Electronic Supplementary Material (ESI) for Journal of Materials Chemistry C.

< Supporting Information >

PCBM-blended Chlorobenzene Hybrid Anti-solvent Engineering for Efficient Planar Perovskite Solar Cells

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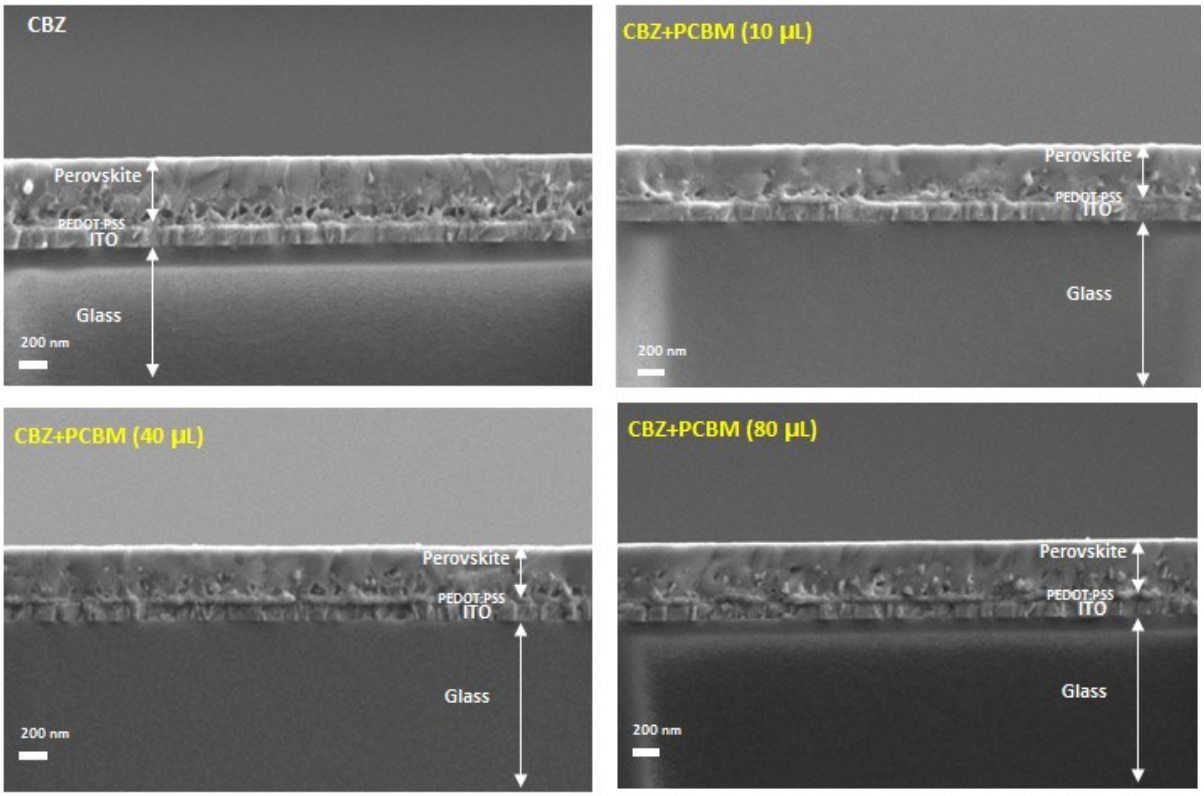


Fig. S1 Cross-sectional images of the perovskite light harvester film made under various secondary washing treatments of CBZ only and CBZ+PCBM hybrid (10-80 μL), analyzed by FE-SEM.

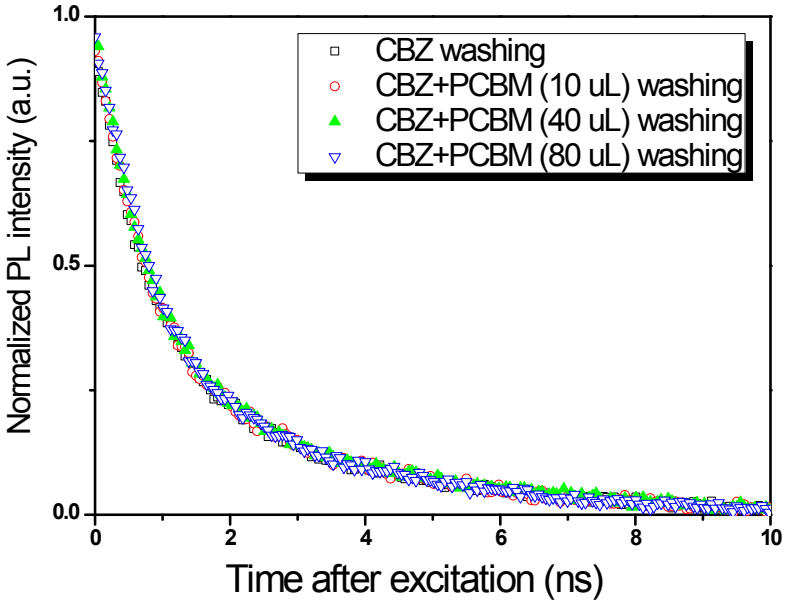
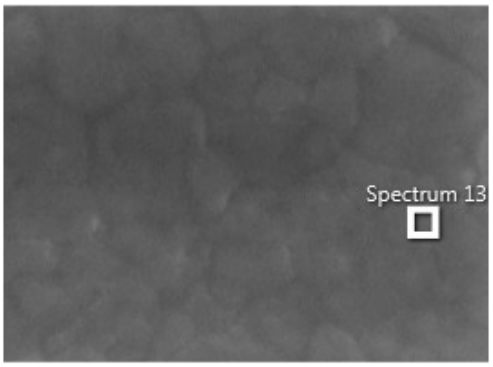


Fig. S2 Time-resolved photoluminescence (TRPL) of the perovskite films made with and without various introduction of PCBM additive solutions (from 10 μL to 80 μL).

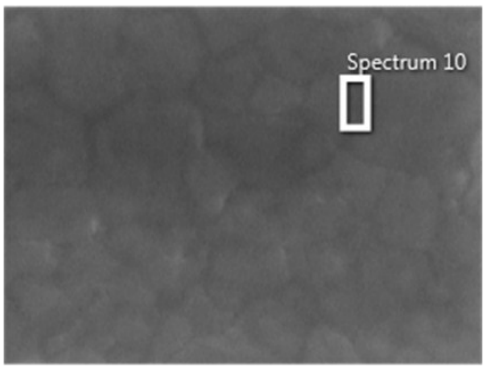
< CBZ washing>

In grain



Element	Atomic %
C	51.10
Cl	3.68
I	32.07
Pb	13.15
Total:	100.00

Grain Boundary

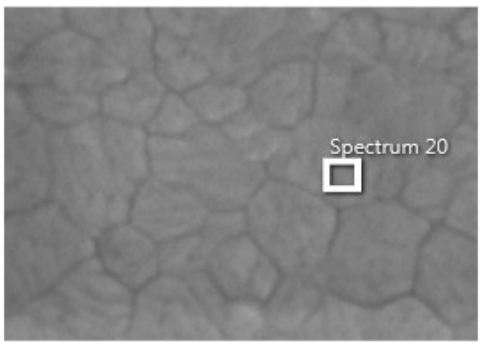


Element	Atomic %
C	51.40
Cl	4.20
I	31.29
Pb	13.10
Total:	100.00

(a)

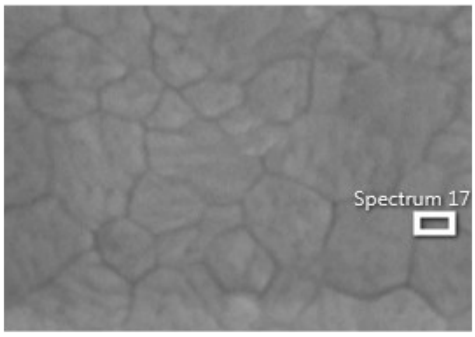
< CBZ+PCBM (10 μL) washing>

In grain



Element	Atomic %
C	55.11
Cl	4.09
I	28.37
Pb	12.43
Total:	100.00

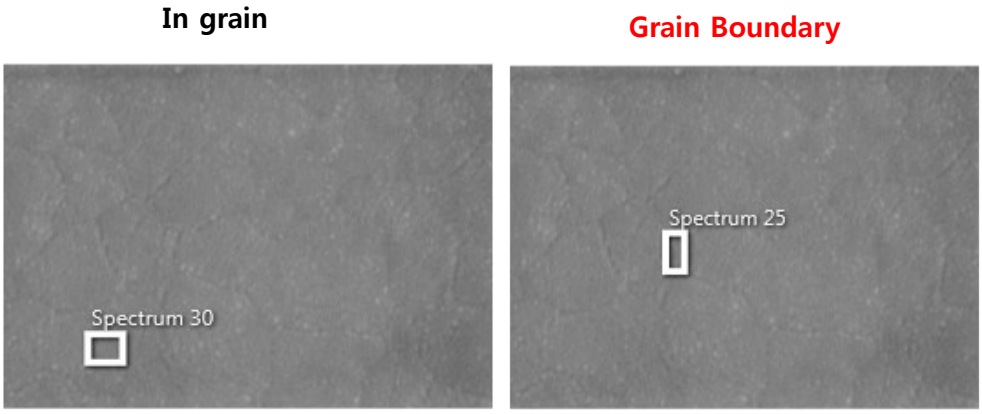
Grain Boundary



Element	Atomic %
C	55.90
Cl	4.98
I	26.99
Pb	12.13
Total:	100.00

(b)

< CBZ+PCBM (40 μL) washing>

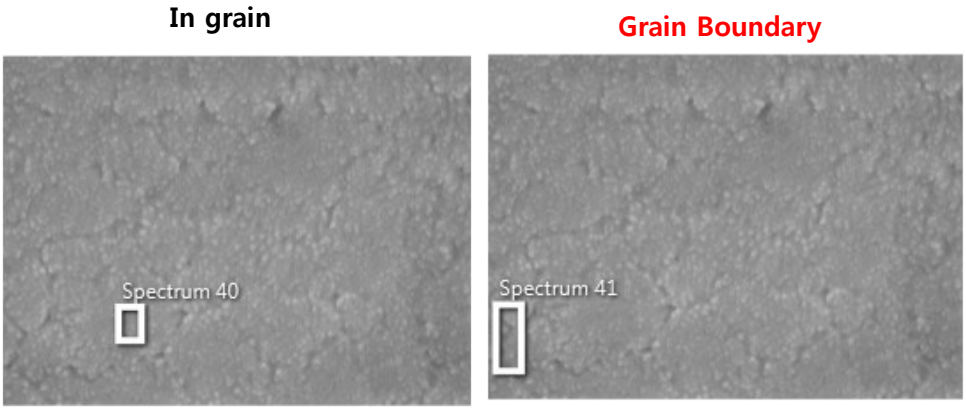


Element	Atomic %
C	52.53
Cl	4.48
I	29.92
Pb	13.07
Total:	100.00

Element	Atomic %
C	56.52
Cl	4.25
I	27.42
Pb	11.80
Total:	100.00

(c)

< CBZ+PCBM (80 μL) washing>



Element	Atomic %
C	58.00
Cl	5.04
I	25.32
Pb	11.64
Total:	100.00

Element	Atomic %
C	61.45
Cl	5.11
I	22.98
Pb	10.46
Total:	100.00

(d)

Fig. S3 EDS mapping data of perovskite films with different washing treatment using (a) CBZ only, (b) CBZ+PCBM (10 μL), (c) CBZ+PCBM (40 μL), and (d) CBZ+PCBM (80 μL)

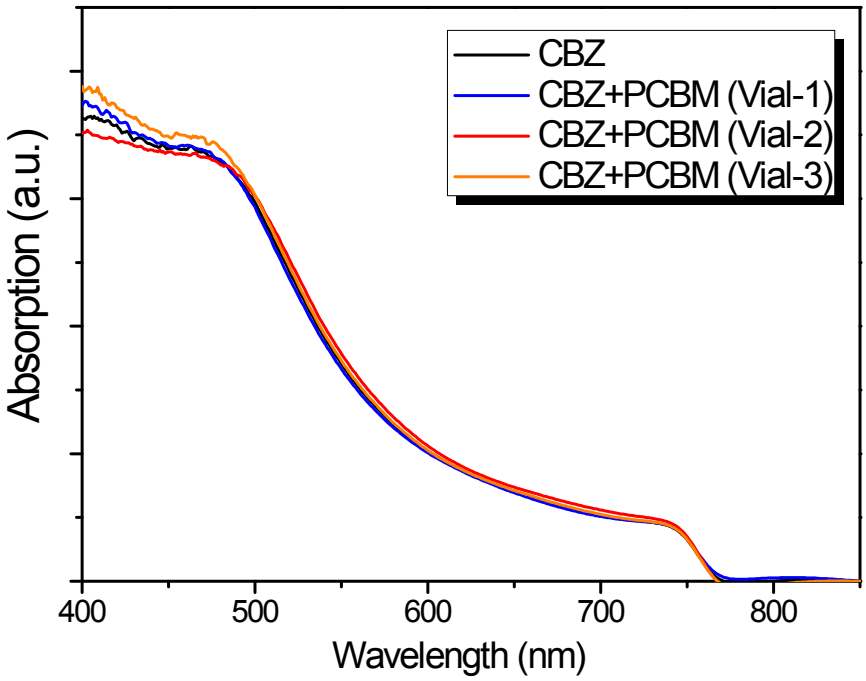


Fig. S4. Absorption spectra of the PRV films processed with CBZ only and CBZ+PCBM hybrid washing treatments.

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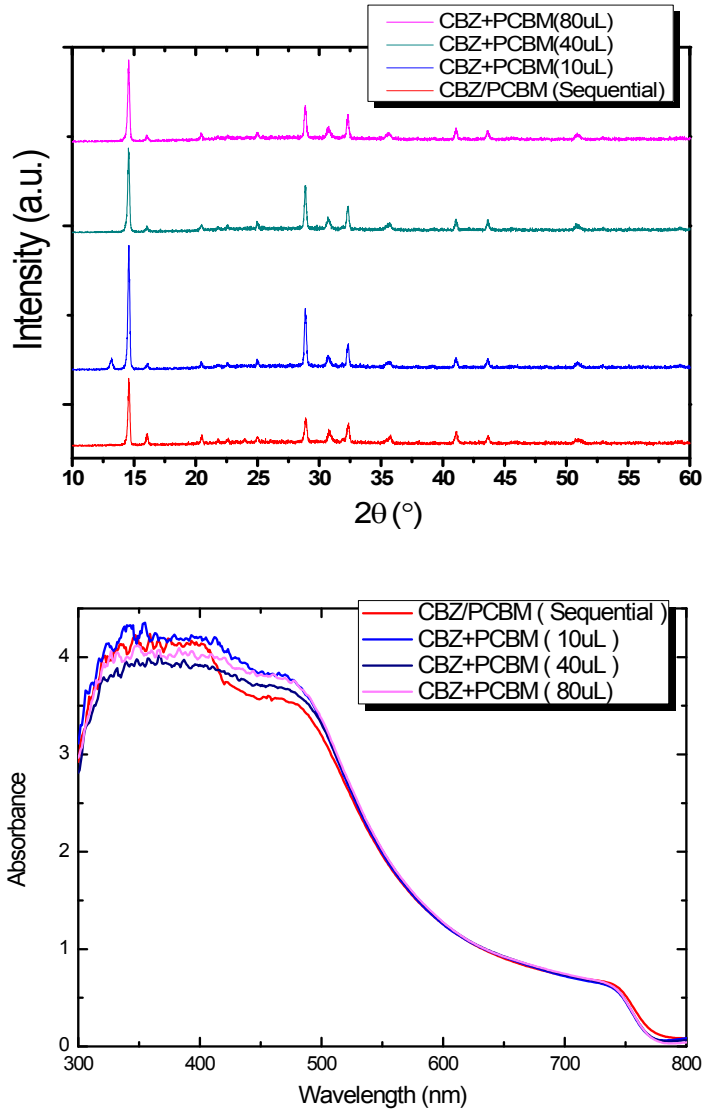


Fig. S5 XRD and UV-Vis absorption spectra of the perovskite films made with CBZ/PCBM sequential washing and CBZ+PCBM hybrid washing process.

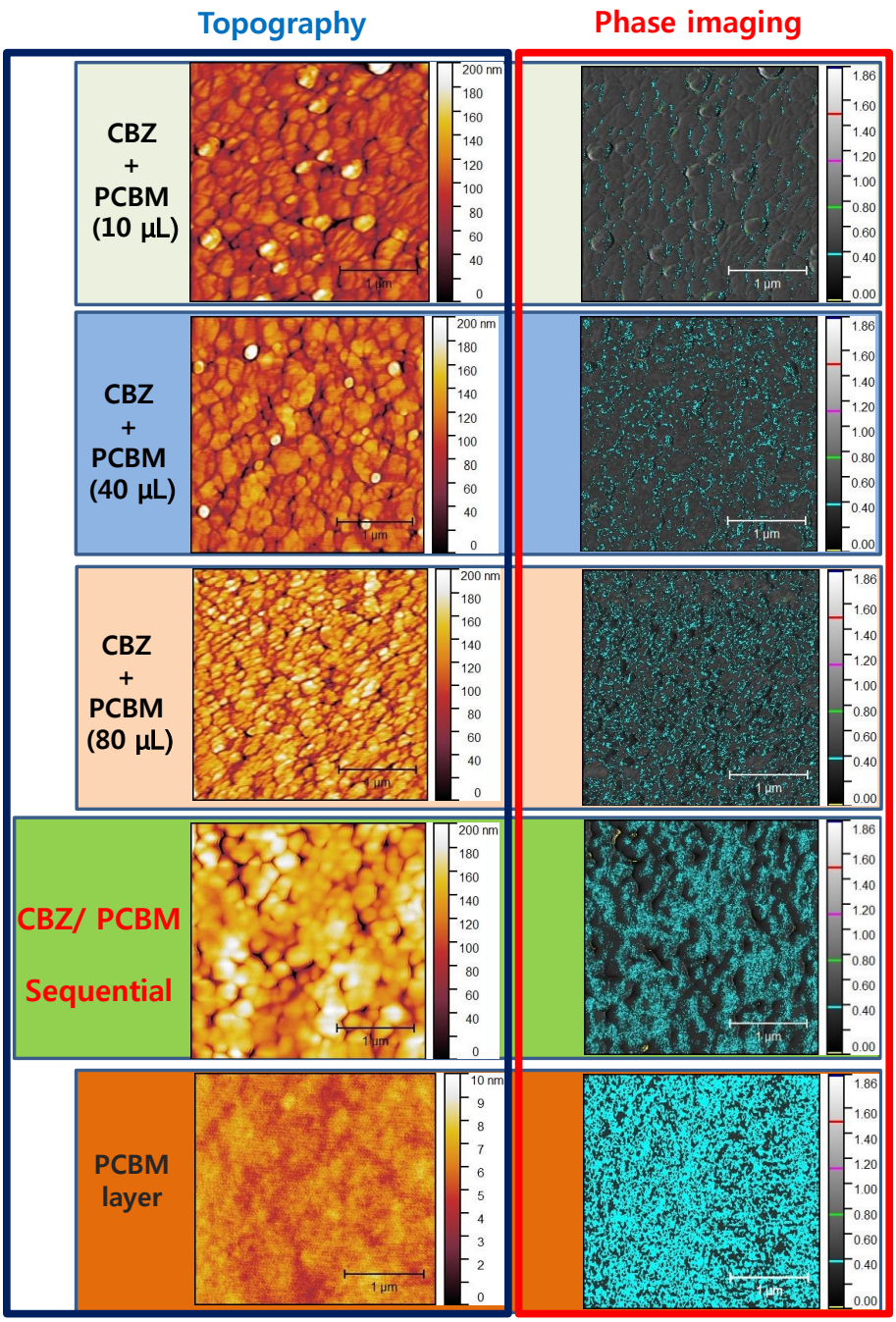


Fig. S6 Surface morphologies and phase imaging of the perovskite films made with CBZ/PCBM sequential washing process. Those are compared with the films made under CBZ+PCBM hybrid washing.

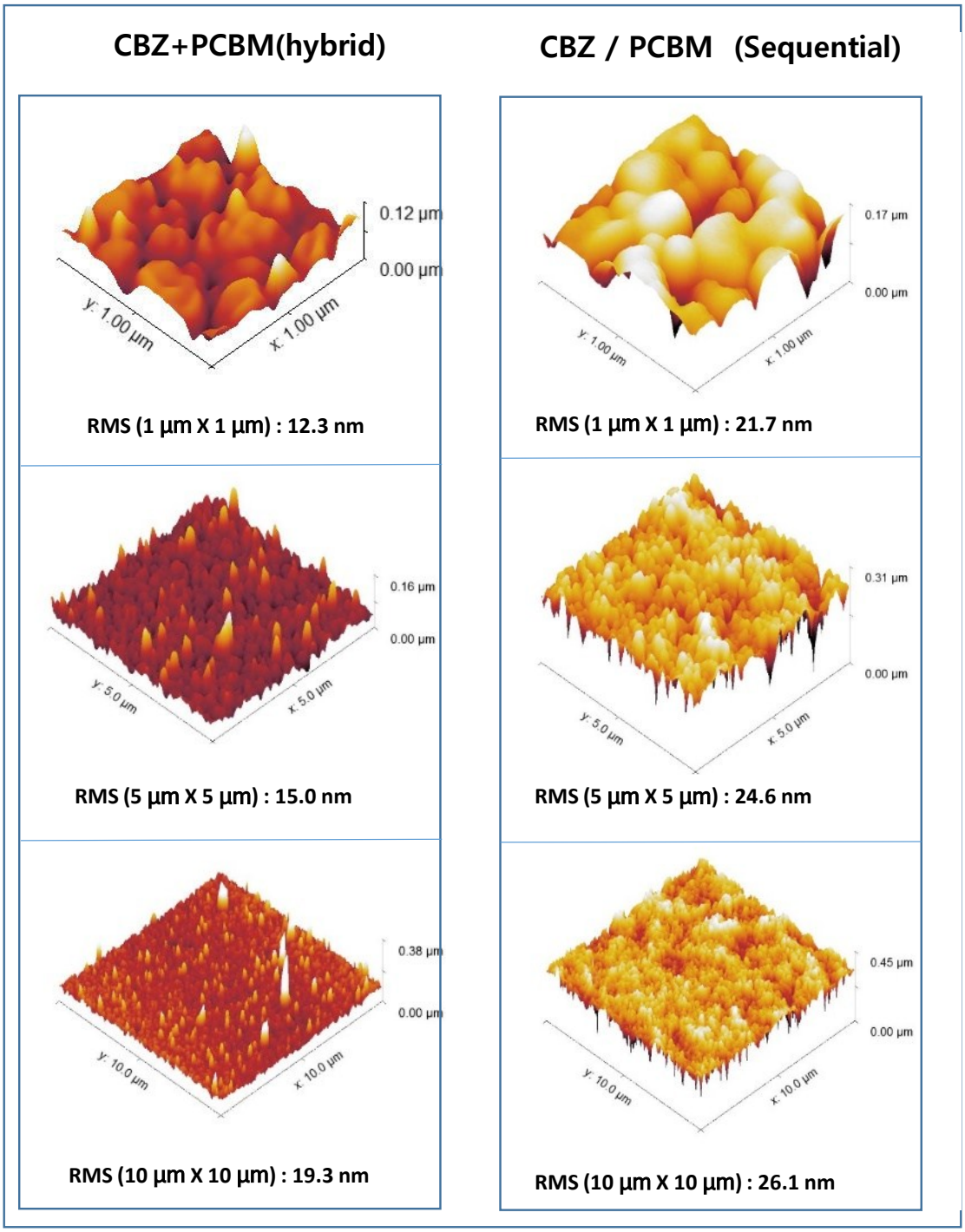
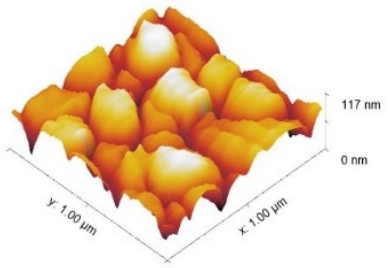
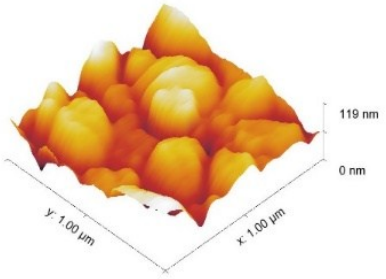
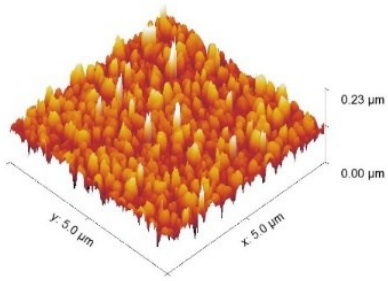
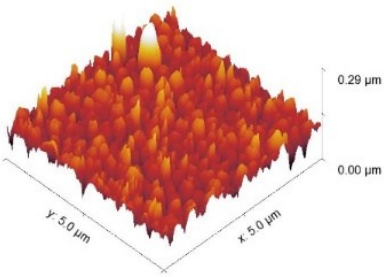
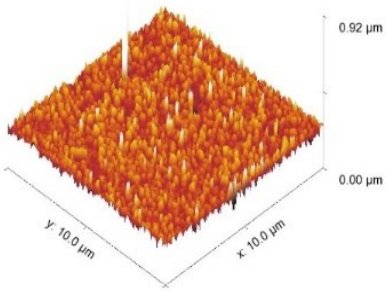
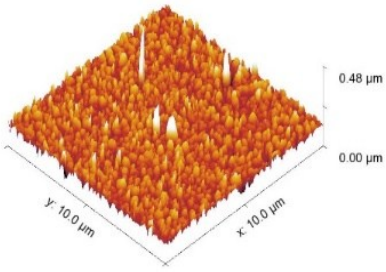
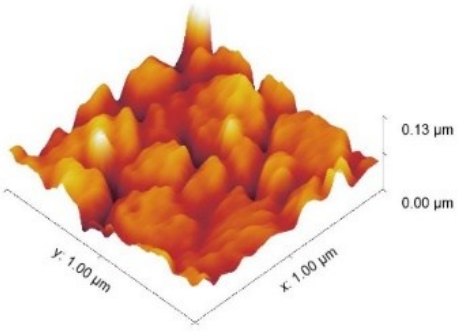
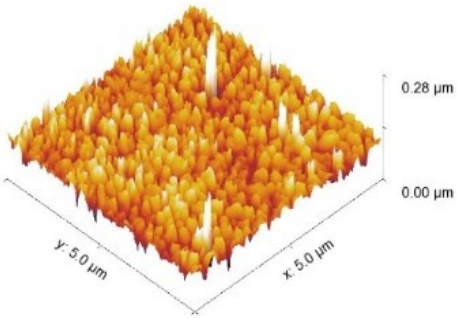
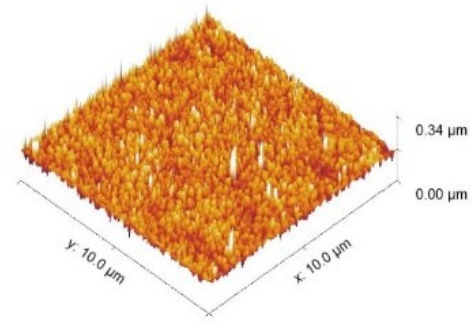


Fig. S7 A comparison of surface morphologies for the perovskite films made with CBZ+PCBM hybrid and CBZ/PCBM sequential washing process.

(a) CBZ	(b) CBZ+PCBM(1 μL)
	
RMS (1 μm X 1 μm) : 17.8 nm	RMS (1 μm X 1 μm) : 17.7 nm
	
RMS (5 μm X 5 μm) : 17.9 nm	RMS (5 μm X 5 μm) : 19.6nm
	
RMS (10 μm X 10 μm) : 20.9 nm	RMS (10 μm X 10 μm) : 19.8 nm

(c) CBZ+PCBM(5 µL)  RMS (1 µm X 1 µm) : 13.3 nm	(d) CBZ+PCBM(10 µL) RMS (1 µm X 1 µm) : 12.3 nm
 RMS (5 µm X 5 µm) : 14.9 nm	RMS (5 µm X 5 µm) : 15.0 nm
 RMS (10 µm X 10 µm) : 14.6 nm	RMS (10 µm X 10 µm) : 19.3 nm

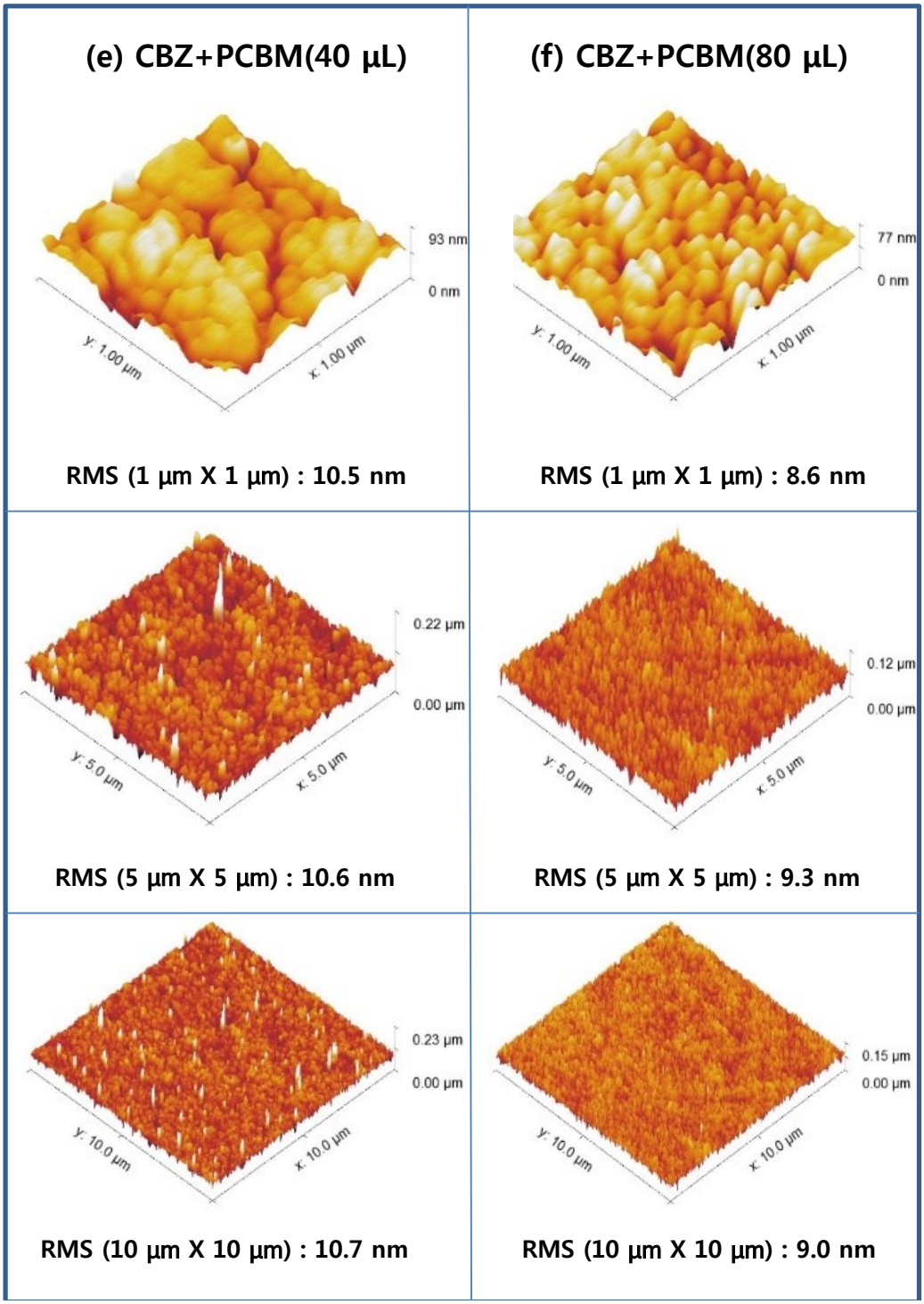


Fig. S8 A comparison of surface topography with various scales (1 µm × 1 µm, 5 µm × 5 µm, and 10 µm × 10 µm) for all perovskite films made with various PCBM additive concentration such as (a) No PCBM, (b) 1 µL, (c) 5 µL, (d) 10 µL, (e) 40 µL, and (f) 80 µL.

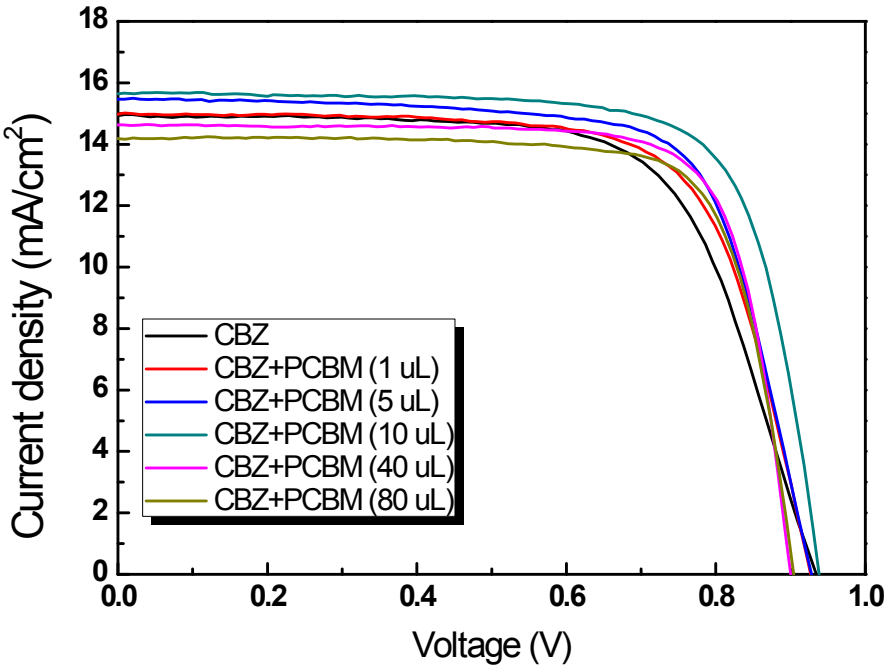


Fig. S9 Current density-voltage (J-V) characteristics of the perovskite solar cells of which absorber layers were made with solvent washing processes using CBZ only and the CBZ+PCBM hybrid solutions.