Enhanced electron field emission properties of high aspect ratio
silicon nanowire-zinc oxide core-shell arrays

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Supporting Information:

Energy Dispersive X-ray Spectroscopy (EDS):

\begin{center}
\includegraphics[width=0.4\textwidth]{energy-dispersive_x-ray_spectroscopy.png}
\end{center}

\textbf{Fig. S1} Energy Dispersive X-ray Spectroscopy (EDS) analysis of SiNW-ZnO core-shell arrays.

EDS analysis confirms the elements Si, Zn and O of the SiNW-ZnO arrays. Fig S1 shows the silicon has emission X-ray signals at $K_\alpha$ at 1.740 eV and $K_\beta$ at 1.829 eV while Zn has $L_\alpha$ at
1.022 eV, $K_\alpha$ at 8.637 eV and $K_\beta$ at 9.570 eV. Oxygen has $K_\alpha$ signals at 0.523 eV. The signal $K_\alpha$ at 8.040 eV is assigned for copper from the TEM grid.

**AFM imaging:**

The surface roughness changes effected after the ZnO coating are also studied by tapping mode atomic force microscopy (AFM) technique; accordingly the height profile AFM image in Fig. S2 a of blank SiNWs of $10 \times 10 \, \mu m^2$ area shows that the nanowires occur in bundles. Fig. S2 b is the linear section height profile of marked line in Fig. S2 a which shows that the surface roughness of the bundles of nanowires is $\sim 350 \, nm$ which acts as the core arrays for the growth of ZnO. Similarly, Fig. S2 c is the height profile AFM image of SiNW-ZnO arrays of $10 \times 10 \, \mu m^2$ area shows that, after ZnO layer formation, there is no any change the orientation of SiNW arrays. Fig. S2 d is the linear section height profile of marked line in Fig. S2 c which shows that the surface roughness of ZnO layer on SiNW arrays is upto 120 nm. The significant change of surface roughness from $350 \, nm$ of blank SiNWs to $120 \, nm$ of SiNW-ZnO arrays is due to the uniform ZnO formation on SiNW arrays.

![AFM images](image)

**Fig. S2** (a) top surface AFM image of blank SiNWs and (b) cross sectional analysis of the marked line in Fig. S2 (a); similarly (c) top surface AFM image of SiNW-ZnO arrays and (d) cross sectional analysis of the marked line in Fig S2 (c).
Field Emission Stability data:

![Graph showing field emission stability data](image)

**Fig. S3** Field Emission stability data of SiNW-ZnO core-shell arrays at 11 V µm⁻¹.

Field Emission stability data for SiNW-ZnO arrays shown in Fig. S3 confirms that the core-shell arrays are stable for 40 minutes at the applied potential of 11 V µm⁻¹. It is also notable that there is no current degradation during the measurement.
FESEM images after FE measurements:

Fig. S4 (a) and (b) are vertical section FESEM images of blank SiNW and SiNW-ZnO arrays after field emission (FE) measurements respectively.

Fig. S4 (a) and (b) shows a FESEM images after the field emission measurements of blank SiNW and SiNW-ZnO arrays respectively. There is no obvious deterioration even after a typical long-term operation indicating the excellent mechanical stability of these core-shell arrays with no field induced mechanical stresses. This excellent current stability would be an asset for sustained performance of the emitters.