Supporting information

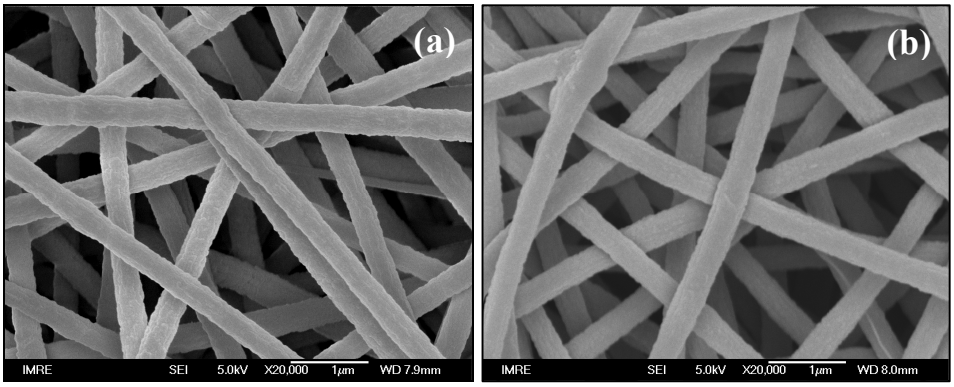

Fig. S1 SEM micrographs showing morphologies of (a) as-spun and (b) carbonized nanofibers. The fibrous morphology is perfectly maintained after stabilized at 280 ºC in air for 1 hr followed by carbonized at 550 ºC for 2.5 hrs. The average diameter of nanofibers is slightly reduced by about 50 nm, from 390 nm to 340 nm, due to the conversion from PAN and $Sn(CH_3COO)_2$ to carbon and SnO_2, respectively.

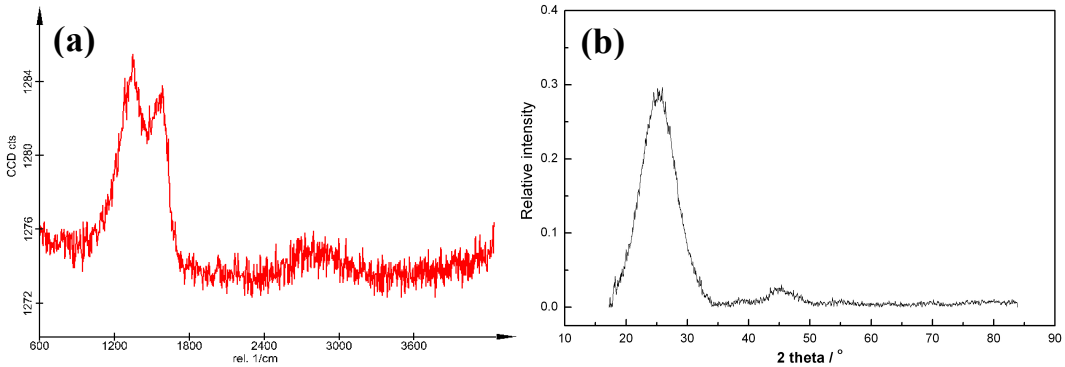

Fig. S2 (a) Raman spectrum and (b) WAXD pattern of the neat CNFs, showing that the carbon formed is in amorphous form containing disordered graphene sheets. The neat CNFs were obtained by carbonzing neat PAN nanofibers under exactly the same conditions as that for PAN/$Sn(CH_3COO)_2$ nanofibers, i.e., the temperature was ramped from 25 ºC to 280 ºC at 1 ºC/min and kept at 280 ºC for 1 hr in atmospheric environment (stabilization), and it was then ramped to 550 ºC at 10 ºC/min and kept at 550 ºC for 2.5 hrs in argon environment (carbonization) before cooling down to room temperature. The Raman spectrum of the neat CNFs shows two strong peaks centered at 1350 nm^{-1} and 1580 nm^{-1}, respectively. The stronger band at 1350 nm^{-1} can be assigned to defect-induced structures of carbon (D band), while the weaker band at 1580 nm^{-1} is indicative of high frequency E2g first-order graphitic crystallites (G band). The Raman result is consistent with XRD pattern that shows a wide peak at about $2\theta \approx 25.0°$ (002 plane) and a very weak peak at about $2\theta \approx 45.0°$ (100 plane) corresponding to graphitic structure, indicating that CNFs prepared under the designated carbonization conditions are amorphous carbon with disordered graphene sheets.[1, 2]

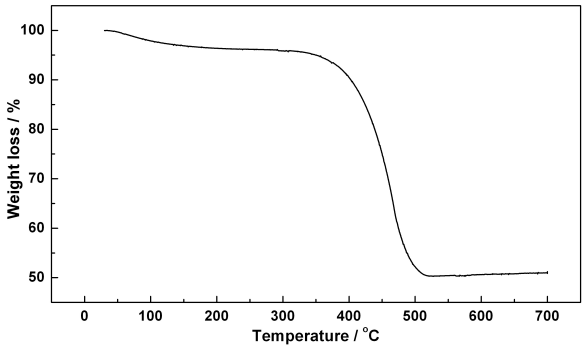

Fig. S3 TGA profile of carbonized carbon/SnO_2 nanofibers. The measurement was conducted under the following conditions: ramped from room temperature to 700 ºC at a heating rate of 10 ºC/min in air flow (60 ml/min) and isothermal at 700 ºC for 10 min. The TGA curve indicates that the content of SnO_2 in hybrid nanofibers is around 50 wt%, which is consistent with the nominal value calculated from the suspension composition.

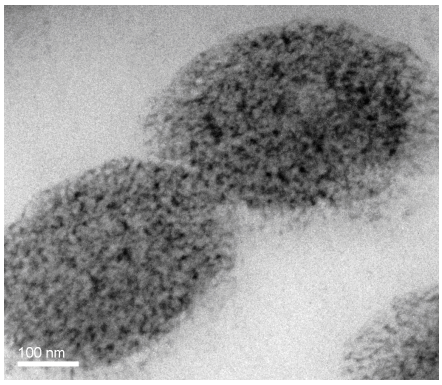

Fig. S4 Cross-sectional TEM view of the PAN/$Sn(CH_3COO)_2$ hybrid nanofibers stabilized at 280 ºC for 1 hr in Ar, showing uniform distribution of Sn-based particles rather than core-shell morphology.

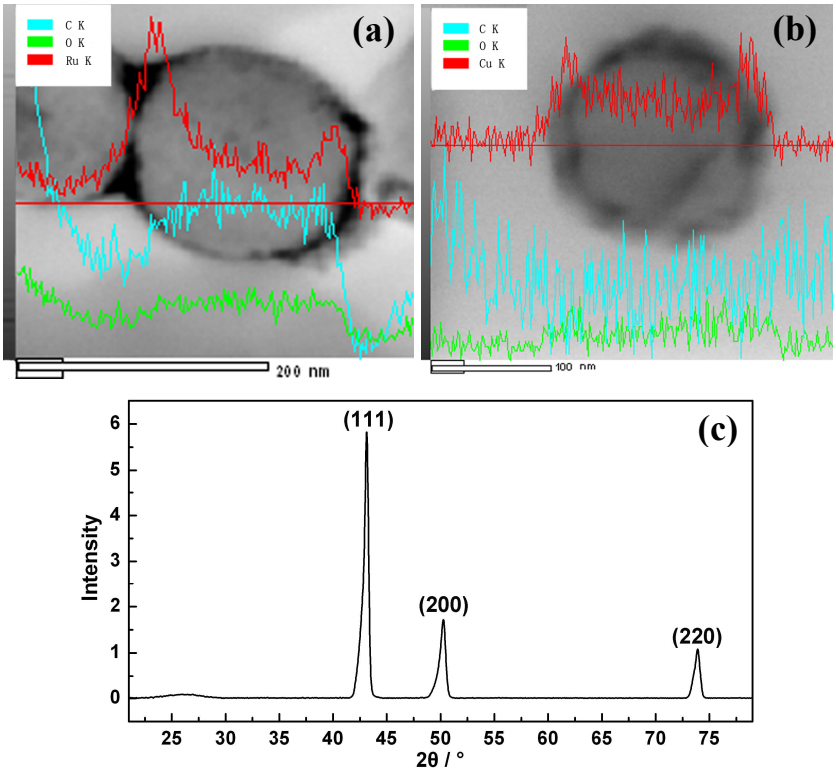

Fig. S5 STEM-EDX line analysis of (a) carbon-RuO_2 and (b) carbon-Cu hybrid nanofibers, confirming their core-shell morphologies. The heat treatment was carried out under the same procedure as that to PAN/$Sn(CH_3COO)_2$ nanofibers: ramped from 25 ºC to 280 ºC at 1 ºC/min and kept at 280 ºC for 1 hr in atmospheric environment; then ramped from 280 ºC to 550 ºC at 10 ºC/min and kept at 550 ºC for 2.5 hrs in argon environment before cooling down to room temperature. (c) X-ray diffraction pattern of the carbon-Cu hybrid nanofibers, showing that the Cu component has been reduced to metallic Cu during carbonization.

References

[1] C. Kim, S. H. Park, J. I. Cho, D. Y. Lee, T. J. Park, W. J. Lee and K. S. Yang, J. Raman Spectrosc., 2004, 35, 928.
[2] L. W. Ji and X. W. Zhang, Nanotechnology, 2009, 20, 155705.