

Supporting Information

Controlling the surface characteristics of ZnO and Al-doped ZnO thin films using the electrostatic spraying for their application in 12% efficient perovskite solar cells

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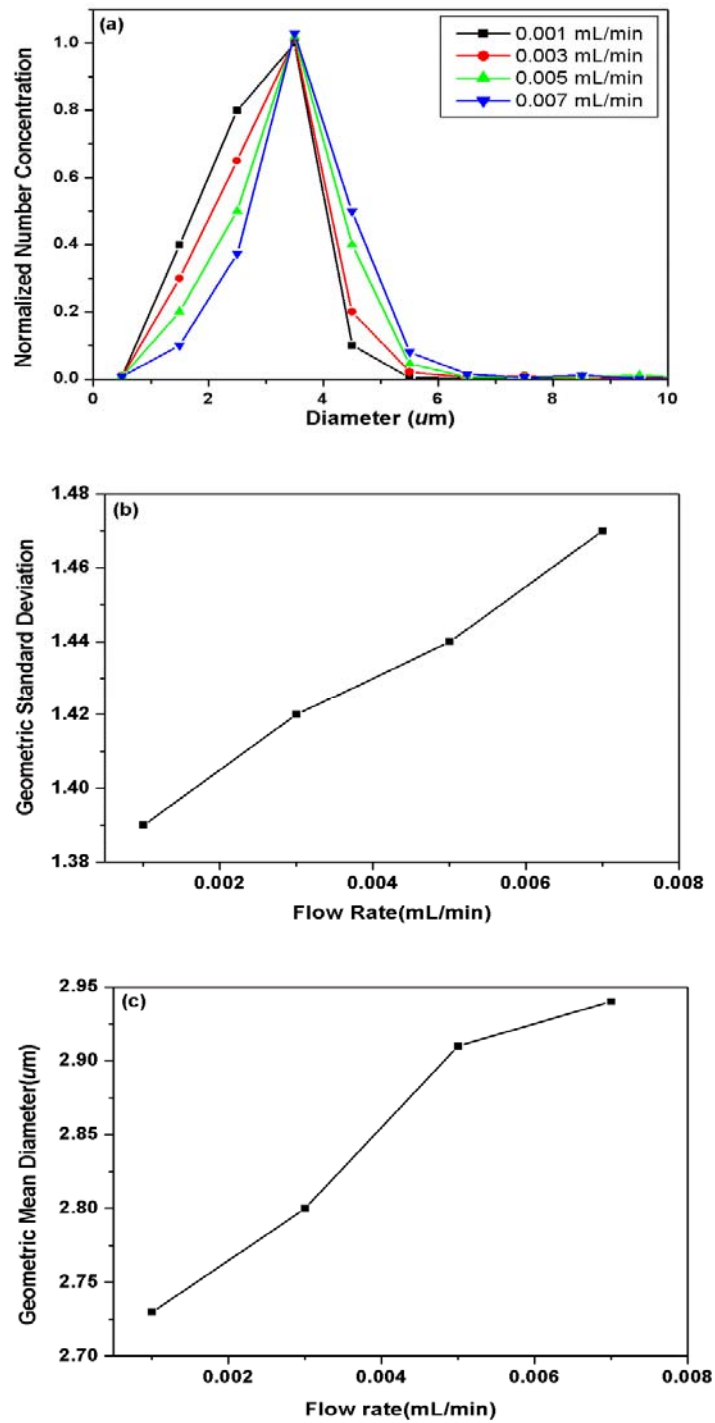


Fig. S1. (a) Real-time size distribution of the droplets, (b) Geometric standard deviation (GSD) as a function of flow rate, and (c) Geometric mean diameter (GMD) as a function of flow rate, respectively.

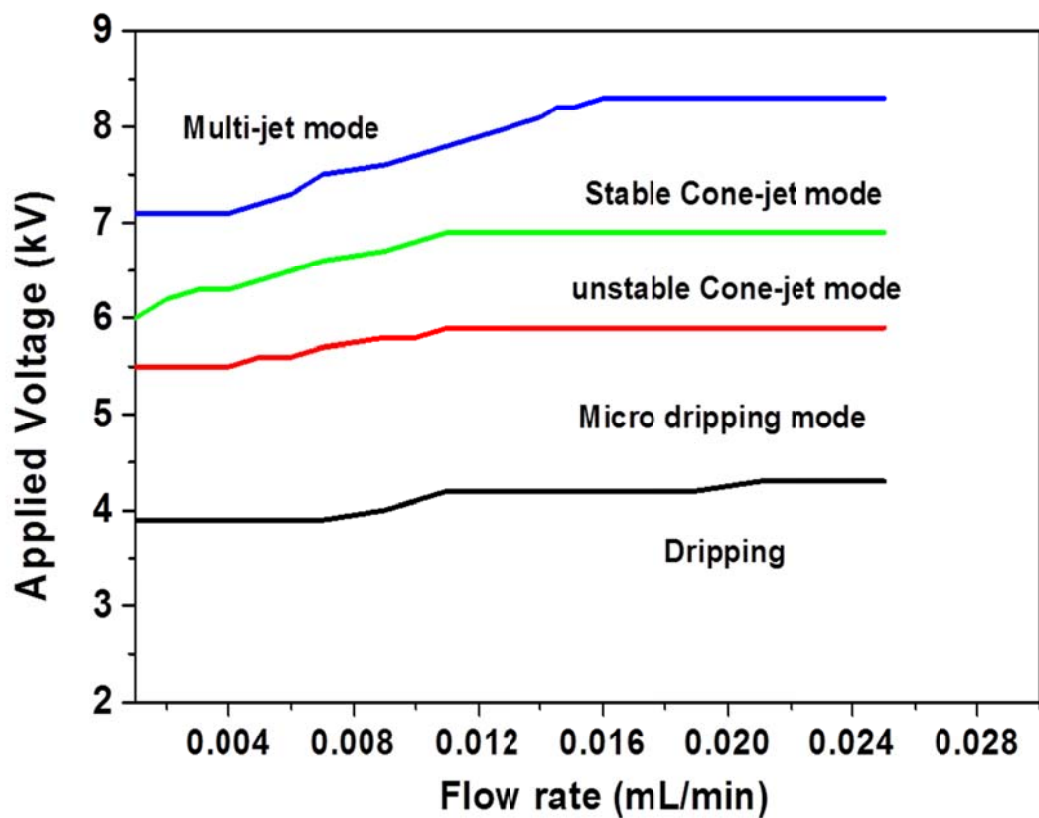


Fig. S2 Operating envelope for precursor solution atomization, showing the different modes of electrostatic spraying.

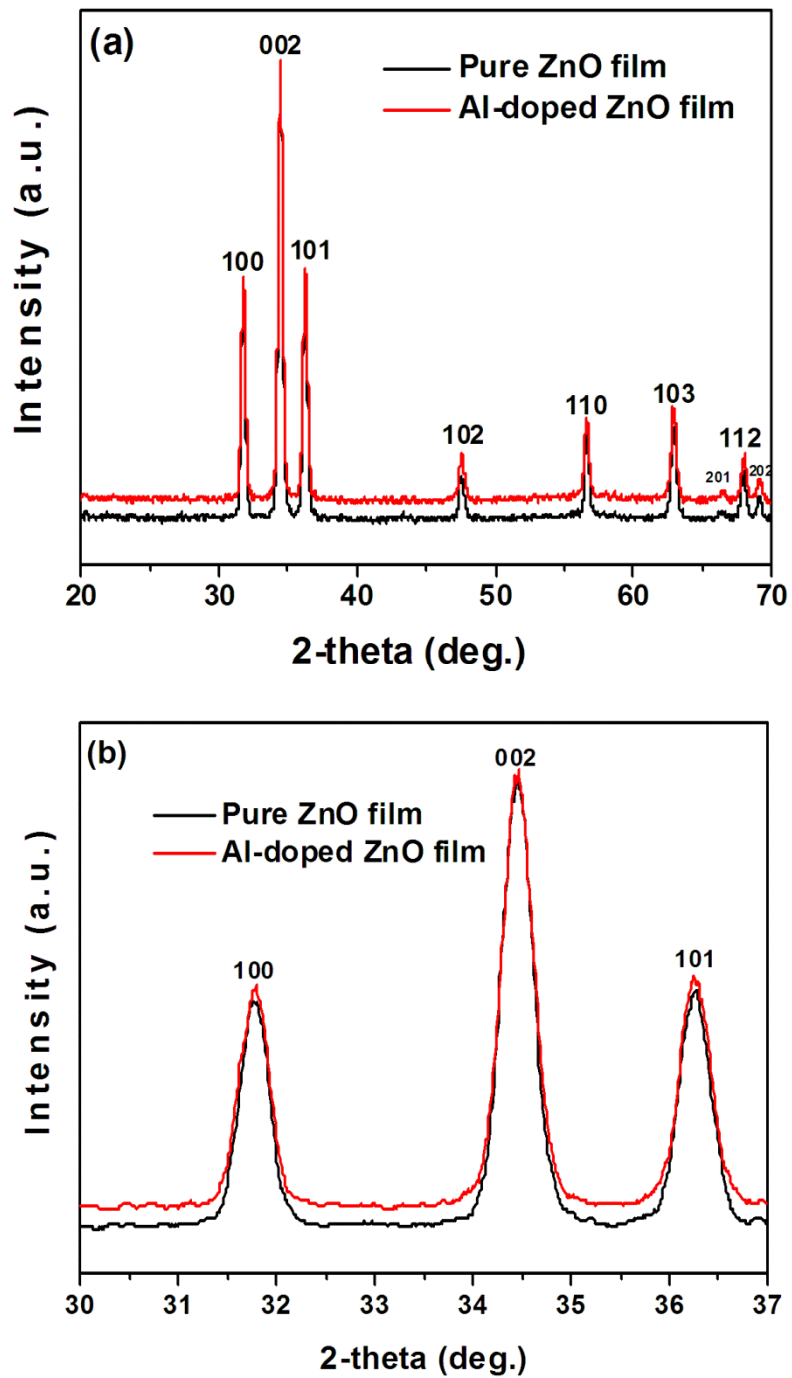


Fig. S3 (a) Comparison of XRD spectra of pure and Al-doped ZnO thin films, and (b) XRD spectra showing the peak shifting due to the Al-doping.

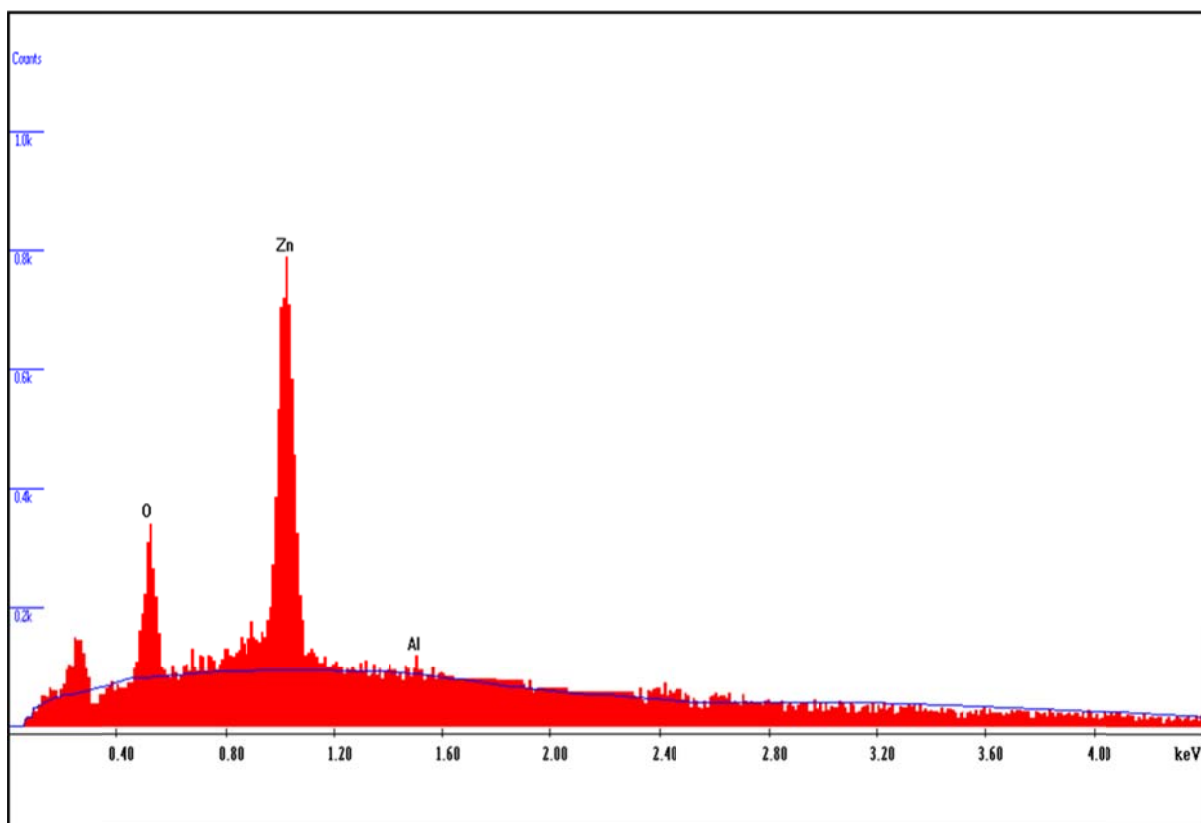


Fig. S4 EDS spectrum for Al-doped ZnO films exhibiting the co-existence of Al, Zn and O peaks.

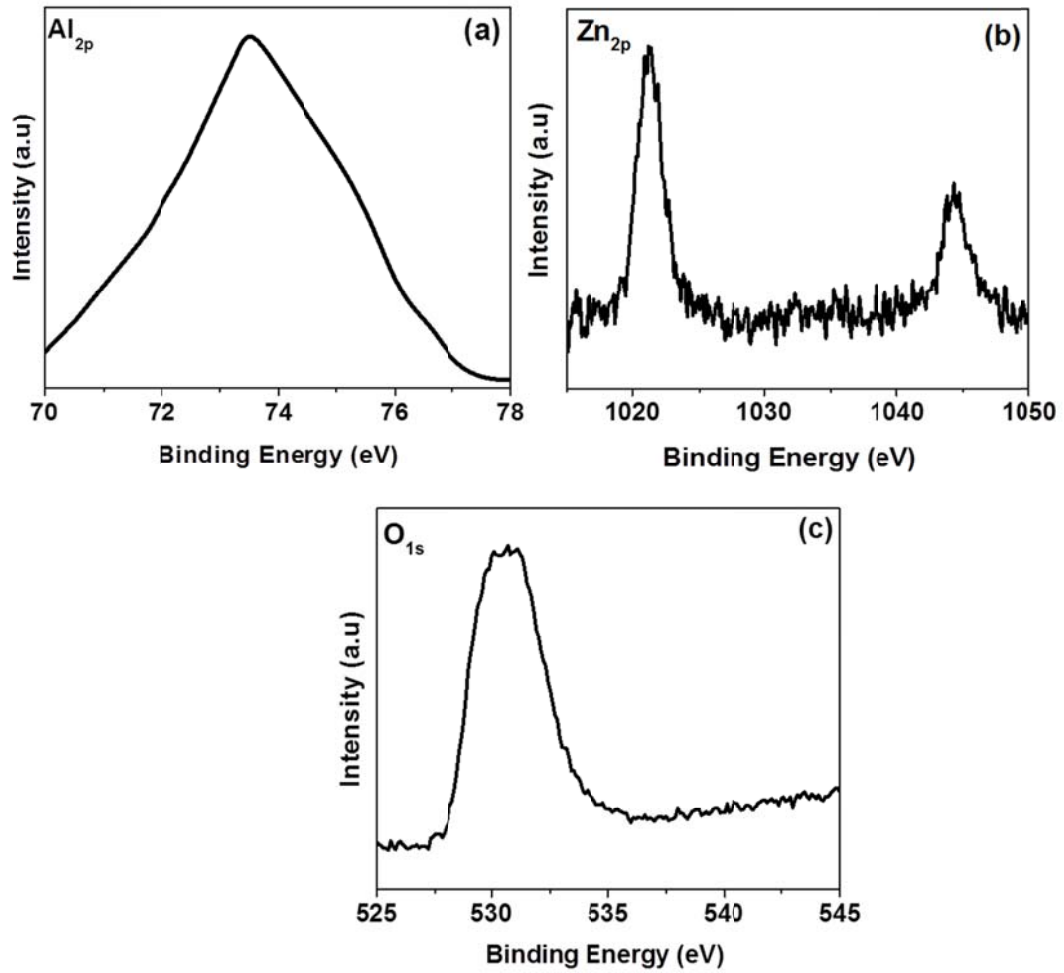


Fig. S5 XPS spectra of Al-doped ZnO film related to (a) Al_{2p}, (b) Zn_{2p}, and (c) O_{1s}, respectively.

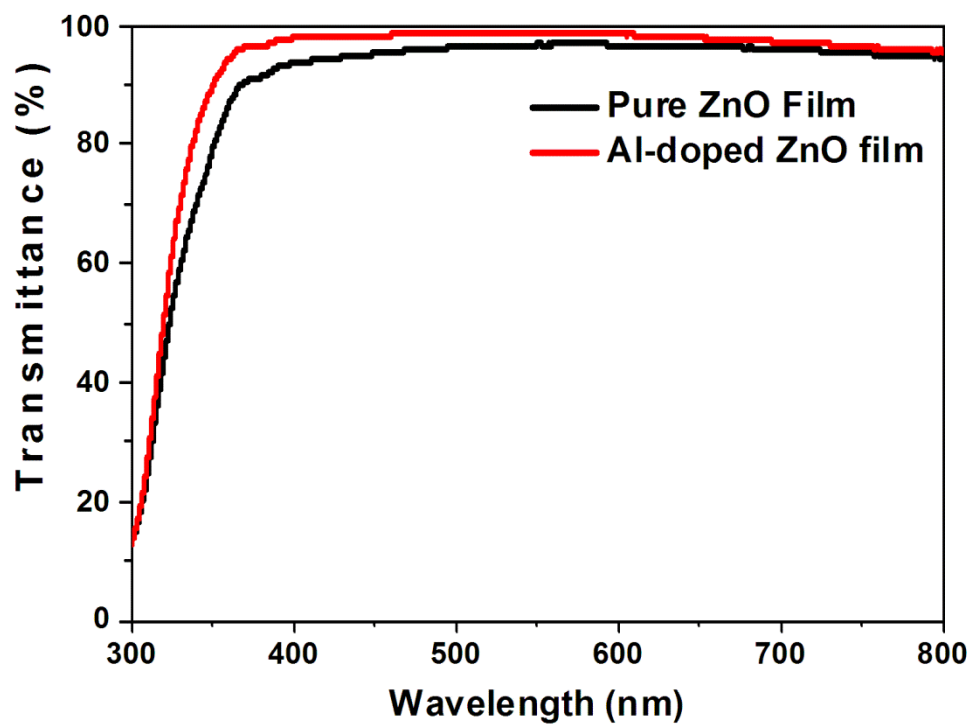


Fig. S6 Comparison of optical transmittance spectra for pure and Al--doped ZnO thin films.