Electronic Supplementary Information

**Morphological Optimization of Large-area Arrays of the TiO₂ Nanowires &
Nanotubes for Enhanced Cold Field Emission: Experiment and Theory**

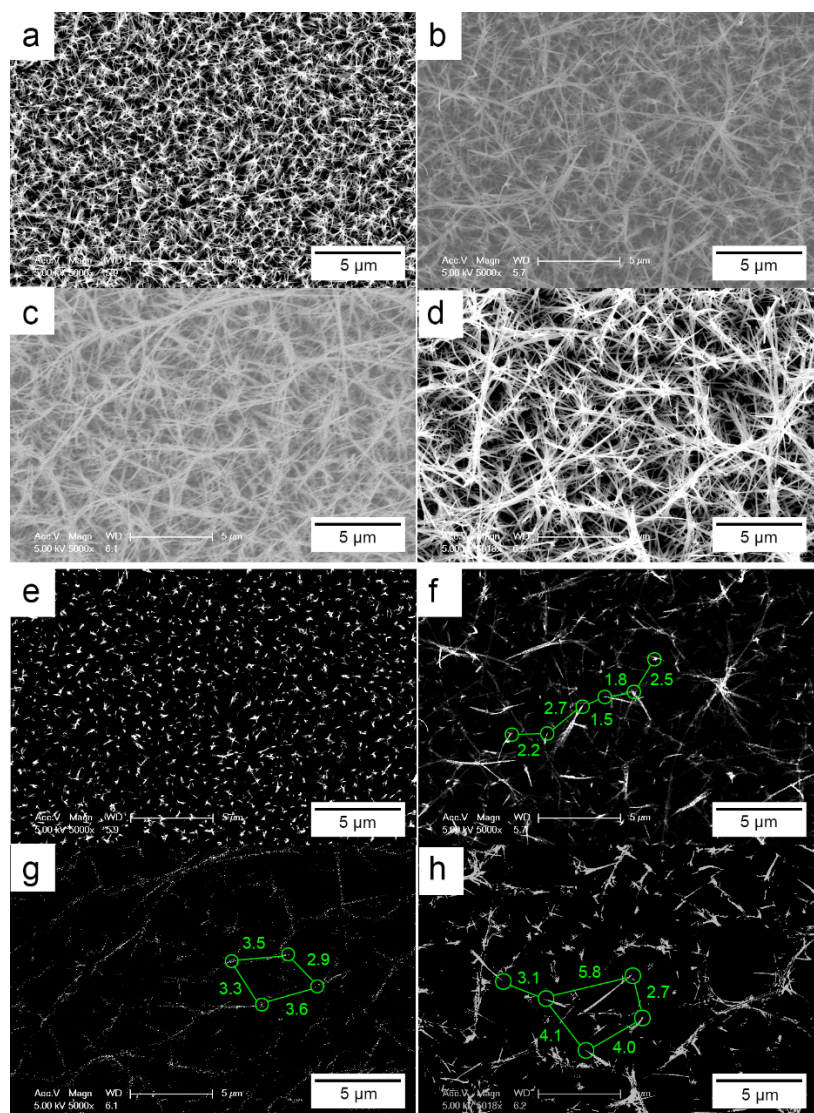*Mingi Choi, Zhuo Zhang, Jingkun Chen, Zexiang Deng and Kijung Yong**

Fig. S1 a-d) Top-view SEM images of the TiO₂ nanowire arrays having growth
durations for 4, 8, 12 and 16 hours, respectively; e-h) Photographs taken from
figure S1a-d with increased contrast and weakened brightness. The green circles
mark the top-tips of the taller nanowires and the green values (μm) present the
inter-distances between the neighboring circles.

Fig. S1 a-d exhibit the top-view SEM images of the TiO$_2$ nanowire arrays having growth durations for 4, 8, 12 and 16 hours, respectively. We can see that the TiO$_2$ nanowires turns more sparse with the increasing height. Although it is difficult to point out and mark the taller nanowires from their initial images, the top-tips of them become clearer when we weaken the lightness and increase the contrast of their images (Figure S1 e-h). Here, green circles are used to mark the neighboring top-tips of the taller nanowires. It should be noticed that there is no mark for the TiO$_2$ nanowires grown for 4 hours, because the taller and shorter wires are equal for this sample. For the other three samples, the inter-distance between the taller nanowires is presented by green figures. Thus, it can be seen from Figure S1 f-h that the average inter-distances are about 2, 3 and 4 μm for the nanowires grown for 8, 12 and 16 hours, respectively.
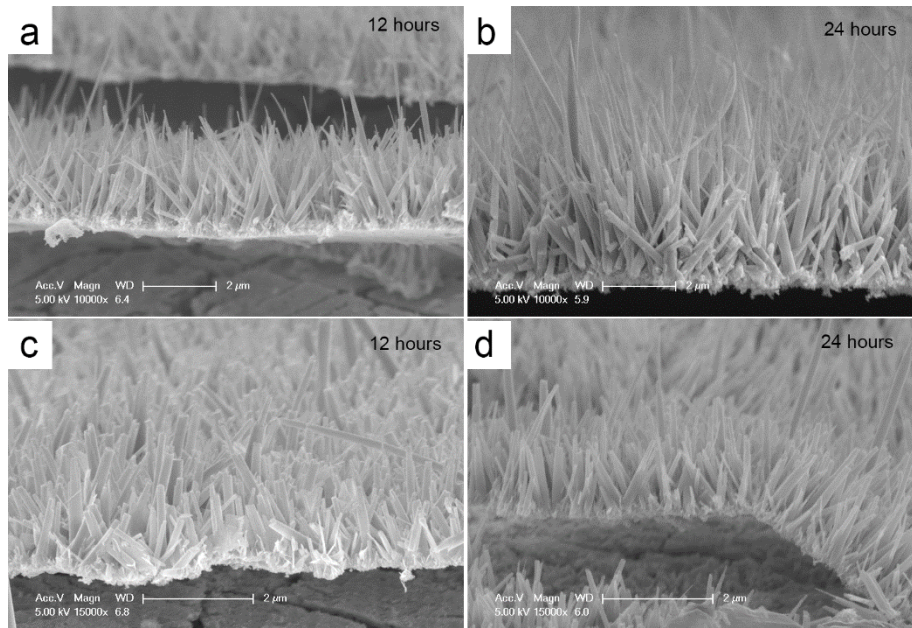

Fig. S2 TiO$_2$ nanotube arrays grown for 12 (a and c) and 24 (b and d) hours, respectively. The upper row is side-view and the bottom row is tilted-view.

Then, for nanotubes, we can also find that the taller nanotubes became longer and sparser with the increasing growth durations (Fig. S2). Therefore, the theoretical inter-distances between the taller effective nanowires and nanotubes determined from the "ZTCD" model are well confirmed by the experiments.