Electronic Supplementary Information

Soft nanocomposites of lead bromide perovskite and polyurethane prepared via coordination chemistry for highly flexible, stable, and quaternary metal alloy-printed light emitting diodes

Ga Eun Kim, Hae-Jin Kim, Heesuk Jung, and Minwoo Park*

G. E. Kim and Prof. M. Park
Department of Chemical and Biological Engineering
Sookmyung Women's University, Seoul, 04310, Korea

Prof. H. –J. Kim
School of Mechanical Engineering,
Yonsei University, Seoul, 03722, Korea

Dr. H. Jung
Advanced Photovoltaics Research Center,
Korea Institute of Science and Technology (KIST), Seoul, 02792, Korea

*Corresponding author: M. Park (mwpark@sm.ac.kr)

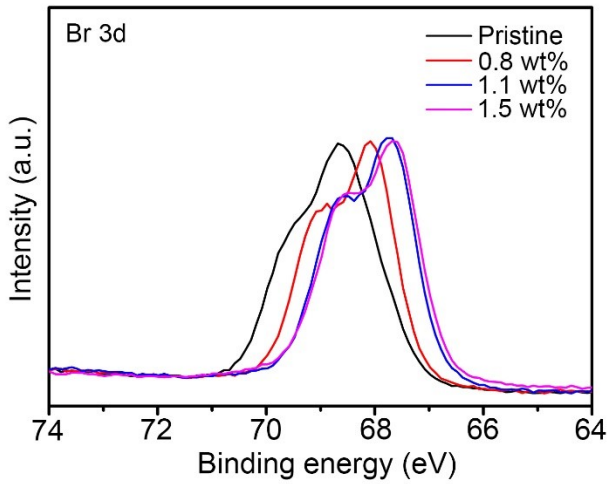

Figure S1. Br 3d X-ray photoelectron spectra of $MAPbBr_3$-DMSO and $MAPbBr_3$-PU-DMSO complex films.

Table S1. Time-resolved photoluminescence parameters of perovskite deposited onto glass/ITO/PEDOT:PSS substrates fitted using biexponential decay function.[a)]

PU concentration [wt%]	a_1	τ_1 [ns]	a_2	τ_2 [ns]	τ_{avg} [ns] [b)]
0	0.734	14.03	0.266	64.23	27.38
0.8	0.749	15.94	0.251	114.1	40.58
1.1	0.716	14.98	0.284	135.6	49.24
1.5	0.705	16.67	0.295	177.4	64.09

a)Fit function = $a_1 e^{-t/\tau_1} + a_2 e^{-t/\tau_2}$

b) $\tau_{avg} = (\sum_i a_i \tau_i)/(\sum_i a_i), where \sum_i a_i = 1$

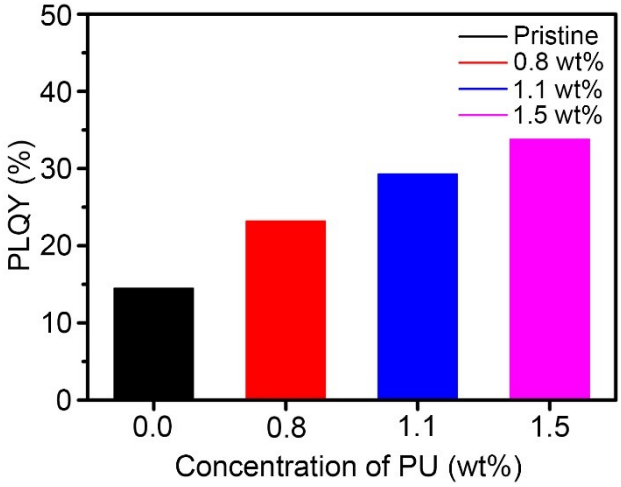

Figure S2. PLQYs of $MAPbBr_3$ and MAPbBr3-PU films.

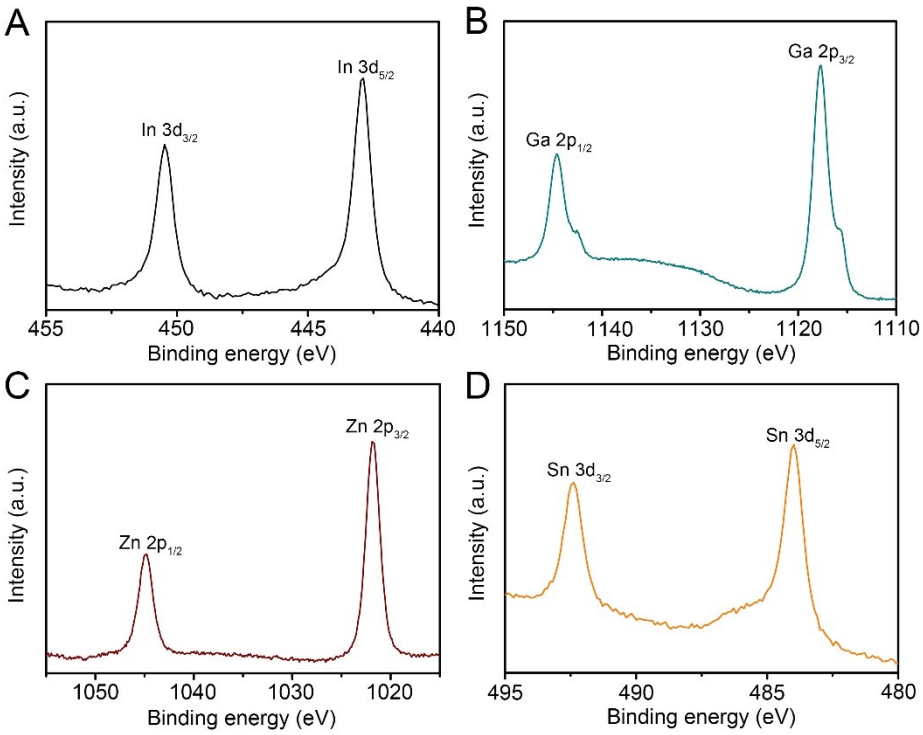

Figure S3. X-ray photoelectron spectra of IGZS displaying (A) In 3d, (B) Ga 2p, (C) Zn 2p, and (D) Sn 3d.

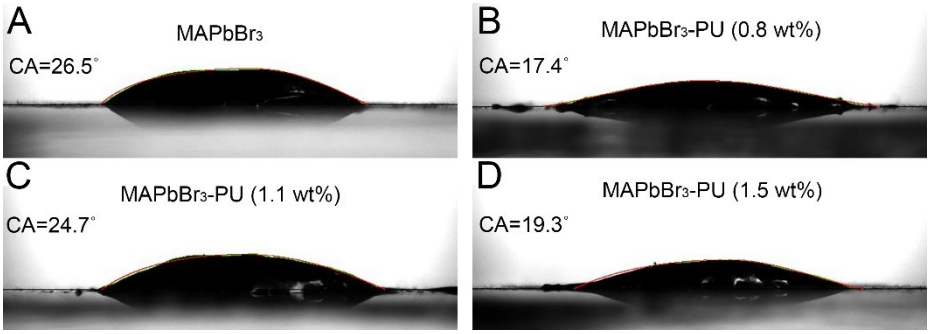

Figure S4. Optical microscopy images of IGZS droplets on (A) glass/ITO/PEDOT:PSS/$MAPbBr_3$/PCBM, (B) glass/ITO/PEDOT:PSS/$MAPbBr_3$-PU0.8/PCBM, (C) glass/ITO/PEDOT:PSS/$MAPbBr_3$-PU1.1/PCBM, and (D) glass/ITO/PEDOT:PSS/$MAPbBr_3$-PU1.5/PCBM.

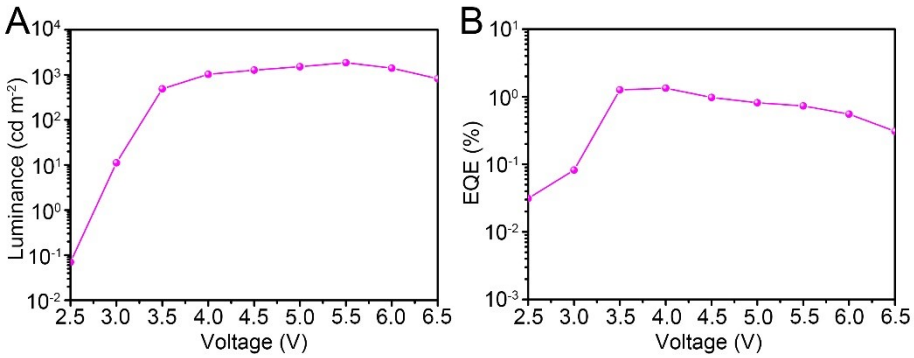

Figure S5. (A) Luminance–voltage and (B) EQE–voltage curves of $MAPbBr_3$-PU1.5 device with Ag NW cathode.

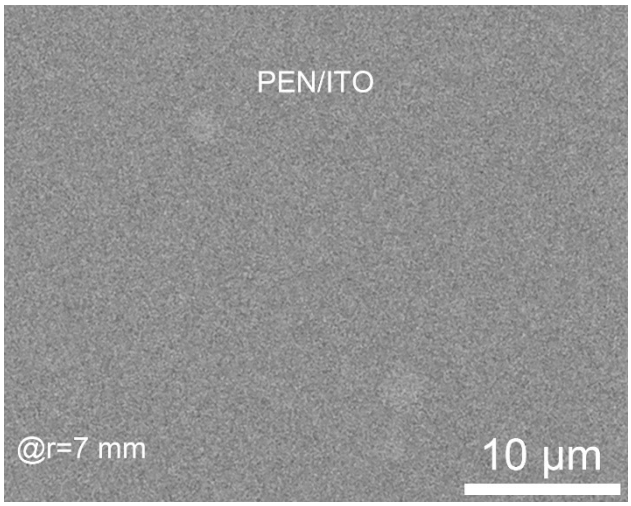

Figure S6. SEM image of PEN/ITO substrate at *r* = 7 mm.

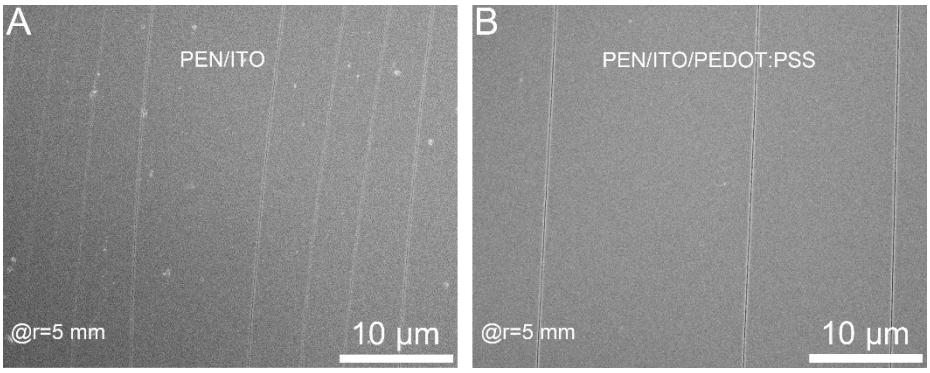

Figure S7. SEM images of (a) PEN/ITO and (b) PEN/ITO/PEDOT:PSS substrates at r = 5 mm.

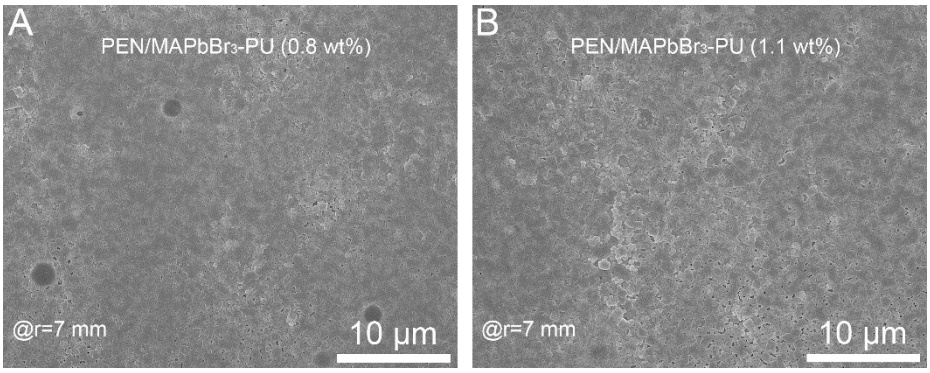

Figure S8. SEM images of (a) PEN/$MAPbBr_3$-PU0.8 and (b) PEN/$MAPbBr_3$-PU1.1 substrates at r = 7 mm.

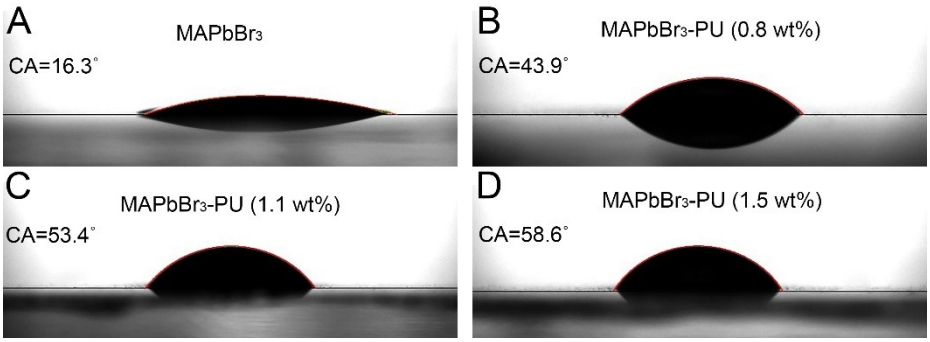

Figure S9. Optical microscopy images of water droplets on (A) glass/ITO/PEDOT:PSS/$MAPbBr_3$, (B) glass/ITO/PEDOT:PSS/$MAPbBr_3$-PU0.8, (C) glass/ITO/PEDOT:PSS/$MAPbBr_3$-PU1.1, and (D) glass/ITO/PEDOT:PSS/$MAPbBr_3$-PU1.5.

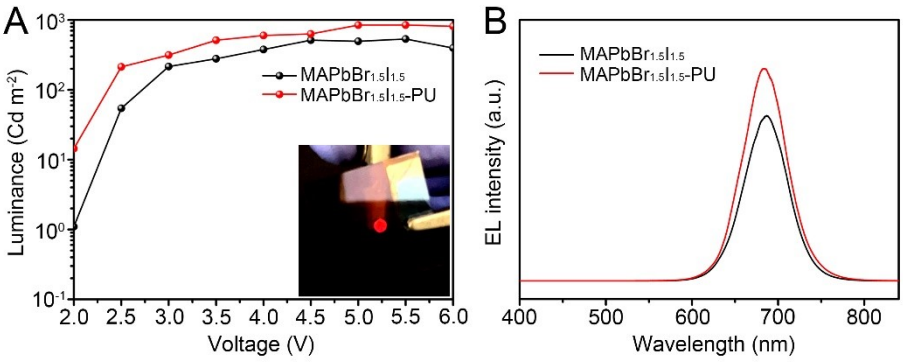

Figure S10. (A) Luminance-voltage and (B) EL spectra of $MAPbBr_{1.5}I_{1.5}$ and $MAPbBr_{1.5}I_{1.5}$-PU devices. The inset photograph exhibits the working device at 2.5V. The EL peaks are observed at 689.4 nm.

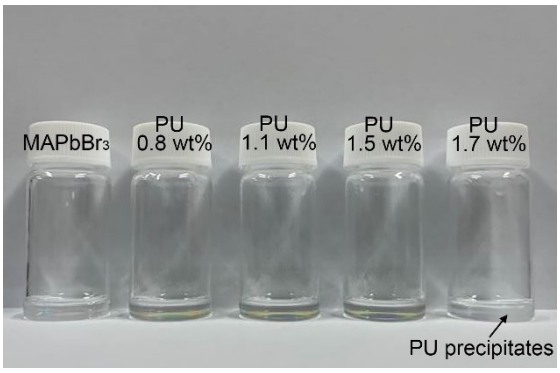

Figure S11. Photographs of $MAPbBr_3$ and $MAPbBr_3$-PU (0.8, 1.1, 1.5, and 1.7 wt%) solutions.

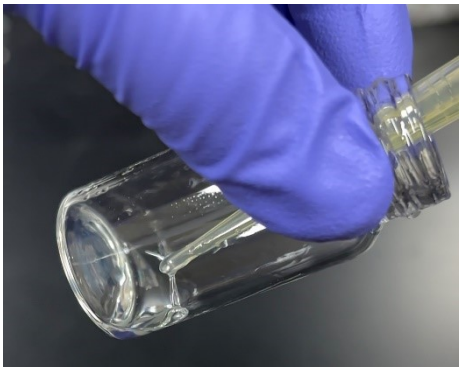

Figure S12. Magnified photograph of $MAPbBr_3$-PU (1.7 wt%) solution. The PU precipitates form a large lump, separated from the solution.