Electronic Supplementary Information

Copper-coated TiN nanofibers with high electrical conductivity: a new advance in conductive one-dimensional nanostructures

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1. Experimental Procedure

Tetrabutyl titanate (TBT, 99%, Aladdin Industrial Co., China), copper nitrate $(Cu(NO_3)_2 \cdot 3H_2O)$, Aladdin Industrial Co., China), N.N-dimethylformamide (DMF, 99%, Sinopharm Chemical Reagent Co. Ltd, China), acetic acid (CH₃COOH, 99%, Sinopharm Chemical Reagent Co. Ltd, China), polyvinylpyrrolidone (PVP, Mw=1 300 000, Aladdin Industrial Co., China) and ethanol (EtOH, 99%, Sinopharm Chemical Reagent Co. Ltd, China) were used as the starting materials. Electrospinning process was conducted on a equipment composed of three components-a collector, a high voltage direct current power supply and a coaxial spinneret. The coaxial spinneret was assembled by two stainless pins with different diameters in coaxial. In preparing the core solution, copper nitrate was dissolved in DMF-ethanol mixture (1:1, weight ratio), PVP-the polymer used to adjust the

viscosity of solution-was then added to the solution and stirred until it dissolved thoroughly. The shell solution was prepared by dropping tetrabutyl titanate in the ethanol-acetic acid mixture (3:2, weight ratio) and then mixed with PVP. After turning into a clear sol by stirring, the two mixture solutions were delivered into the coaxial spinneret. A grounded aluminum foil was placed below the spinneret at a distance of 15 cm as a fiber collector. By applying a high voltage of 14 kV to the spinneret, the nanofibers were collected on the foil. The precursor nanofibers were calcined at 500 °C in air for 2 h to obtain CuO@TiO2 composite nanofibers. Afterward, the synthesized CuO@TiO2 nanofibers were annealed in a tube furnace at 900 °C for 2 h under ammonia atmosphere. The flowing rate of ammonia was 120 ml/min.

X-ray diffraction (XRD, X'pert PRO, PANalytical B.V., Netherlands) coupled with Cu K α radiation (λ =0.15406nm) was used to identify the phase constitutions of these nanofibers. Their morphologies and structures were investigated by field emission scanning electron microscopy equipped with energy dispersive spectroscopy (EDS) and transmission electron microscopy (TEM). The electrical properties of both TiN and Cu-coated TiN nanofibers were measured by a Keithley 4200 measurement system. The sheet resistance measurements of Cu-coated TiN nanofiber networks were carried out by a four-probe method.

2. Experimental results



Fig. S1 SEM images of CuO@TiO2 nanofibers calcined at 500 °C for 2 h.



Fig. S2 (a) SEM images of Cu-coated TiN nanofibers annealed under NH₃ flow at 900 °C, (b) the diameter distribution of the nanospheres.



Fig. S3 TEM image of Cu-coated TiN nanofibers and energy dispersivespectroscopy of the selected area: (A) energy dispersive spectroscopy of the nanofiber,(B) energy dispersive spectroscopy of the nanosphere.



Fig. S4 XRD pattern of CuO nanofibers after annealing under NH₃ flow for 2 h.



Fig. S5 The electrical conductivity change of Cu-coated TiN nanofibers versus time under 300 °C in air.



Fig. S6 XRD pattern of TiN nanofibers after annealing in air for 2 h.



Fig. S7 XRD pattern of Cu-coated TiN nanofibers after annealing in air for 2 h.