Supporting information for the article

Wormlike Micelle Assisted Rod Coating: A General Method for Facile Fabrication of Large-area Conductive Nano-materials Thin Layer onto Flexible Plastics

Jingyi Xie, Huan Wang, Huadong Bai, Peng Yang, Mengxue Shi, Peng Guo, Chen Wang,

Wantai Yang, Huaihe Song*

State Key Laboratory of Chemical Resource Engineering, Beijing 100029, China

College of Materials Science and Engineering, Beijing University of Chemical Technology, Beijing 100029, China

*Corresponding author (email: yangwt@mail.buct.edu.cn)

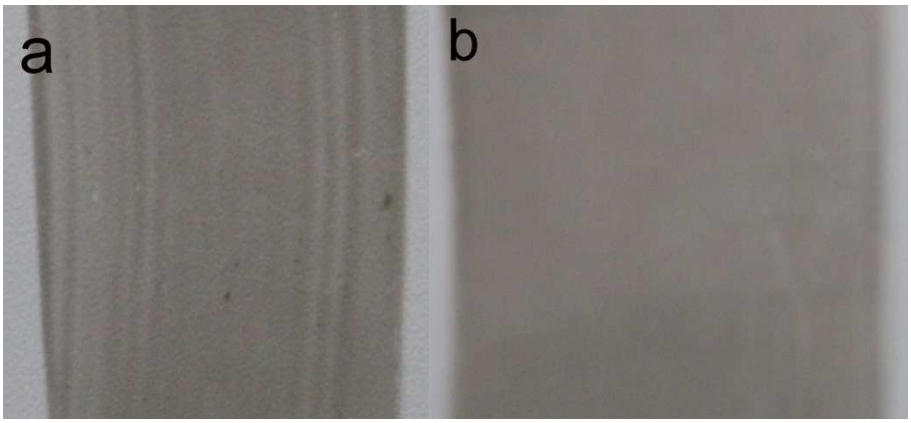

Figure S1. Photo image of (a)Unleveled SWNTs film and (b) a uniform thin film of SWNTs after leveling.

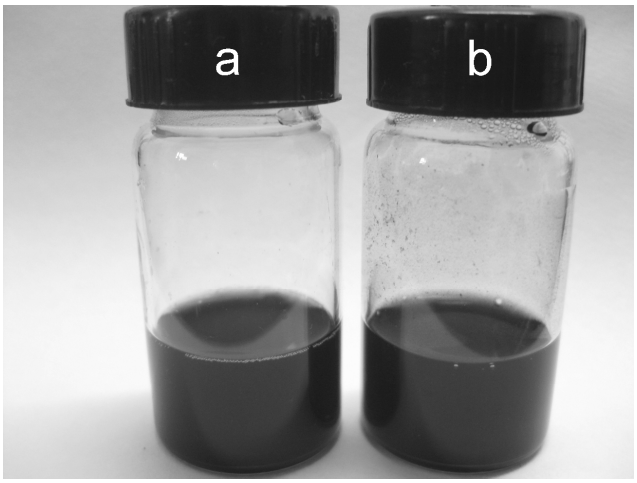

Figure S2. Optical image of SWNTs/wormlike micelles dispersion with different CTAOH/ p-toluenesulfonic acid mole ratio: a) 10/9, b) 10/11.

As showed in Figure S2b, due to high viscosity of wormlike micelle systems, the aggregated SWNTs particles can not deposit on the bottom of bottle. After stirring, large amount of aggregated SWNTs particle could be observed on the sidewall of bottle. When the mole ratio between CTAOH/ p-toluenesulfonic acid is 10/9, no precipitate could be seen (Figure S2a).

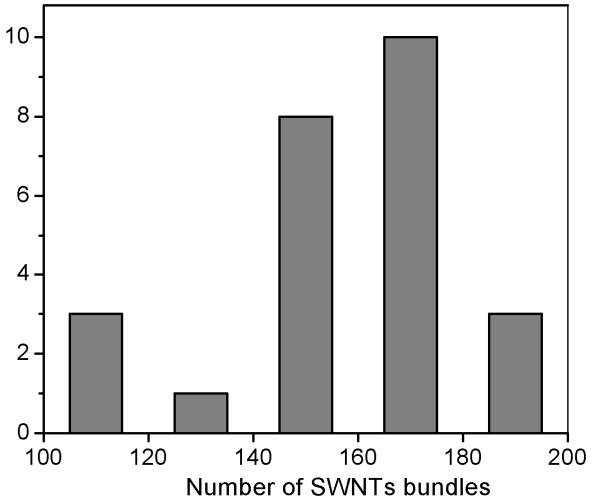

Figure S3. Distribution of the number of SWNTs bundles within 1 square micrometer on 80% transparency SWNTs thin film.

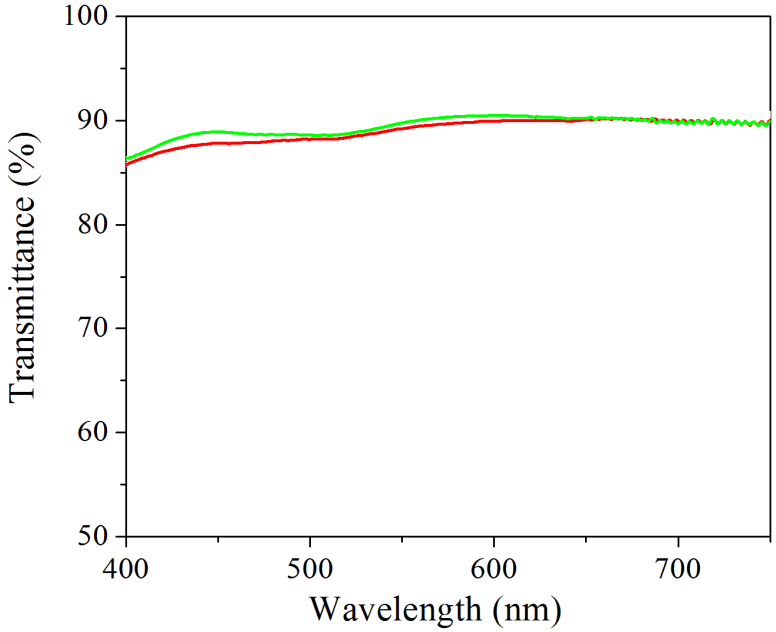

Figure S4. UV-Vis spectra of SWNTs film coated on the PET substrate: (—) before $SOCl_2$ Doping, (—) after $SOCl_2$ Doping.

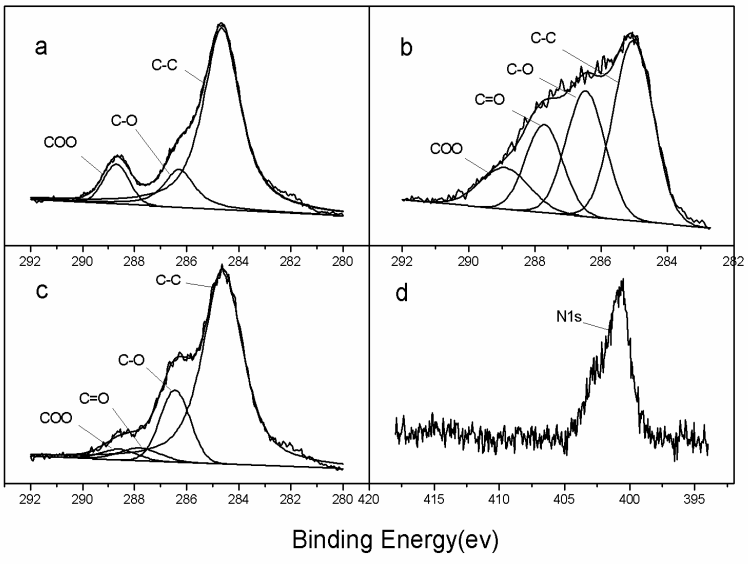

Figure S5. XPS measurement of pristine PET film and PET film coated with a thin layer of graphene oxide. a) The C1s spectra of Pristine PET film; b) The C1s spectra of graphene oxide thin layer on PET film; c) The C1s spectra of reduced graphene oxide thin layer on PET film; d) The N1s spectra of reduced graphene oxide thin layer on PET film.

The XPS C1s spectra of graphene oxide thin layer on PET film showed in Figure S5b demonstrates the existence of large amount of oxygen containing groups on the graphene oxide sheet. After hydrazine monohydrate solution treatment, most of the carboxyl groups and carbonyl group are removed (Figure S5c). However, the hydroxyl groups on graphene oxide sheets can not be eliminated by hydrazine reduction. Figure S5d shows the XPS N1s spectra of reduced graphene thin layer on PET substrate, the atomic percentage of N in reduced graphene thin layer is about 2.7%, which indicated that surfactants can not be effectively removed from reduced graphene oxide thin layer by immersion and extraction.

Through "ion-exchange method"[1], cationic surfactants absorbed on the carboxyl groups of graphene oxide sheets could be partially removed (Figure S6). After immersing in 2% (W/W) p-toluenesulfonic acid aqueous solution for 96h, the atomic percentage of N decreased to 0.8% (Figure 6b). Further treatment with hydrazine monohydrate solution will cause the increase of the atomic percentage of N to approximately 1.5% (Figure S6d). The increase of the atomic percentage of N is

possibly induced by the loss weight of GO thin films during reduction process. The conductivity of RCO films reduced from GO thin films treated by "ion-exchange method" are shown in Figure S7.

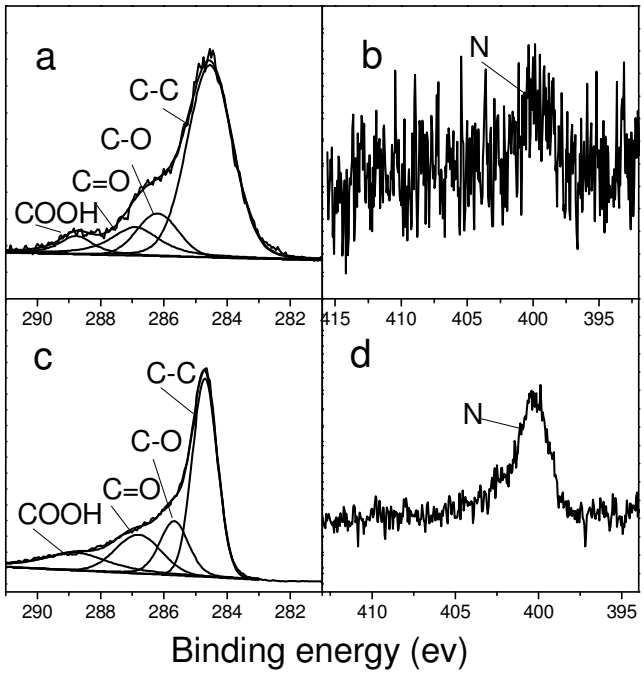

Figure S6. XPS measurement of graphene oxide thin film after p-toluenesulfonic acid treatment: a) C1s spectra of graphene oxide thin film, b) N1s spectra of graphene oxide thin film, c) C1s spectra of reduced graphene oxide thin film, d) N1s spectra of reduced graphene oxide thin film.

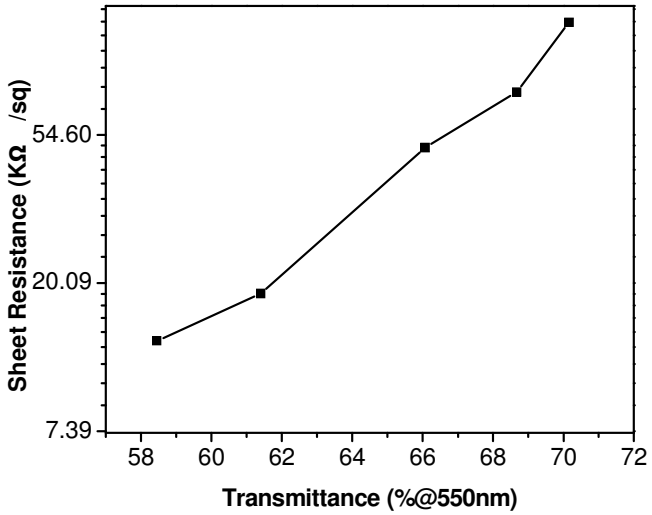

Figure S7. Sheet resistance versus transmittance for RGO based thin films. The films were reduced from rod coated GO films with GO-wormlike micelle dispersion as coating fluid.

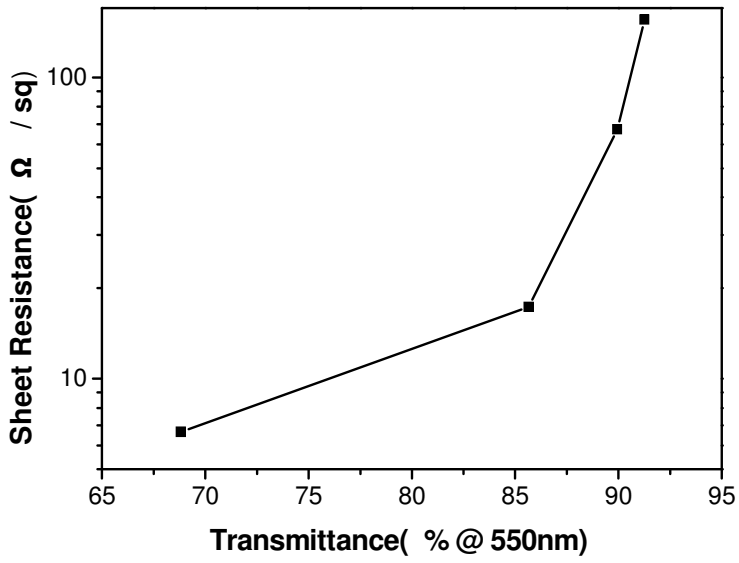

Figure S8. Sheet resistance versus transmittance for Ag based conducting networks.

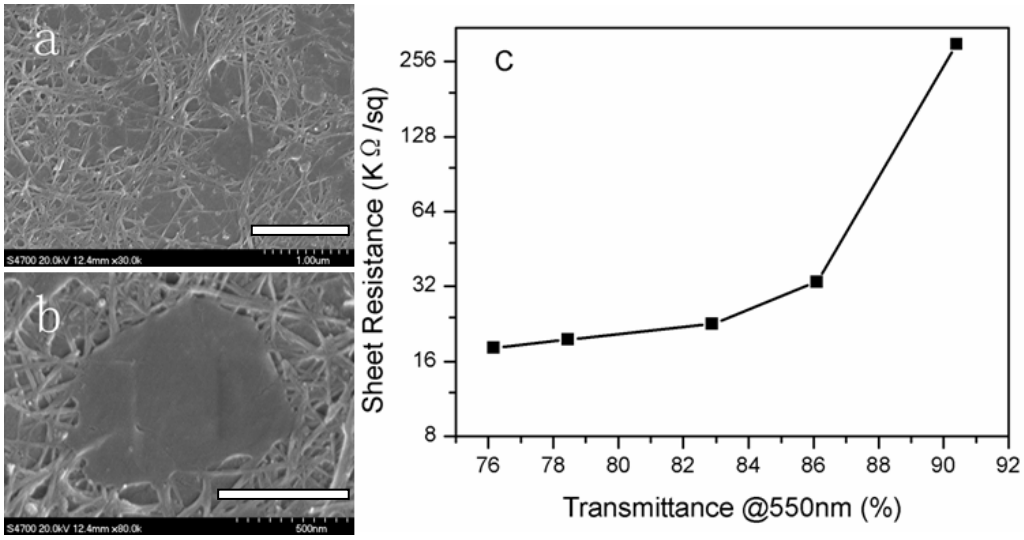

Figure S9. a) SEM image of SWNT/RGO hybrid thin film on PET substrate (The scale bar is 1μm). b) SEM image of SWNT/RGO hybrid thin film on PET substrate (The scale bar is 500 nm). c) Sheet resistance versus transmittance for SWNT/RGO hybrid thin films.

Figure S9 shows the SEM image (Figure S9a and b) and the conductivity (Figure S9c) of SWNT/RGO hybrid thin films. The coating fluid of SWNT/GO hybrid thin films is prepared by simply mixing GO aqueous solution with SWNT fluid. Further reduction of SWNT/GO hybrid thin films will lead to SWNT/RGO films.

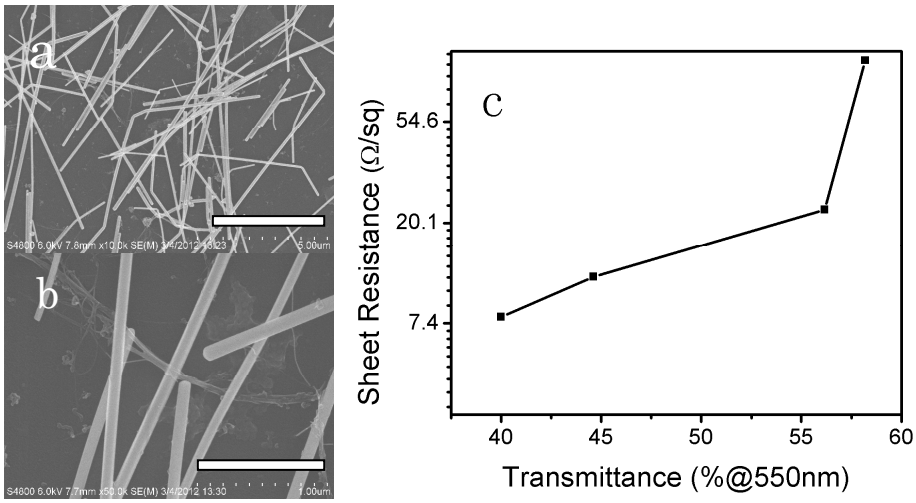

Figure S10. a) SEM image of SWNT/Ag nanowire hybrid thin film on PET substrate (The scale bar is 5μm). b) SEM image of SWNT/ Ag nanowire hybrid thin film on PET substrate (The scale bar is 1μm). c) Sheet resistance versus transmittance for SWNT/ Ag nanowire hybrid thin films.

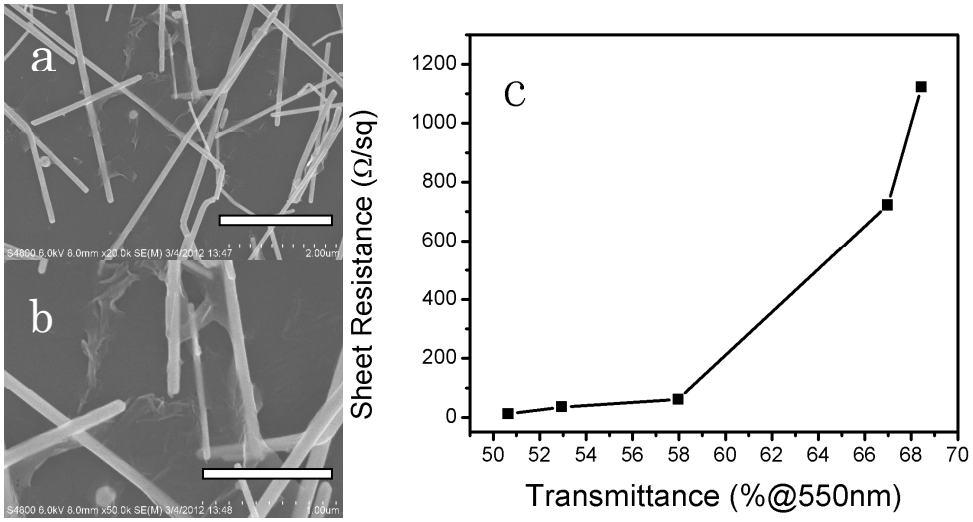

Figure S11. a) SEM image of RGO/Ag nanowire hybrid thin film on PET substrate (The scale bar is 2μm). b) SEM image of RGO/ Ag nanowire hybrid thin film on PET substrate (The scale bar is 1μm). c) Sheet resistance versus transmittance for RGO/ Ag nanowire hybrid thin films.

1. Wakamatsu, N.; Takamori, H.; Tsuyohiko, F.; Nakashima, N. *Adv. Funct. Mater.* **2009**, *19*, 311.