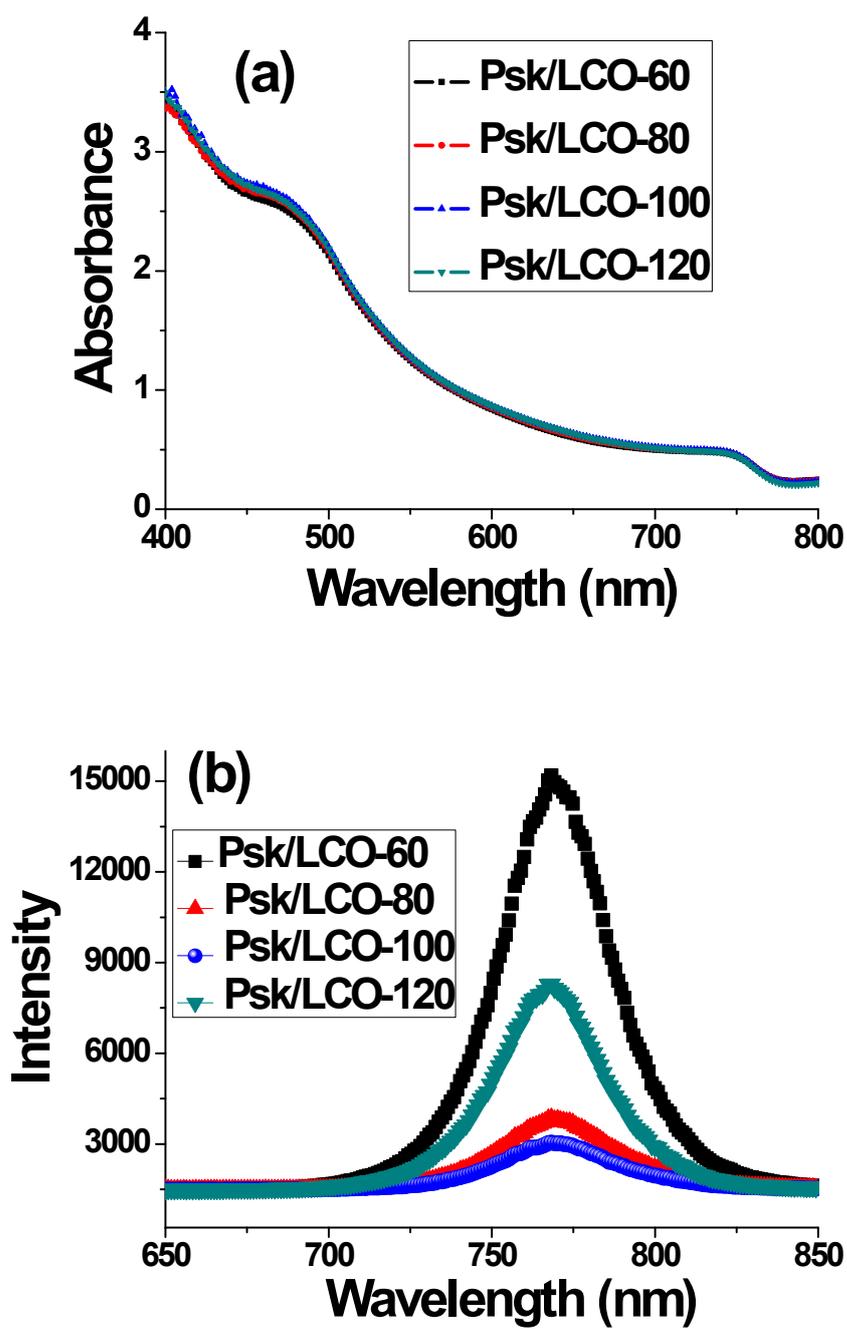


Figure S4: Absorption (a) and photo luminescence spectra of MAPbI<sub>3</sub> films deposited on LiCoO<sub>2</sub> prepared from various sputtering powers.

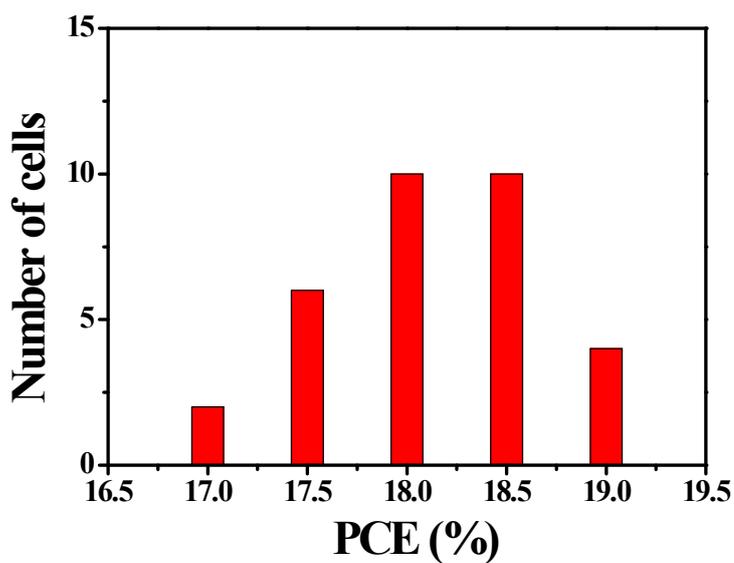


Figure S5: The histograms of the efficiency of the best performance inverted PSCs (total number of the cells: 32)

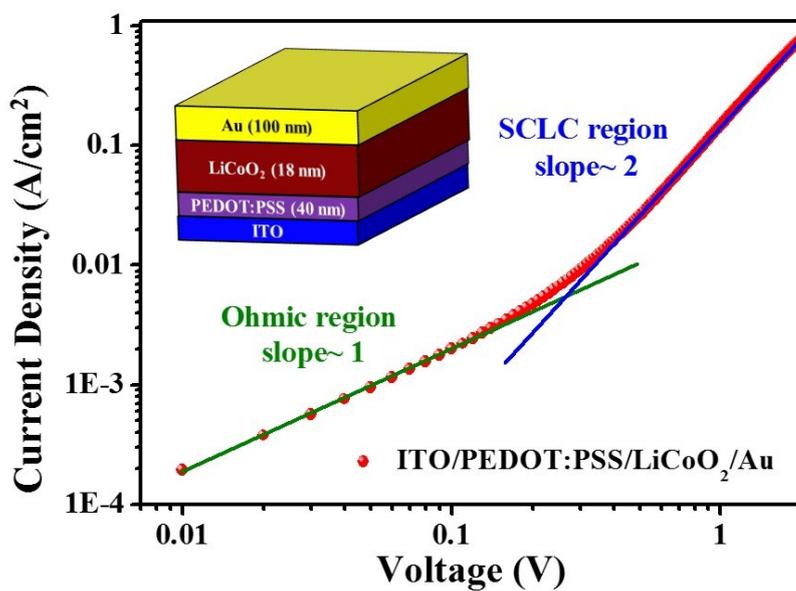


Figure S6: I-V curve of the ITO/PEDOT:PSS/LiCoO<sub>2</sub>/Au hole only device.

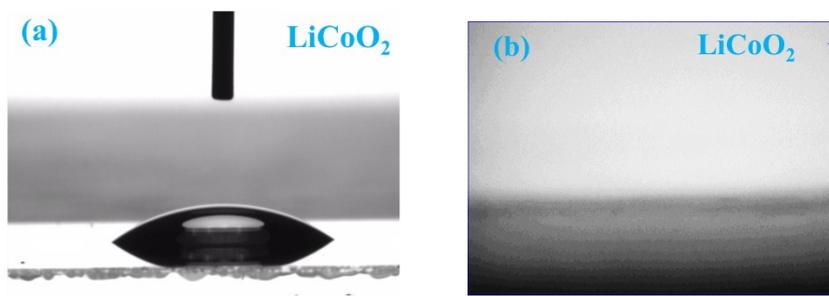


Figure S7: Water contact angle of  $\text{LiCoO}_2$  (LCO-100) films (a) before (b) after UV/ozone treatment.

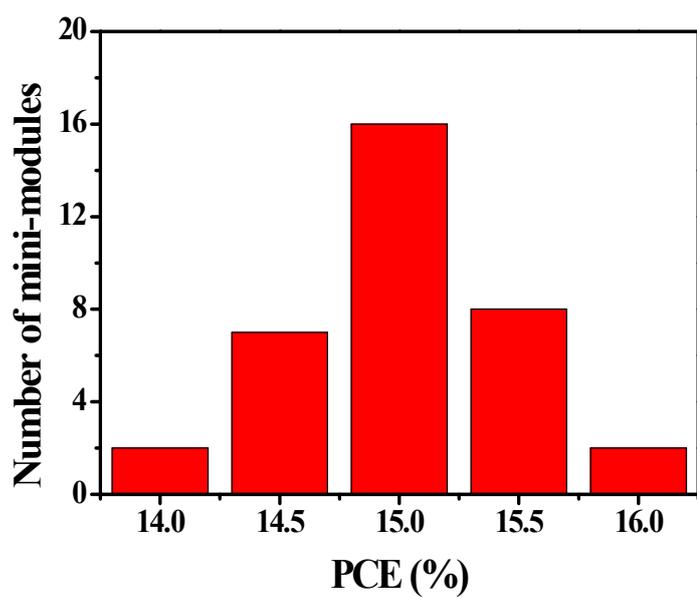


Figure S8: The histograms of the efficiency of the best performance inverted perovskite sub-modules (total number of the sub-modules: 35)

**Applicant-**

Name: Research Center for New Generation Photovoltaics, National Central University, Taiwan  
 Address: No. 300, Zhongda Rd., Zhongli District, Taoyuan City 32001, Taiwan (R.O.C.)  
 Date of Application: April 8, 2016

**Evaluated Sample-**

Sample Name and AROPV Identification: RCNPV-Perovskite-O-10 and 20160421-S1  
 Manufacturer: Research Center for New Generation Photovoltaics  
 Date of Receipt and Sample Type: April 21, 2016 and Perovskite Solar Mini-module  
 Dates of PV Efficiency Evaluation: April 21, 2016 ~ April 29, 2016

**PV Efficiency Evaluation Methods and Conditions-**

IV Measurement Method: IEC 60904-1  
 Reference Solar Spectral Irradiance: IEC 60904-3 (Ed. 2) AM 1.5 Global  
 Irradiance Source: Steady-State Solar Simulator (HFSS) AAA-Class Conforms to IEC 60904-9  
 Sample Temperature:  $25 \pm 1$  °C  
 Spectral Irradiance and Temperature Correction Method: IEC 60891

**Traceability of PV Efficiency Evaluation-**

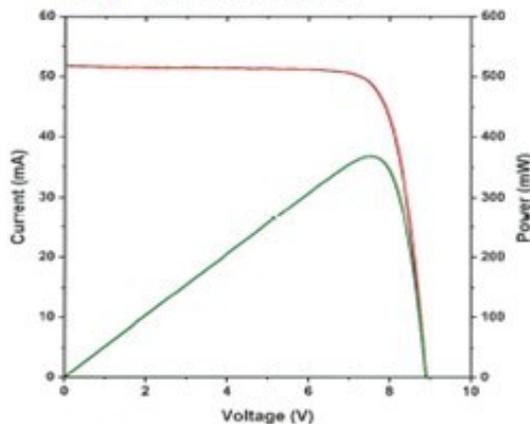
Reference Cell Identification: AROPV-RC-4 (Secondary Reference Cell)  
 Calibration Date and Expiration Date: November 13, 2014 and November 13, 2017  
 Calibration Traceability: JIS-S3-018 (No. 0910-6) (Primary Reference Cell) Calibrated by AIST, Japan

**PV Efficiency Evaluation Result-**



**EFFICIENCY EVALUATION**  
 AM 1.5G (IEC 60904-3 Ed.2)  
 IEC 60904-1 HFSS-IV

Date: 2016/04/22  
 Sample ID: RCNPV-Perovskite-O10  
 Data No.: 20160421-S1-IV-3i



Repeat Times: 1  
 Sweep Mode: Isc to Voc

Mirr.	100.0	mW/cm <sup>2</sup>
MTemp.	24.7	°C
Isc	51.75	mA
Voc	8.918	V
F.F.	79.8	%
Pmax.	368.3	mW
I <sub>pm</sub> max.	49.09	mA
V <sub>pm</sub> max.	7.503	V
Area (da.)	24.58	cm <sup>2</sup>
Jsc	2.11	mA/cm <sup>2</sup>
Efficiency	15.0	%

Responsible Researcher for Issuing Report-

Chia-Yuan Chen, Ph.D.



Figure S9. The report of the efficiency verification of the inverted perovskite solar sub-module.

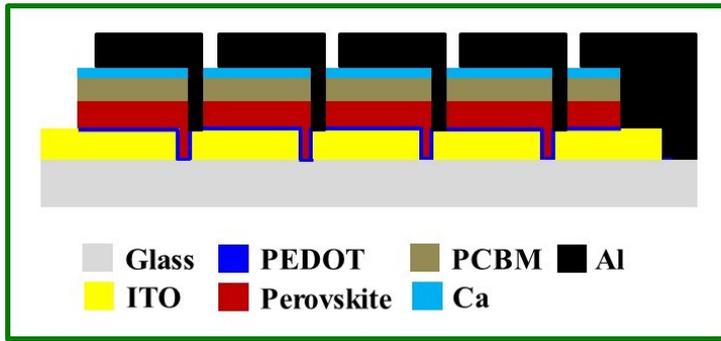


Figure S10. The pattern designed for the inverted perovskite solar sub-module.