Electronic Supplementary Material (ESI) for Nanoscale.
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Electronic Supplementary Information

Shape-Engineerable Composite Fibers and Their Supercapacitor Application

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Materials and method

Materials

Large GO flakes that were stably dispersed in DI water were used for fiber spinning and are called GGO in this paper. The average GO size was ~37 μm. The SWNT powder (average diameter; 1.3 to 1.5 nm, thickness ~20 nm, purity 60–70 wt% (90 vol%), catalyst metal; 10 wt%, and graphitic impurities; 20 wt%) were supplied by Hanwha Nanotech (South Korea). SDBS as a surfactant and PVA (Mw: 146,000–186,000; hydrolysis: 99%) were purchased from Sigma-Aldrich (USA). Sulfuric acid liquid electrolyte (1M H_2SO_4) was purchased from Daejung Chemical (South Korea).

Wet-spun GGO/SWNT/PVA Ribbon

0.3 wt% SWNT was dispersed in DI water with 1 wt% SDBS surfactant using ultrasonication for 1 h. The SWNT/water dispersion was mixed with a dispersion of 0.3 wt% GGO in water by hand shaking. The final concentrations of SWNT, GGO, and SDBS were 0.15, 0.15, and 0.5 wt%, respectively. The GGO/SWNT/SDBS dispersion was injected at an injection rate of 24 mL/h into a 5 wt% PVA coagulation bath. The PVA bath was placed on a stage rotating constantly at 10 rpm during spinning. The GGO/SWNT ribbon gel came up to the surface of the PVA solution just after spinning. The output mass of the GGO/SWNT/PVA was about 860 mg per hour. The GGO/SWNT/PVA ribbon gel was formed and sank to the bottom of the coagulation bath after 18 to 24 h in an oven at 60 °C. The final width of the ribbon gel was 500 to 700 μm.

Characterization

The surface and cross-section morphology of the GGO/SWNT hollow fiber, twisted fiber, and ribbon were obtained using SEM (S4700; Hitachi, Japan). The diffraction intensities from the ribbon before and after annealing were measured using an XRD apparatus (D8 Advance; Bruker, USA). Mechanical properties of hollow fibers, twisted fibers, and ribbons were characterized using a universal testing machine (Instron 5966, USA). Cyclic voltammetry and electrochemical impedance spectroscopy measurements were obtained using electrochemical analyzers (Gamry Instruments, USA).

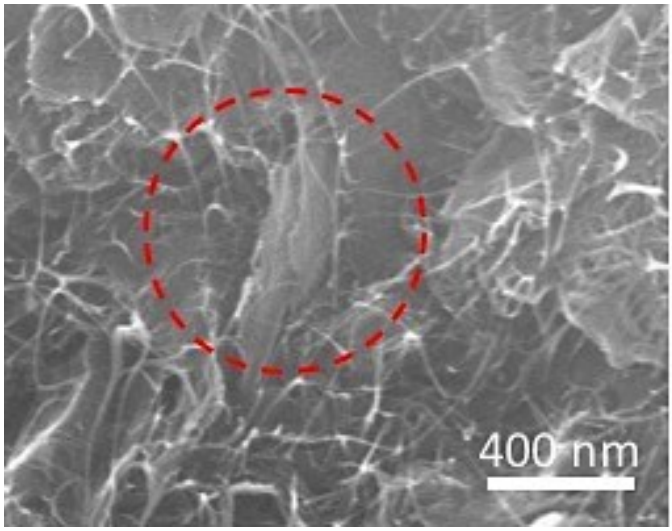

Fig S1. Cross sectional SEM image of hollow graphene/CNT fiber which was annealed at 600 °C for 2 hours. The red circle indicates graphene particle in the fiber.

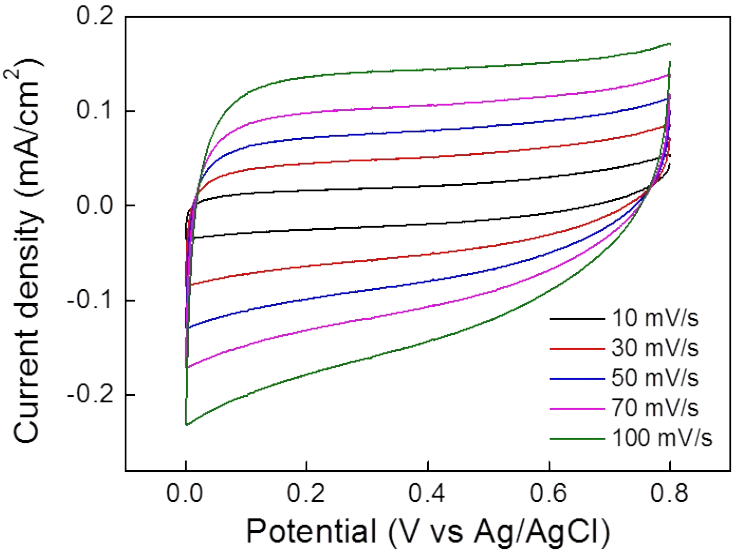

Fig S2. CV curves of rGO/SWNT ribbon fibre measured in three electrode system using Ag/AgCl and Pt mesh as reference and counter electrode, respectively. Liquid electrolyte of 0.1 M Na_2SO_4 solution is used.