

## **Electronic Supplementary Information**

### **Catalyst free N-doped carbon nanotube arrays based on ZnO nanorod template with high performance field emissions**

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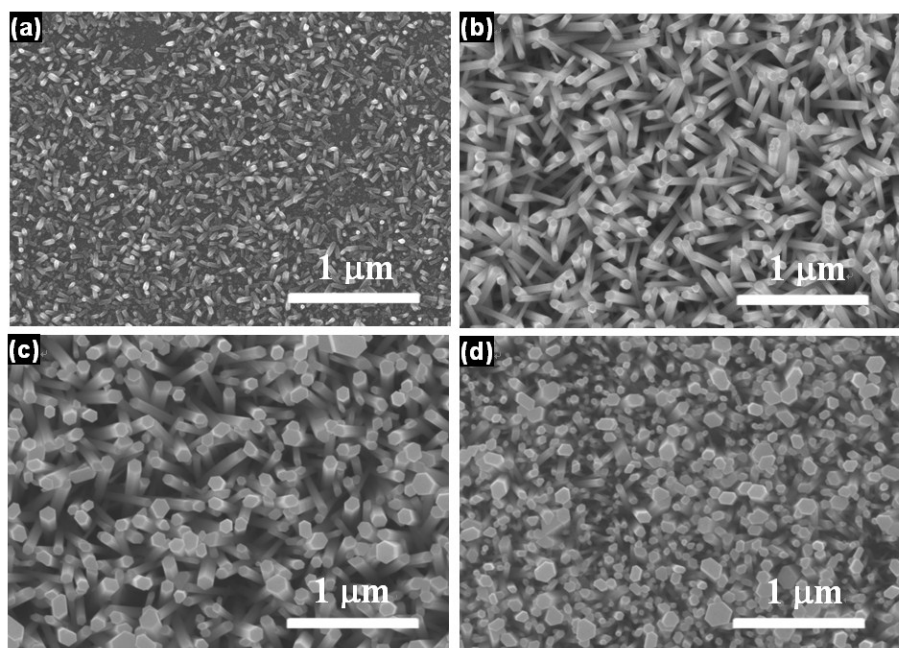
**SI-3** SEM images of the NCNT samples

**SI-4** The repeatability test of the FE characteristics for NCNT samples

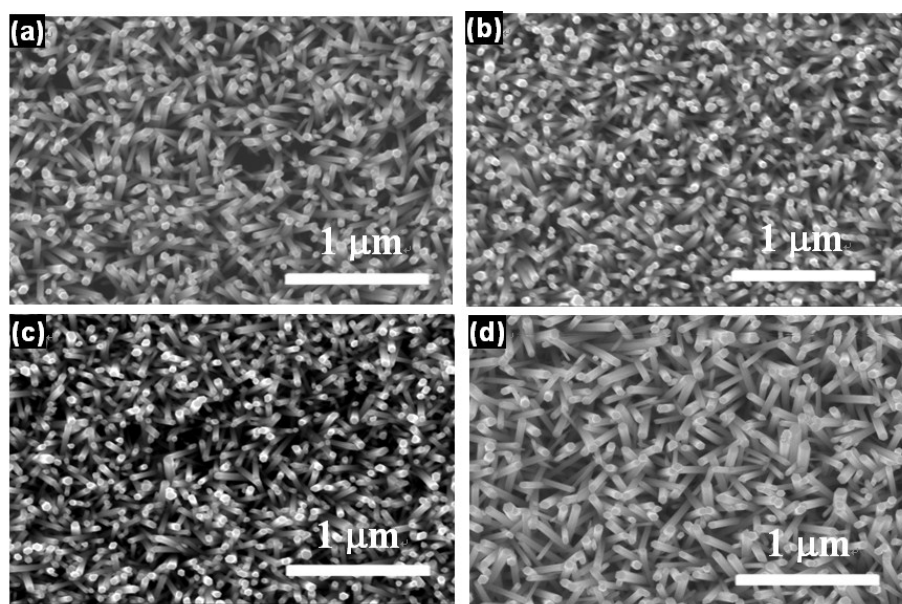
#### References

### SI-1 The optimized experimental condition

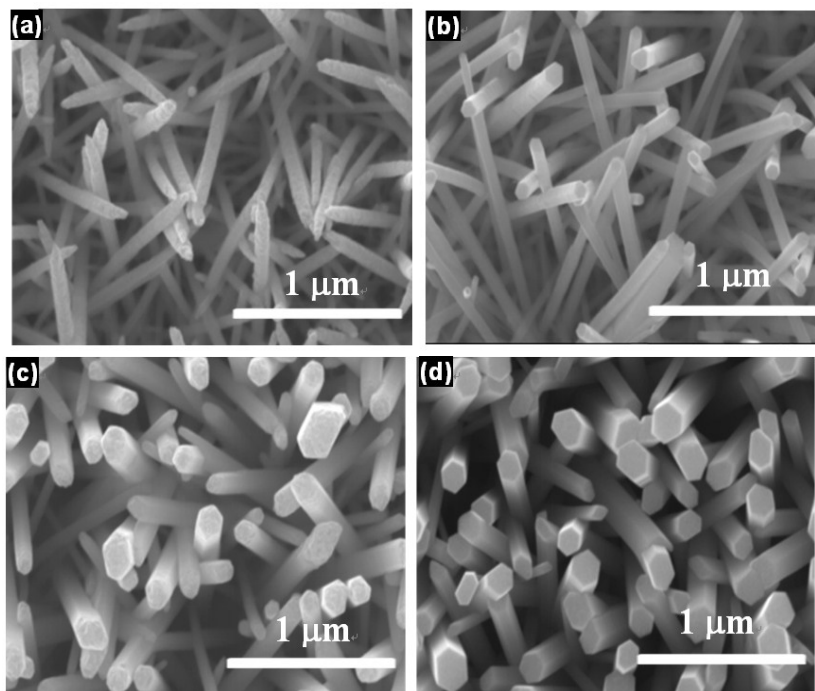
The morphologies of ZnO nanorods by hydrothermal method are mainly related to the reaction time, reaction temperature, and concentration & ratio of the reaction solution ( $\text{Zn}(\text{NO}_3)_2 \cdot 6\text{H}_2\text{O}$  with  $\text{C}_6\text{H}_2\text{N}_4$ ).<sup>1-3</sup> We did a series of single factor experiments, as shown in Figs. S1, S2, and S3, and the optimized conditions (6 h, 90°C, and concentration of 0.1 M) were selected in our experiments to obtain high aspect ratios and structural uniformities of ZnO nanorods, leading to optimized structural and field emission properties of the nanotube.



**Fig. S1** SEM images of the ZnO nanorods with different reaction times. (a) 3h; (b) 6h; (c) 12h; (d) 20h.

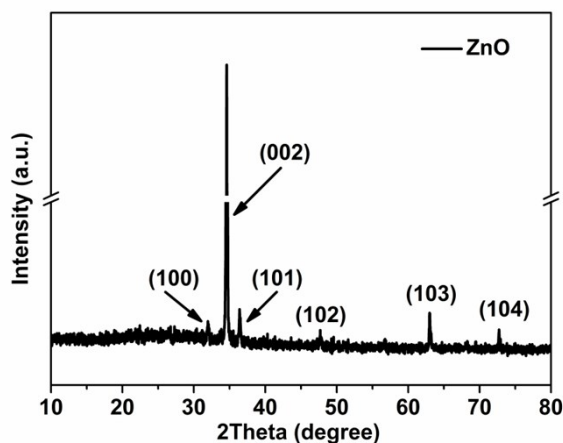


**Fig. S2** SEM images of the ZnO nanorods with different temperatures. (a)70°C; (b) 80°C; (c) 85°C; (d) 90°C.



**Fig. S3** SEM images of the ZnO nanorods of different thicknesses with different reactant concentrations. (a) 0.005M; (b) 0.01M; (c) 0.025M; (d) 0.05M.

#### SI-2 XRD pattern of ZnO nanorods



**Fig. S4** XRD characterization of the ZnO nanorods.

As shown in Fig. S4, XRD characterization indicates that six sharp peaks at 31.8°, 34.4°, 36.3°, 47.5°, 62.7° and 72.8° come from the (100), (002), (101), (102), (103) and (104) planes of ZnO nanorods,<sup>4-6</sup> respectively. Moreover, the intensity of the (002) peak is much higher than the other five peaks, suggesting that the ZnO nanorods is highly grown along the c-axis orientation.

### SI-3 SEM images of the NCNT samples

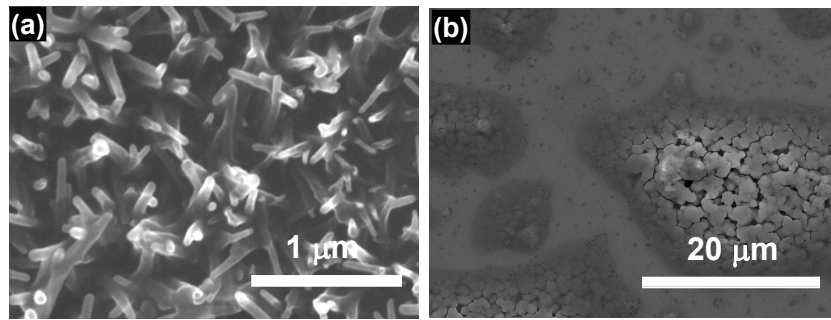


Fig. S5 SEM images of the (a) NCNT-5 and NCNT-30 samples

### SI-4 The repeatability test of the FE characteristics for NCNT samples

The FE tests of the NCNT samples are repeated four times to confirm the repeatability of the FE characteristics. As shown in Fig. S6, the FE repeatability between different NCNT samples are excellent, and the J-E curves, also F-N curves, do not deviate from each other evidently after four round FE tests.

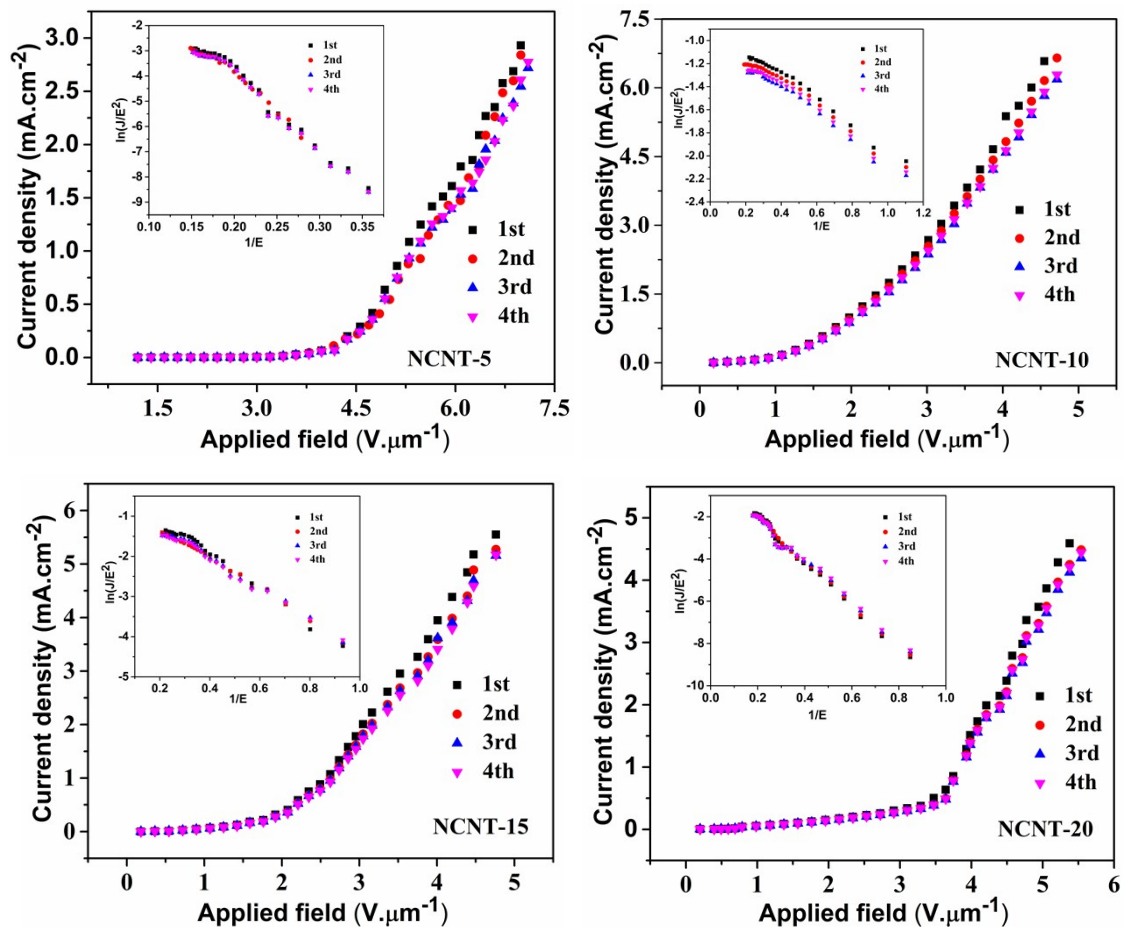


Fig. S6 J-E curves of the different NCNT samples with four times FE tests.

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