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

Supporting Information

Graphene/ZnO Electron Transfer Layer Together with Perovskite Passivation Enable Highly Efficient and Stable Perovskite Solar Cells

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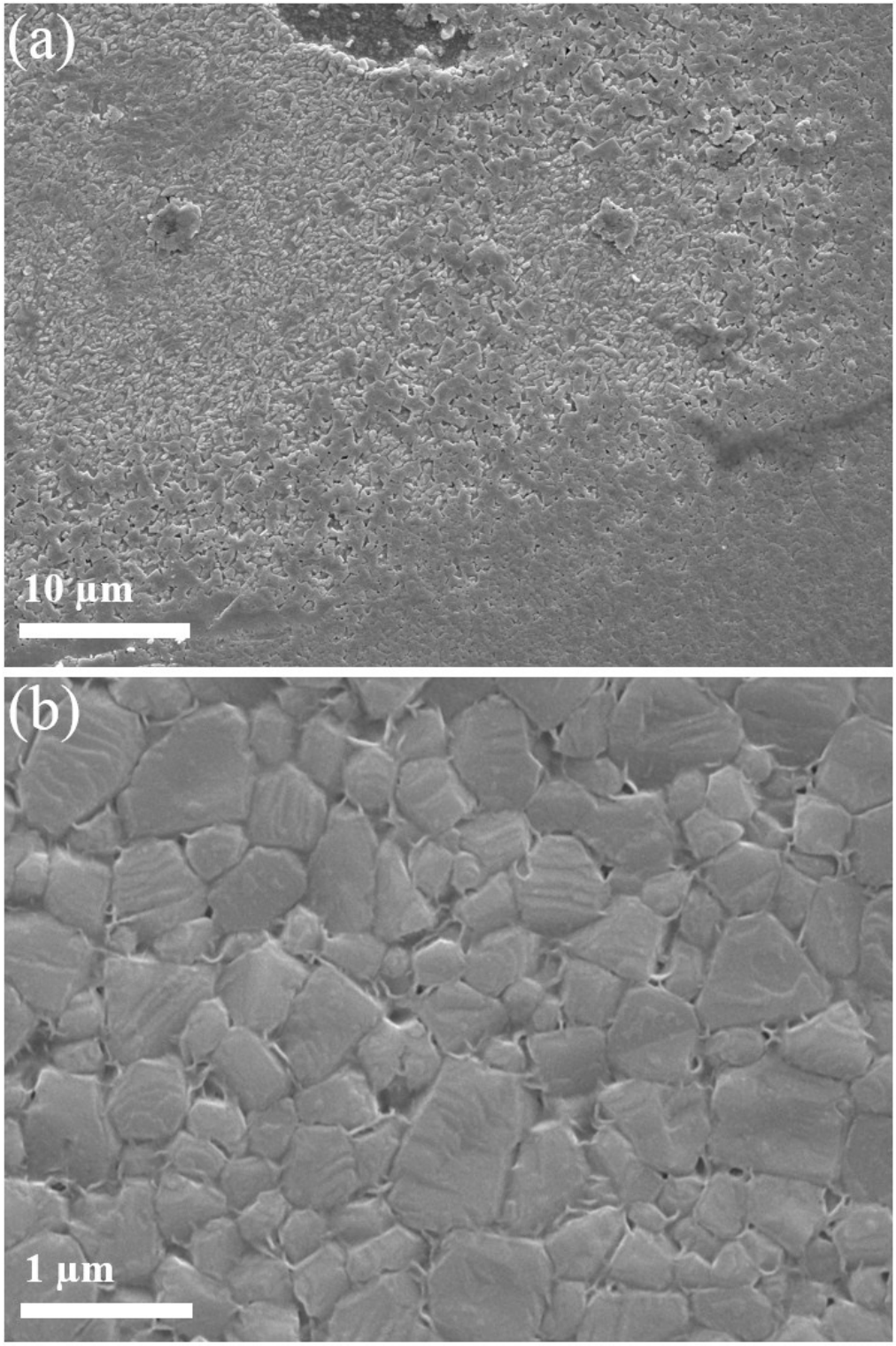

Figure S1. Top-view SEM images of perovskite film annealed on ZnO ETL at 100 °C with (a) low and (b) high magnifications.

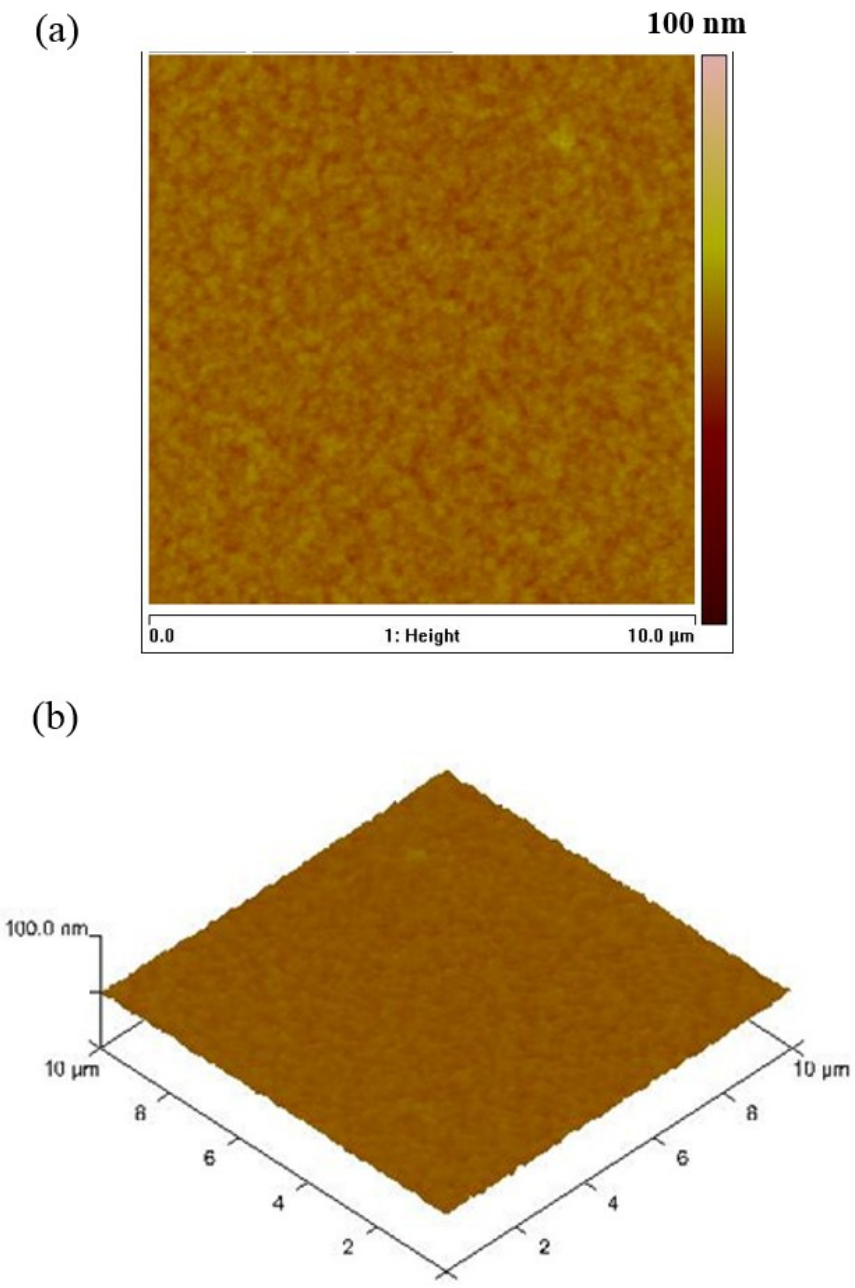

Figure S2. AFM image of MLG after transfer onto the surface of ZnO ETL using a wet transfer process, (a) two-dimensional and (b) three-dimensional images.

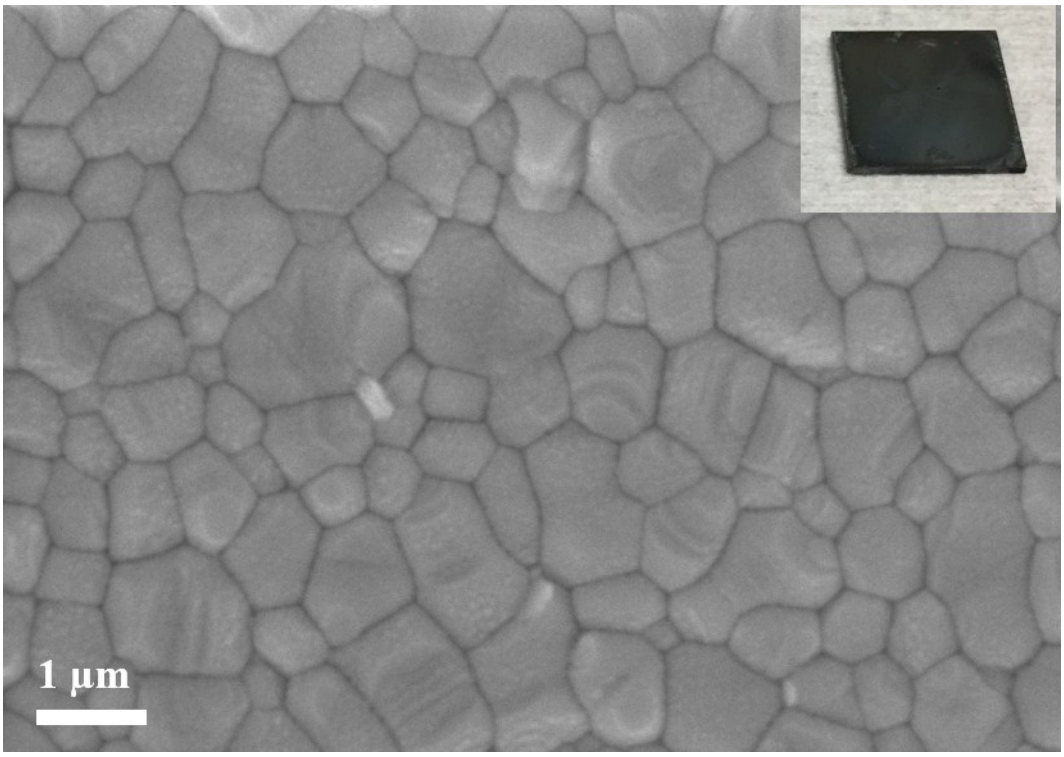

Figure S3. Top-view SEM images of perovskite films on MLG/ZnO (annealed at 150 °C). The inset image is the photograph of perovskite film annealed on top of MLG/ZnO at 150 °C.

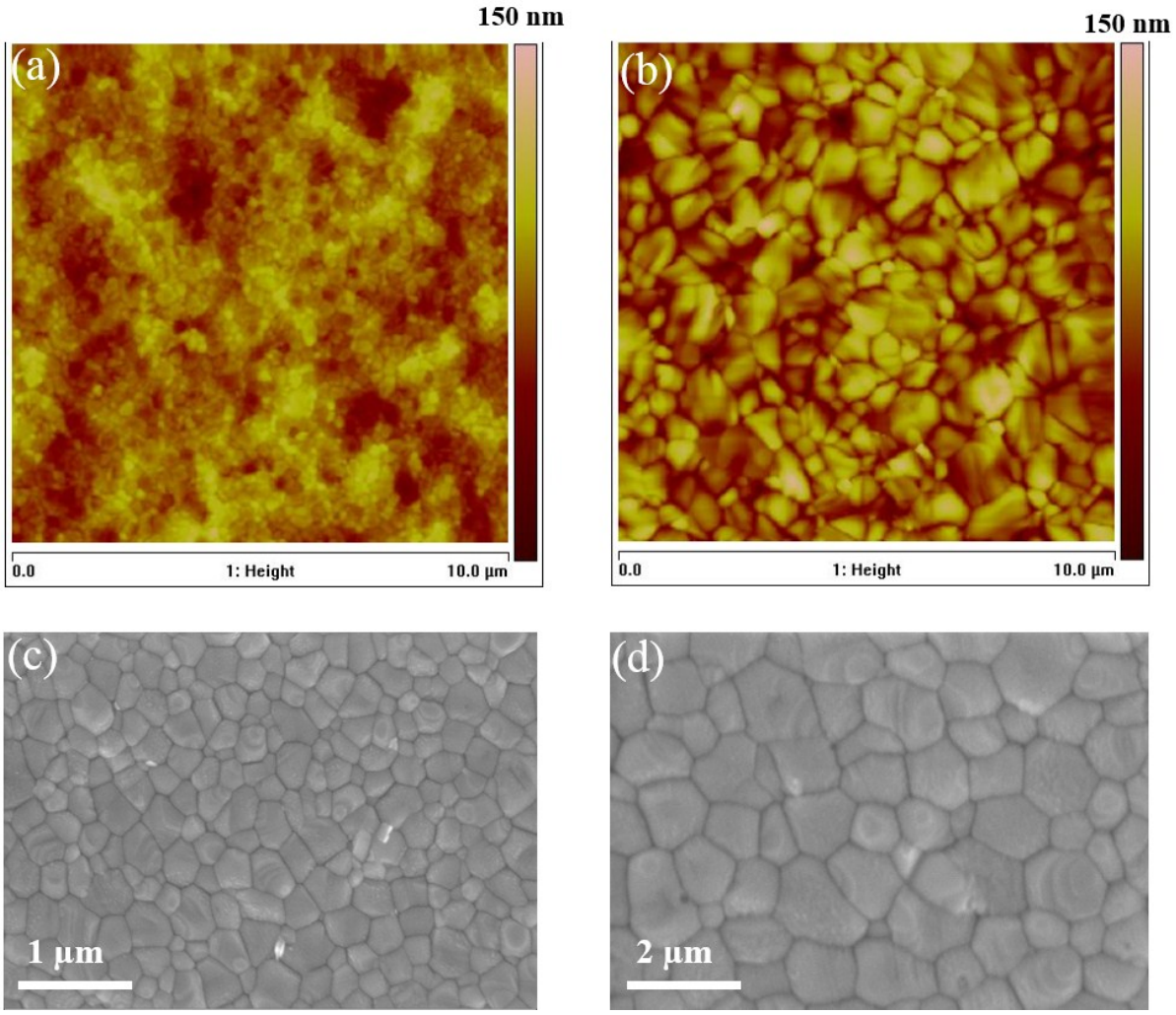

Figure S4. AFM images of perovskite films on MLG/ZnO annealed at (a) 70 ˚C and (b) 150 °C. SEM images of the perovskite films on MLG/ZnO annealed at (c) 70 ˚C and (d) 150 °C.

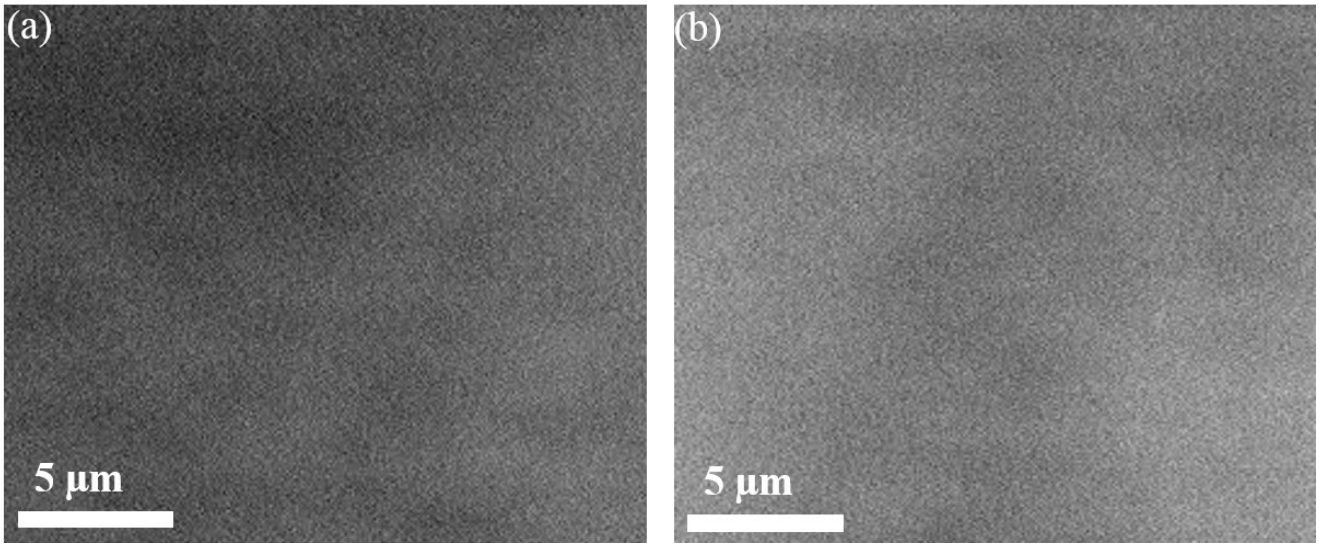

Figure S5. The original EBIC images of PSC devices before (a) and after (b) passivation with PFPA.

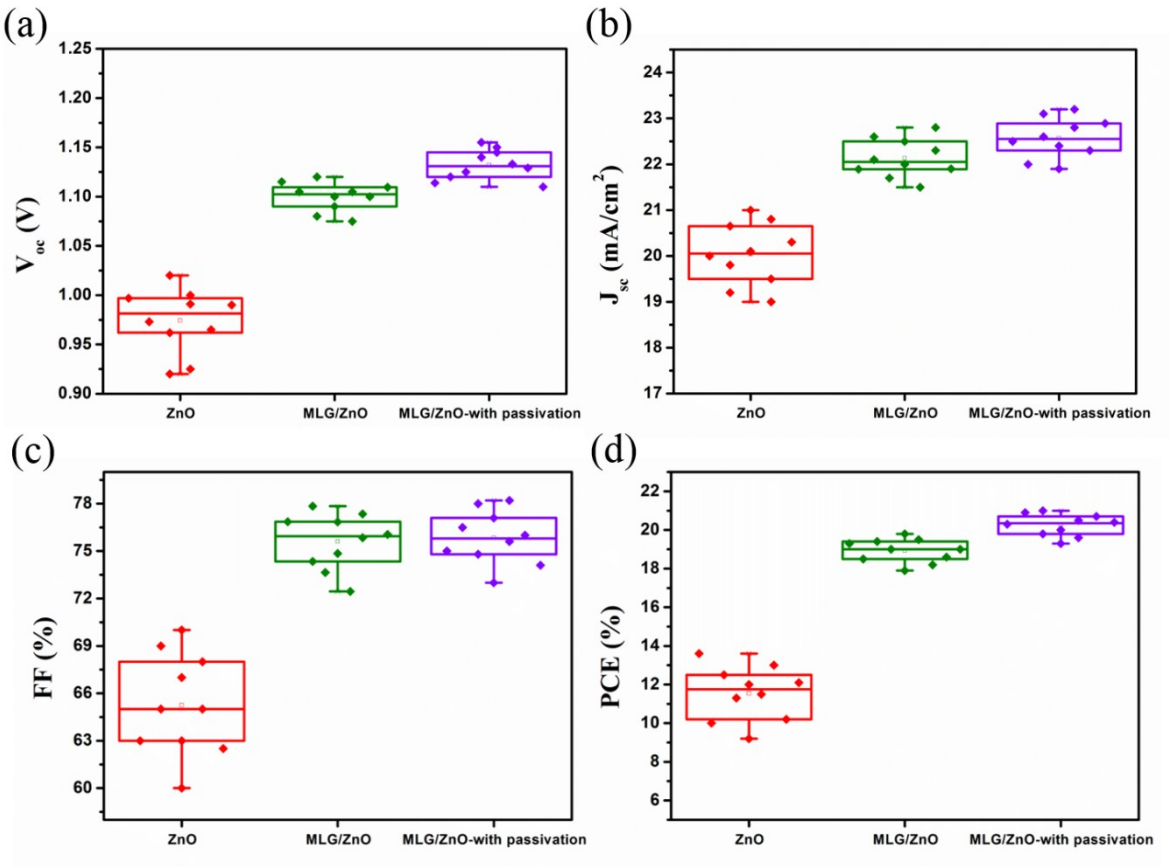

Figure S6. Statistical photovoltaic data for PSCs based on ZnO, MLG/ZnO, and MLG/ZnO-with passivation, (a) V_{oc}, (b) J_{sc}, (c) FF, and (d) PCE.

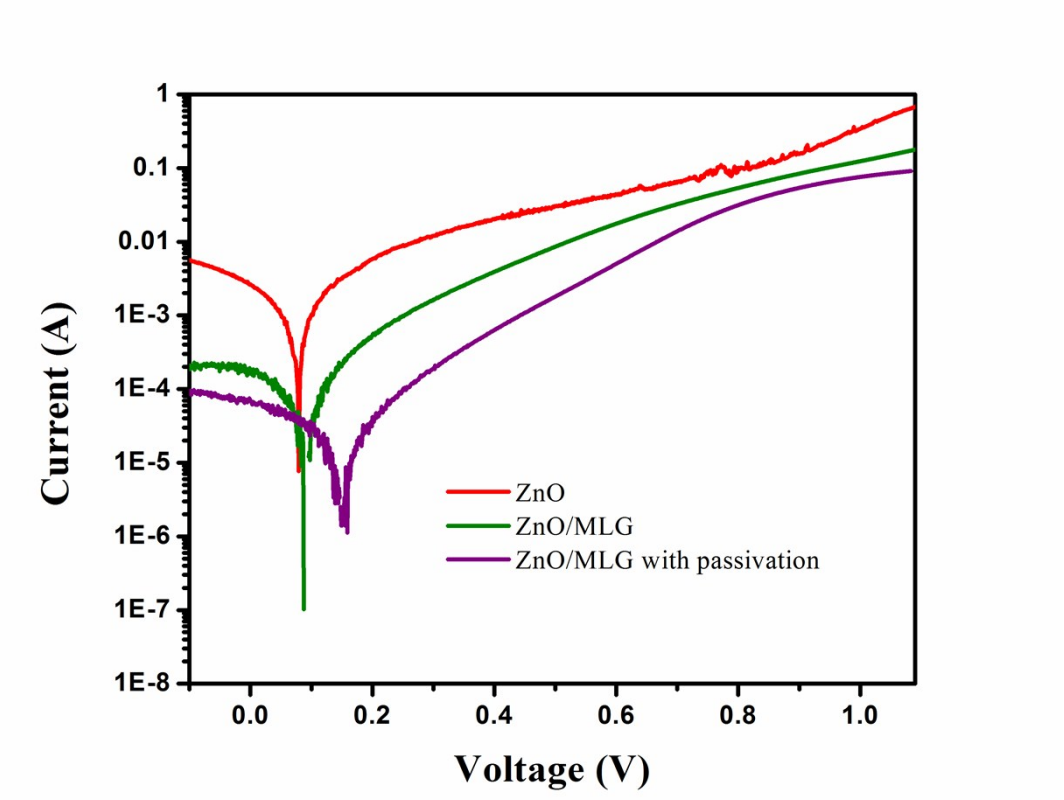

Figure S7. Dark Current-voltage characteristics in Log scale for PSC devices based on ZnO, MLG/ZnO before and after passivation.

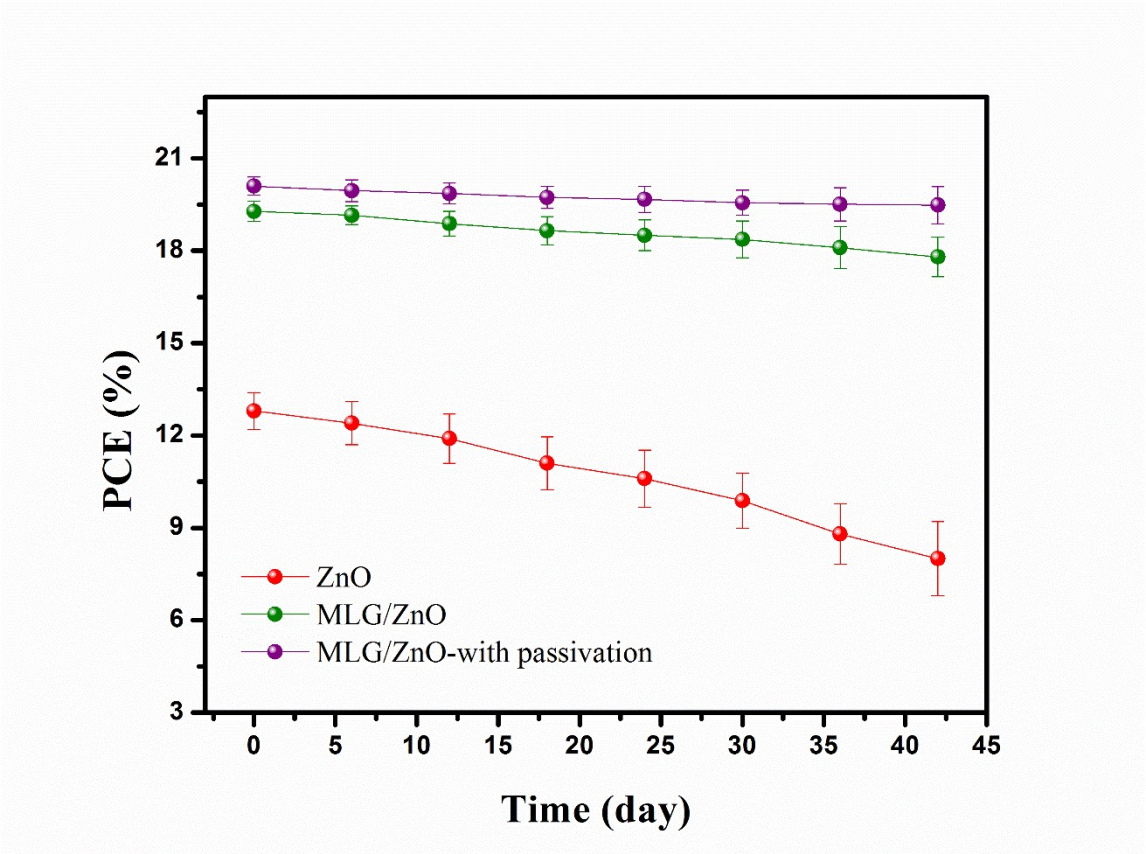

Figure S8. Shelf-life stability test of PSC devices based on ZnO, MLG/ZnO before and after passivation.

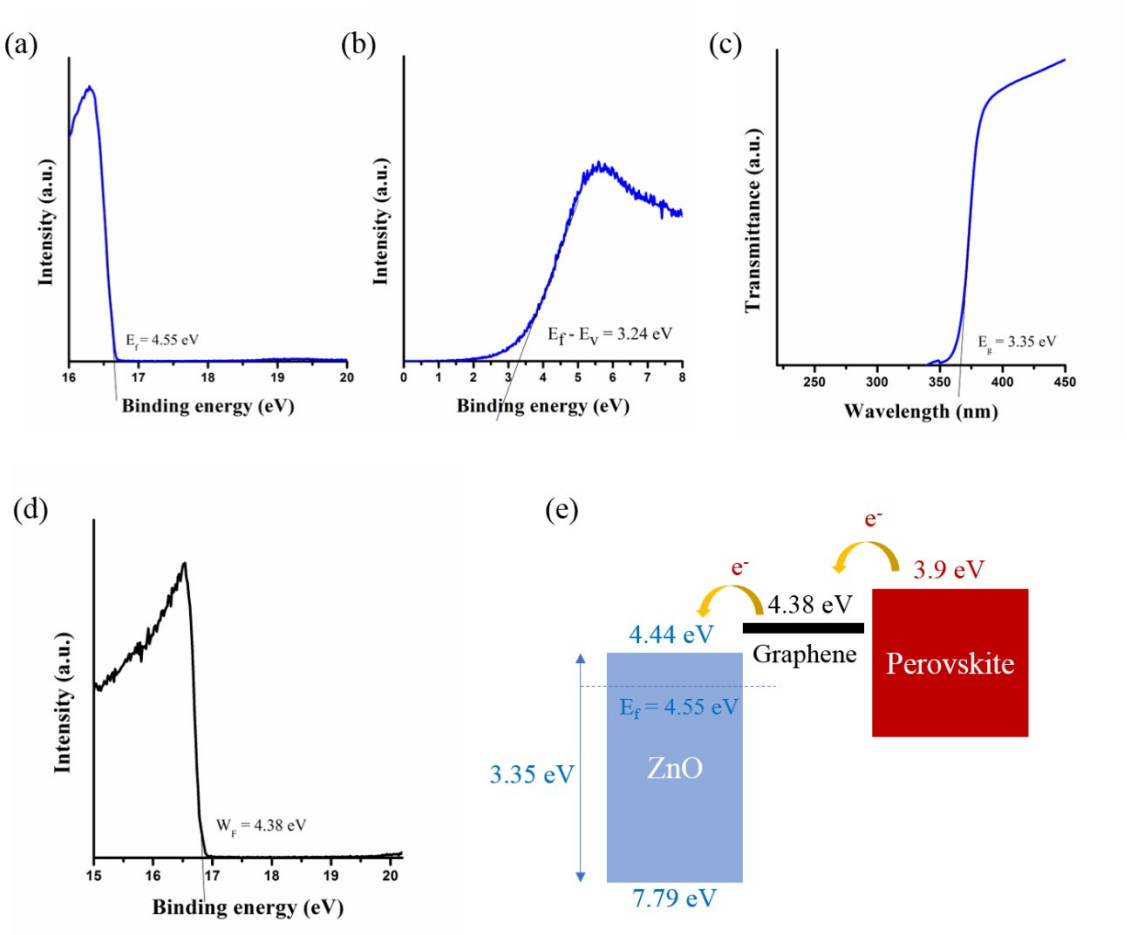

Figure S9. UPS measurement of ZnO ETL and MLG indicating (a) the Fermi level of ZnO, (b) the differences between the valence band and the Fermi level of ZnO, (c) the transmittance of ZnO, and (d) the work function of MLG. (c) Schematic band diagram of the PSC device based on MLG/ZnO.