

Supplementary Information

Carrier Transport Behaviors Depending on the Two Orthogonally Directional Energy Bands in the ZnO Nanofilm Affected by Oxygen Plasma

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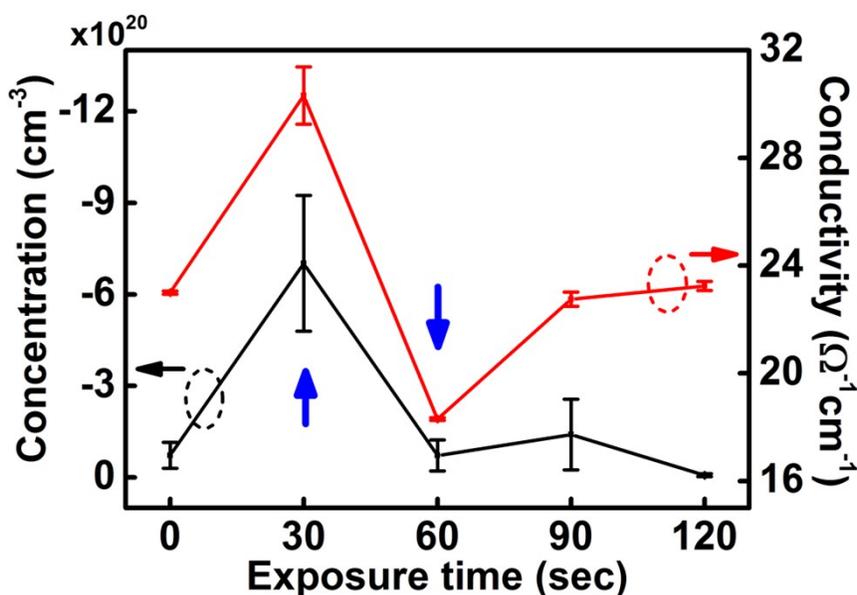


Fig. S1 Carrier concentrations and conductivity measured using the Hall-effect at room temperature according to the various exposure times to oxygen plasma (30, 60, 90, and 120 s). This initial experiment was repeated five times immediately after ALD deposition of ZnO nanofilm and subsequent oxygen plasma treatment. The error bars represent standard deviation taken from the repetitive experiments. We observed repeatedly that the maximum and minimum peak (blue arrows) of conductivity existed at 30 s and 60 s of exposure time.

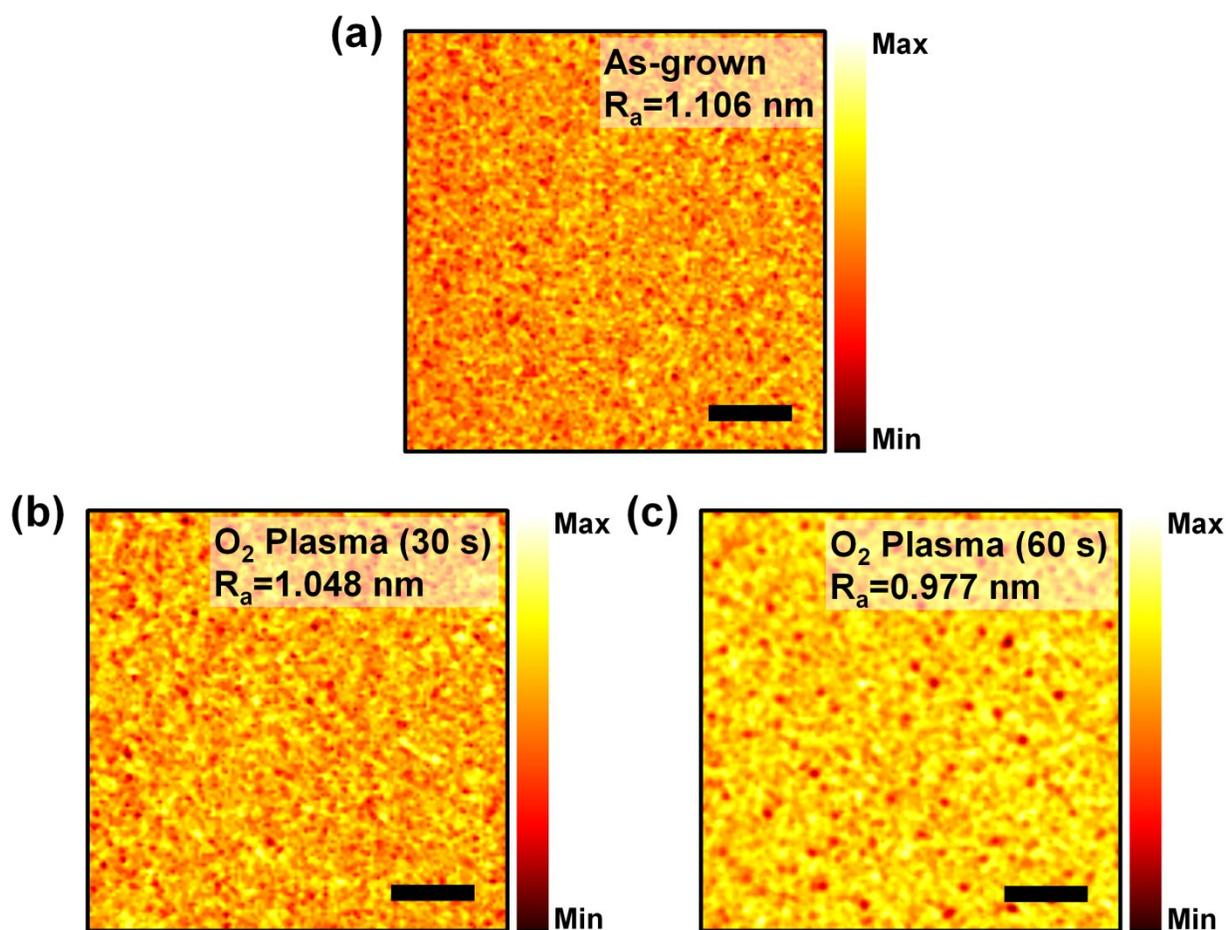


Fig. S2 AFM images of ZnO nanofilm regarding as-grown (a), O₂ plasma for 30 s (b) and O₂ plasma for 60 s (c). The scale bar is 300 nm. The average surface roughness (R_a) is reduced according to the increase in exposed time.

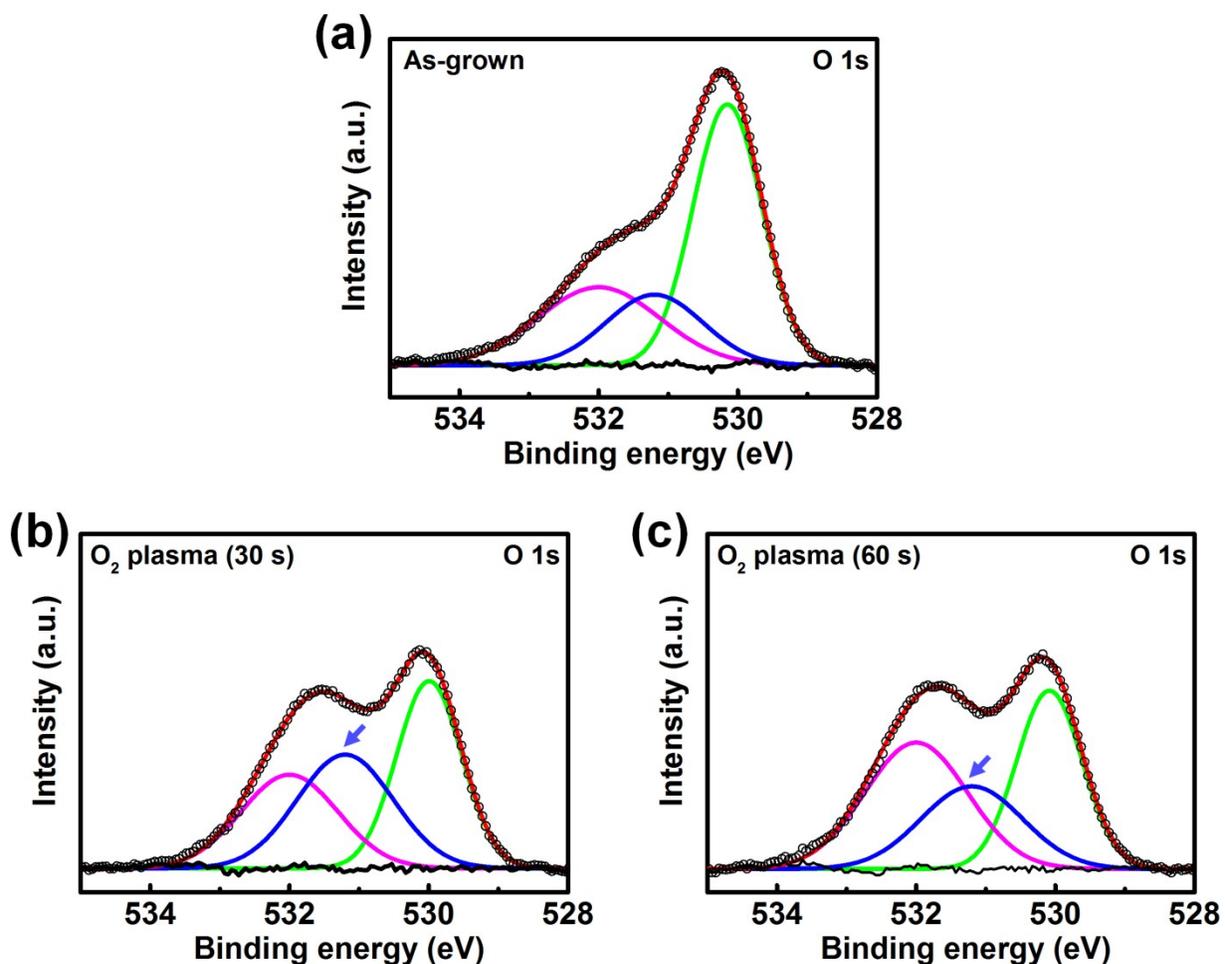


Fig. S3 The O 1s peaks spectra of samples were deconvoluted into three peaks by a combination of Gaussian (80%) and Lorentzian (20%) fits,^{1,2} regarding as-grown (a), O₂ plasma for 30 s (b), and O₂ plasma for 60 s (c). The lower binding energy peak (LP, green line) near 530 eV is associated with the O-Zn bonds in the hexagonal wurtzite ZnO structure. The medium binding energy peak (MP, blue line) near 531 eV is related to the oxygen vacancy. Last, the higher binding energy peak (HP, purple line) near 532 eV is involved in chemisorbed or dissociated oxygen and/or OH⁻ groups on the surface. The blue arrows indicate an intensity change of the MP peak between the 30-s and 60-s samples.

References

- 1 S. Bang, S. Lee, J. Park, S. Park, Y. Ko, C. Choi, H. Chang, H. Park and H. Jeon, *Thin Solid Films*, 2011, **519**, 8109–8113.
- 2 C. Park, J. Lee, H. M. So and W. S. Chang, *J. Mater. Chem. C*, 2015, **3**, 2737-2743.