Supplementary Information

One-pot Synthesis of SnO_2 Nanotubes Based on Nanoscale Kirkendall Effect at Room Temperature

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Experimental section

All the chemicals used were analytical grade without further purification. 0.5 ml PDDA (20% Wet.) and 0.1g $NaBH_4$ were dissolved in 60 ml deionized water. Such a mixed solution was dropwise added with 30 ml $SnCl_4$ solution containing 0.18 g $SnCl_4$ at room temperature. The product was collected by the burette when the reaction time was 5min, 30min and 12h, respectively. The resulting solid products were successively centrifuged, washed with the deionized water and ethanol to remove the ions possibly remaining in the final products, and finally dried at 60 ^{o}C in air. In order to change the size of the resulting SnO_2 nanotubes, the volume of the added PDDA was changed while keeping other conditions as mentioned above unchanged. The product was collected by burette when the reaction time was 5min and 12h, respectively.

The obtained samples were characterized by X-ray powder diffraction (XRD) using a Japan Rigaku D/max-ga x-ray diffractometer with graphite monochromatozed CuKa radiation (λ=1.54178Å). The morphologies of the samples were observed by transmission electron microscopy (TEM, JEM 2010 200 kV). High-resolution transmission electron microscopy (HRTEM) observation was performed on JEM 2010F operated at 300 kV. X-ray photoelectron spectroscopy (XPS) analysis was performed on an AXIS-Ultra instrument using monochromatc Al Kα radiation (225 W, 15 mA, 15 kV) and low–energy electron flooding for charge compensation.

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Figure S1 shows the TEM and HRTEM images of the as synthesized SnO_2 nanoparticles in absence of PDDA and the corresponding XRD pattern.

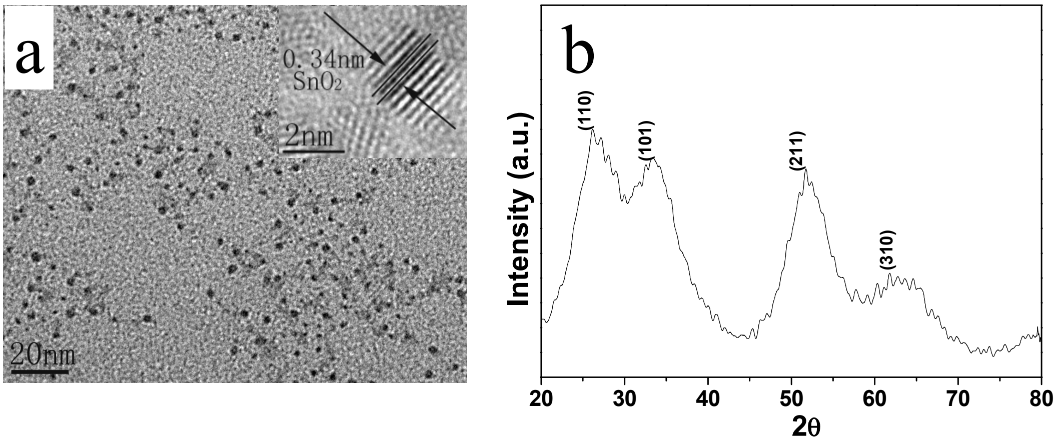


Figure S1 a) TEM image of the as synthesized SnO_2 nanoparticles in absence of PDDA and the right-upper inset HRTEM image. b) XRD pattern of the as synthesized SnO_2 nanoparticles in absence of PDDA.

Figure S2 shows the TEM image of the as synthesized SnO_2 nanoparticles in presence of PSS as the soft template. Only nanoparticles can be seen in the TEM image.

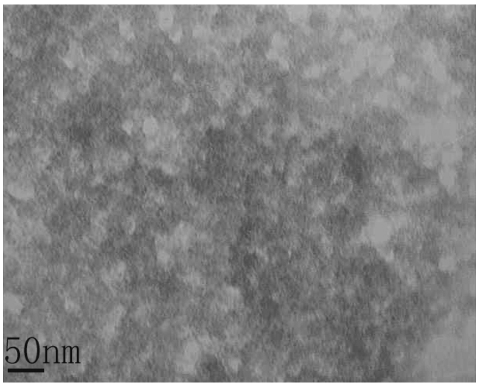


Figure S2 TEM image of the as synthesized SnO_2 nanoparticles in presence of PSS as the soft template

The length of the SnO_2 nanotubes, determined by the length of the Sn nanorods, could be adjusted by the molar ratio of PDDA/$SnCl_4$. As shown in figure S3, when 5 ml PDDA was used, the length of the Sn nanorods increased to 700-800 nm and the corresponding SnO_2 nanotubes also increased to 700-800 nm. When 0.1 ml PDDA was used, the length of the Sn nanorods decreased to 30-50 nm and the corresponding SnO_2 nanotubes also decreased to 30-50 nm. The results indicate that the length of the SnO_2 nanotubes could be controlled by the molar ratio of PDDA/$SnCl_4$.

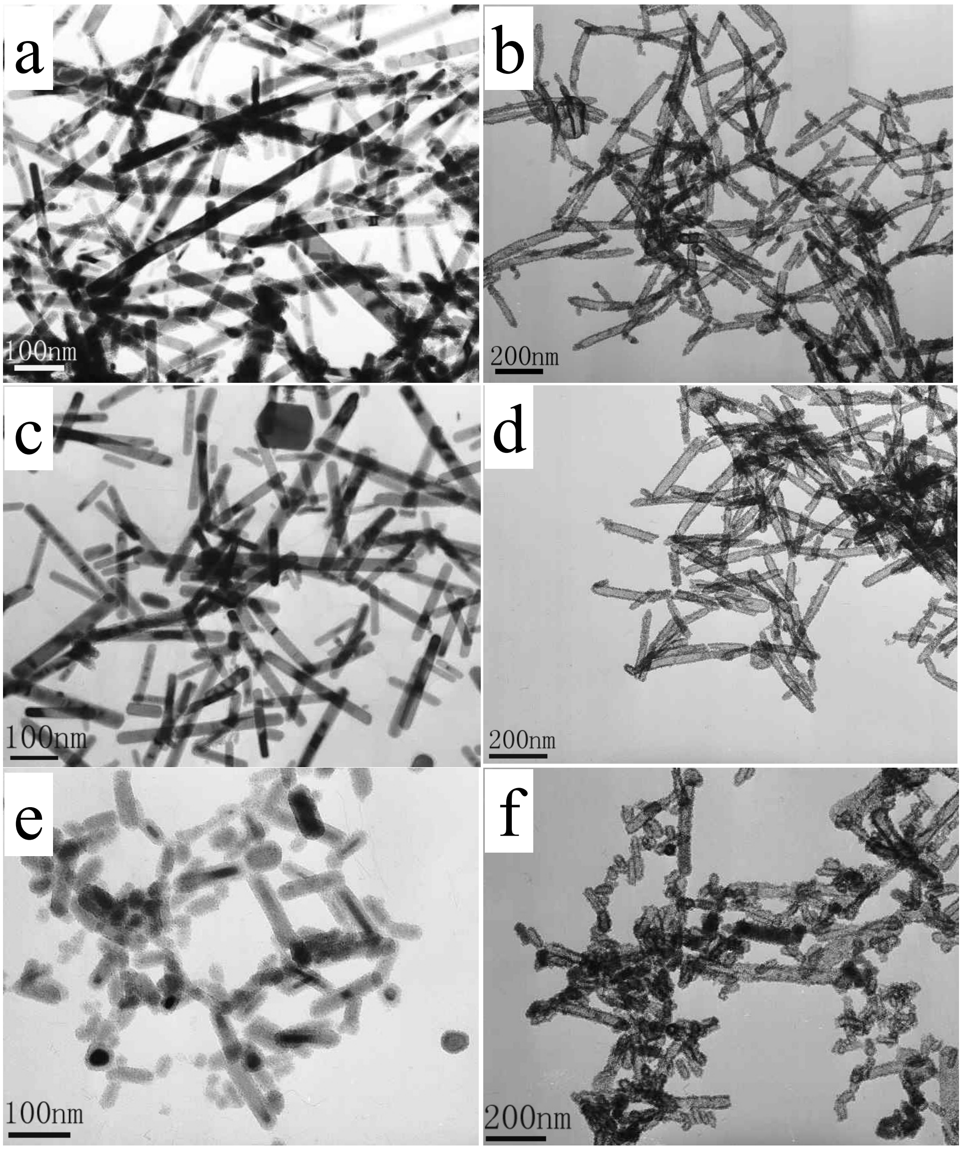


Figure S3 TEM images of the as synthesized Sn nanorods (a,c,e) with the addition of 5, 2, and 0.1 ml PDDA, respectively and the corresponding TEM images of the SnO_2 nanotubes (b,d,f)

Figure S4 shows the HRTEM image of the interface between Sn and SnO_2 in the as-synthesized Sn/SnO_2 partially hollow nanotubes obtained with the reaction time of 30 min, confirming the coexistence of Sn and SnO_2.

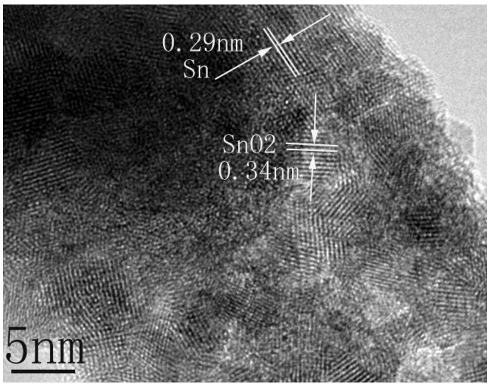
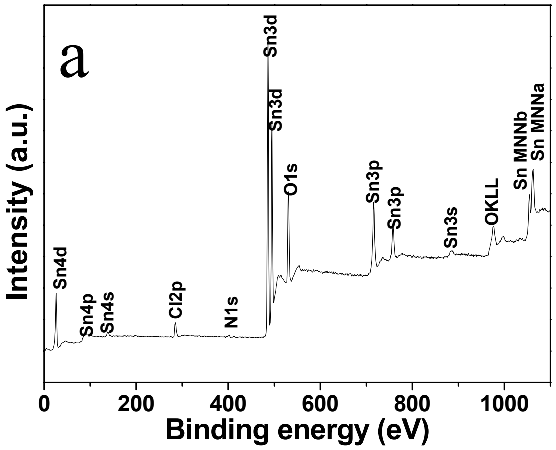


Figure S4 HRTEM image of the interface between Sn and SnO_2 in the as-synthesized Sn/SnO_2 partially hollow nanotubes obtained with the reaction time of 30 min

Figure S5 shows the XPS spectra of the as-synthesized Sn/SnO_2 partially hollow nanotubes obtained with the reaction time of 30 min



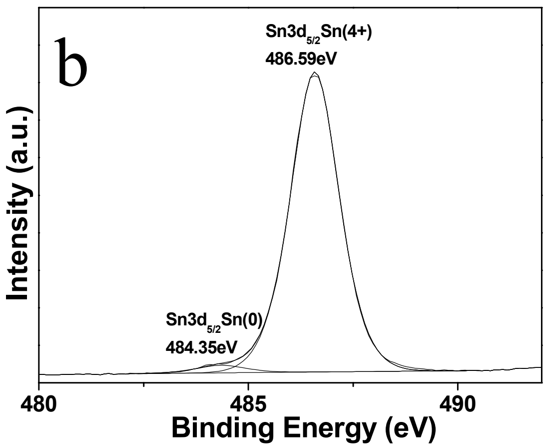


Figure S5 XPS spectra of the as-synthesized Sn/SnO_2 partially hollow nanotubes obtained with the reaction time of 30 min