Supporting Information

Fabrication of a novel hierarchical assembly of ZnO nanowires on WOx nanowhiskers for highly efficient field electron emission

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**Fig.S1.** TEM analysis of the hierarchical ZnO/WOx heteronanostructures (a) A high angular annual dark field (HAADF) scanning TEM image of single hierarchical ZnO/WOx sample and scanning TEM-EDX elemental mapping images of (b) W, (c) Zn, and (d) O. (e) Energy dispersive spectra (EDS) recorded from the hierarchical ZnO/WOx heteronanostructures.
Fig. S2. Field-emission J-V curves: (a) ZnO nanowires/W_{10}O_{49} nanowhisker arrays on tungsten substrates with different growth times for the ZnO NWs (3 hr and 6 hr). The inset includes the FN plots of both samples. (b) and (c) depict the field emission images of samples grown in 3 hr and 6 hr, respectively.

Figure S2 depicts the field emission characteristics of the ZnO/WOₓ hierarchical nanostructures with different ZnO growth times of 3 hr and 4.5 hr at 95 °C using 10 mM Zn(NO₃)₂ with an ammonia solution. Although the ZnO nanowires were grown for longer time duration, the field emission current was decreased as observed from these results. The obtained turn-on field voltages at 10 mA/cm² were estimated to be 4.1 and 4.6 V/μm for the samples that were grown at 3 hr and 4.5 hr, respectively. The reasons for the observed degradation in emission properties may be ascribed to screen effects due to an increased density of ZnO nanowires. A longer growth time produced ZnO nanowires having longer lengths with higher densities on the WOₓ nanowhiskers, as confirmed by the SEM images. The field emission images of both samples were taken at 0.8 kV (5.3 V/μm). As seen in the field emission images of figure S2(b, c), the 3hr grown sample exhibited a brighter and more uniform emission in comparison to the 4.5 hr grown sample.