Electronic Supplementary Information

Solution processed bulk heterojunction photovoltaic cells based on a squaraine compound

Guo Chen,[a] Hisahiro Sasabe,*[a] Zhongqiang Wang,[a] Xiaofeng Wang,[a] Ziruo Hong,*[a] Junji Kido [a] and Yang Yang [b]

[a] *Department of Organic Device Engineering, Graduate School of Science and Engineering, Research Center for Organic Electronics (ROEL), Yamagata University,, 4-3-16 Jonan, Yonezawa, Yamagata 992-8510, Japan. E-mail: h-sasabe@yz.yamagata-u.ac.jp; ziruo@yz.yamagata-u.ac.jp*

[b] *Department of Materials Science and Engineering, University of California-Los Angeles, Los Angeles, CA 90095, USA*

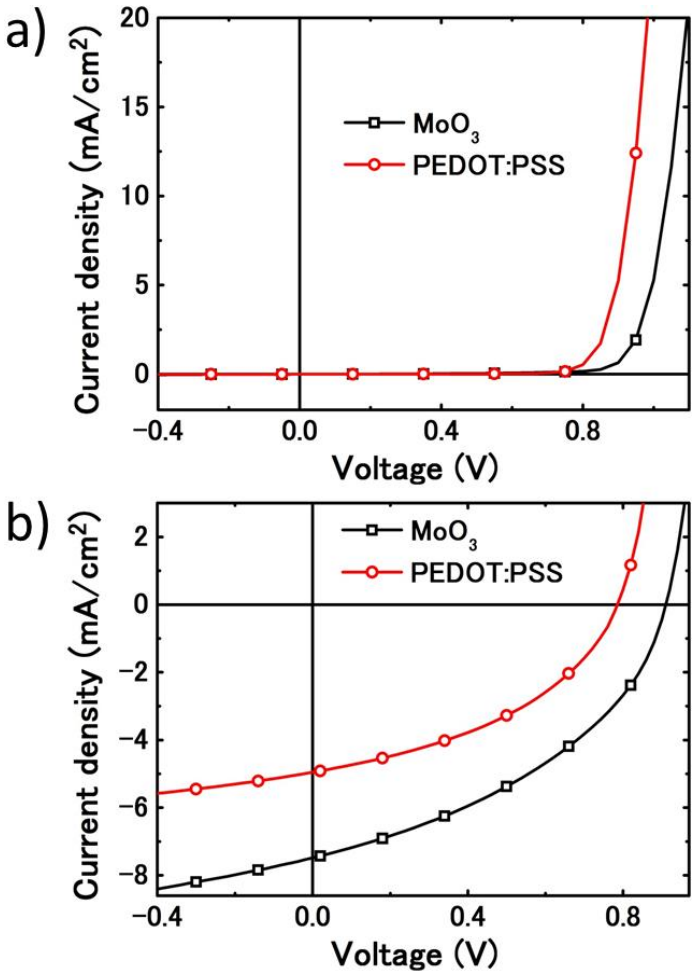

Fig. S1 (a) Dark J-V characteristics, (b) J-V characteristics illuminated at 100 mW/cm^2 (AM 1.5G solar spectrum) for the **SQ:PC$_{60}$BM (1:5, 70nm)** solar cells using MoO_3 and PEDOT:PSS as anode buffer layers. **Note the device data in this figure were based on PC$_{60}$BM, and thus showed low photocurrent.**

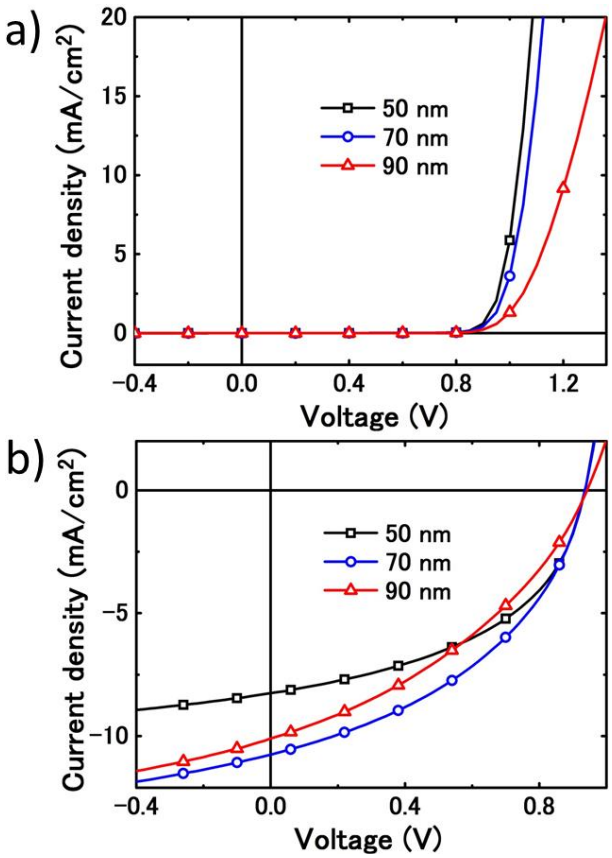

Fig. S2 (a) Dark J-V characteristics, (b) J-V characteristics illuminated at 100 mW/cm^2 (AM 1.5G) for the SQ:PC$_{70}$BM (1:5) BHJ solar cells with varied thicknesses of the active layer.

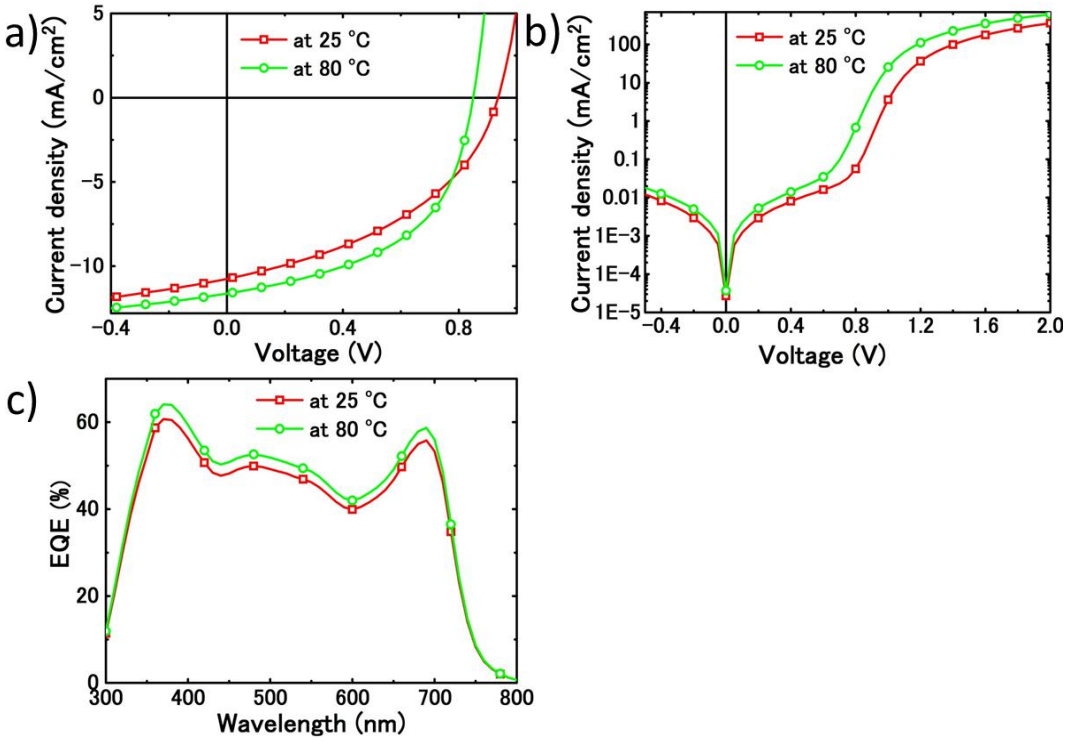

Fig. S3 Comparison of (a) bright-state J-V characteristics; (b) dark-state J-V characteristics; c) external quantum efficiency of SQ:PC$_{70}$BM (1:5) cells at room temperature and 80 °C.

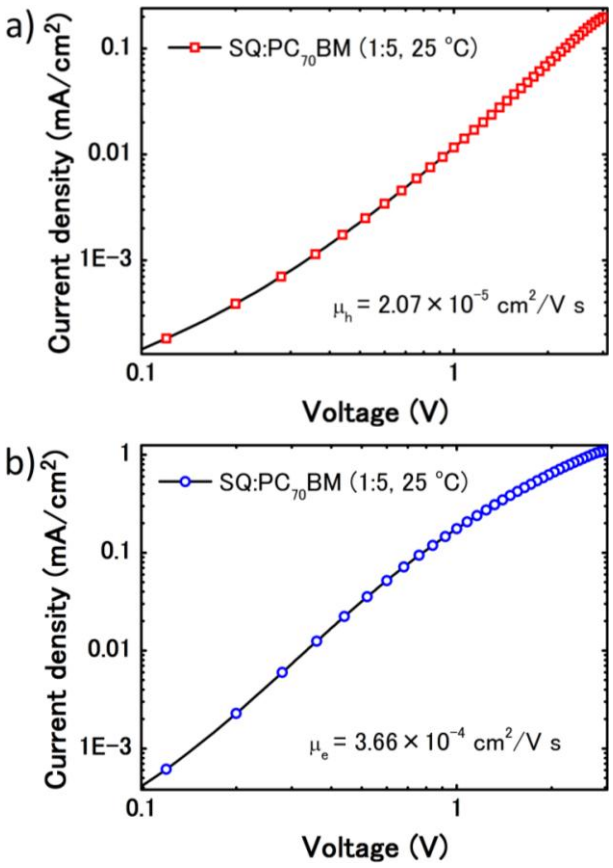

Fig. S4 **Current density vs voltage characteristic of SQ:PC_{70}BM (1:5) single carrier devices used for a) hole and b) electron mobility measurement.**

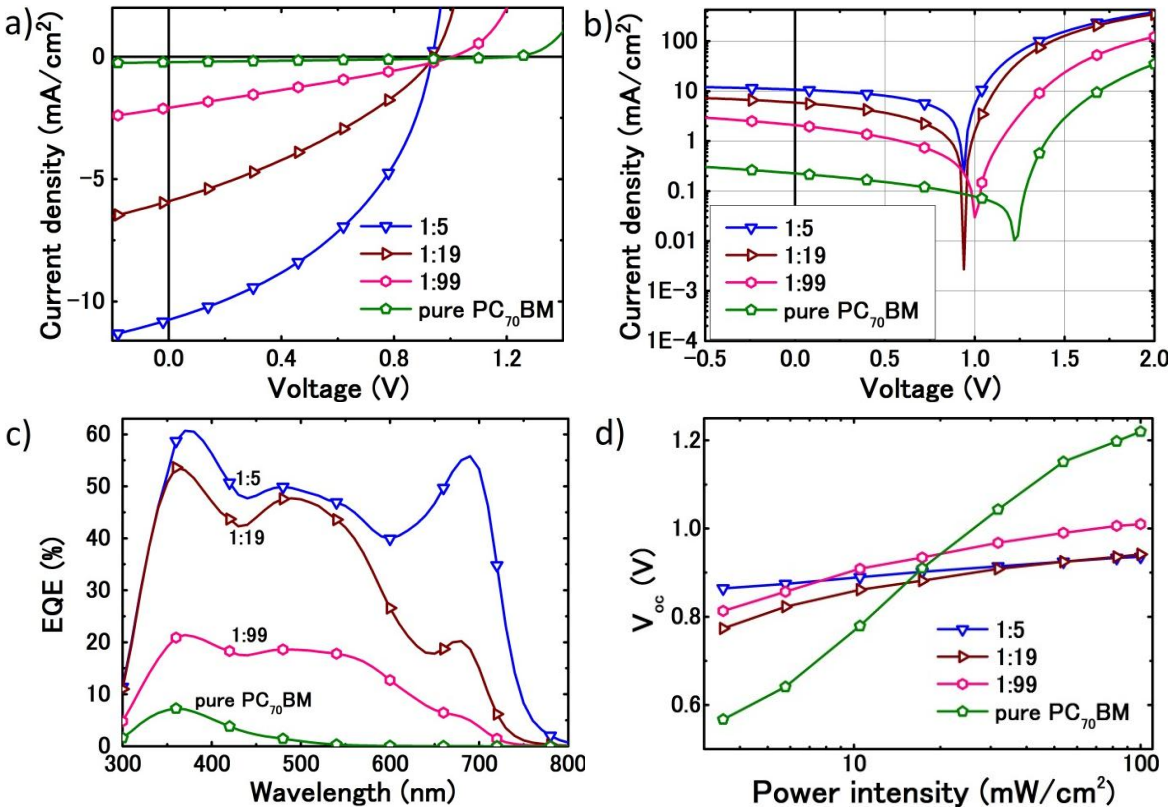

Fig. S5 Linear (a) and logarithmic (b) J-V characteristics of SQ:$PC_{70}BM$ (1:5, 1:19, 1:99) cells and $PC_{70}BM$-only cell illuminated at 100 mW/cm^2 of AM 1.5G; (c) EQE spectra; d) Voc vs incident light intensity.

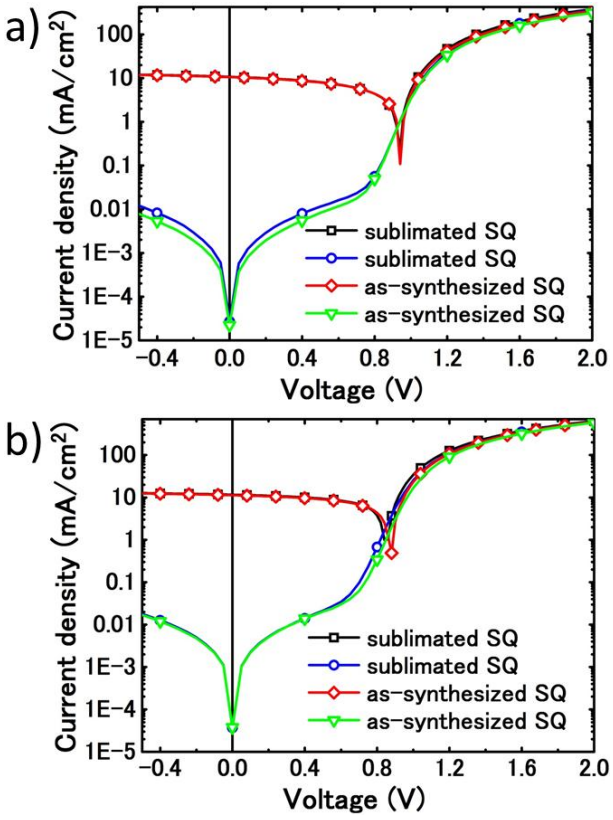

Fig. S6 J-V characteristics from 1:5 SQ:$PC_{70}BM$ ratio cells based on as-synthesized and sublimated SQ at (a) room temperature and (b) 80 ^{o}C. It shows almost identical ***J-V*** characteristics and η_p from the PV cells based on as-synthesized and sublimated SQ.

Table SI. PV performance for the SQ:$PC_{60}BM$ (1:5) BHJ solar cells using MoO_3 and PEDOT:PSS as anode buffers, respectively. Note PC60BM was used for optimization of buffer layers.

HTL	J_{sc} (mA/ cm^2)	V_{oc} (V)	FF	η_p (%) (P_0 =100 mW/cm^2)
MoO_3	7.48	0.91	0.41	2.81
PEDOT:PSS	4.95	0.79	0.42	1.64

Table SII. PV performance for the SQ:$PC_{70}BM$ (1:5) BHJ solar cells with varied thicknesses of the active layer.

Thickness (nm)	J_{sc} (mA/ cm^2)	V_{oc} (V)	FF	η_p (%) (P_0 =100 mW/cm^2)
50 nm	8.26	0.94	0.48	3.68
70 nm	10.75	0.94	0.43	4.30
90 nm	10.11	0.94	0.37	3.54