Supporting Information

Transparent Carbon Nanotube Patterns Templated by Inkjet-Printed Graphene Oxide Nanosheets*

Joong Tark Han,[a] Jun Suk Kim,[a] Donghoon Kwak,[b] Bo Gyeong Kim,[a] Bo Hwa Jeong,[a] Seung Yol Jeong,[a] Hee Jin Jeong,[a] Kilwon Cho,[b] Geon-Woong Lee*[a]*

[a] 70 Boolmosangil, Changwon, Korea, 641-120. Fax: 82-55-280-1590; Tel:82-22-280-1677; Nano Carbon Materials Research Group, Korea Electrotechnology Research Institute; E-mail: jthan@keri.re.kr, gwleephd@keri.re.kr

[b] San 31, Hyojadong, Pohang, Korea, 790-784. Department of Chemical Engineering, POSTECH

Experimental method

Graphene oxide was prepared from natural graphite (Alfa Aesar, 99.999% purity, -200mesh) by a modified Hummers method. Briefly, 20 g of graphite and 460 ml of H_2SO_4 were mixed in a flask. Then, 60 g of $KMnO_4$ were slowly added over about 1 h. Stirring was continued for 2 h in the ice-water bath. After the mixture was stirred vigorously for 18h at room temperature, 920 mL of deionized water was added, and stirred for 10min in the ice-water bath. 50 mL of H_2O_2 (30 wt % aqueous solution) was then added, and the mixture was stirred for 2 h at room temperature. The resulting mixture was precipitated and filtered to obtain the graphite oxide powder. Graphite oxide was then exfoliated into GO nanosheets in deionized water (200mg/L) by bath sonication for 30min. To remove the small-sized and highly functionalized GO sheets, the centrifugation of the aqueous GO solution was repeated twice at 10000 rpm for 30min. Monolayer GO films were fabricated by spin casting on SiO_2 surfaces assisted by N_2 blow. GO patterns were deposited on SiO_2 wafer by using a home-built inkjet printer, which was equipped with a singlen ozzle drop-on-demand piezoelectric print head

(Microfab Jet Drive III), a two-axis motorized positioning system and a CCD camera aligned with an LED for visualization of droplet ejection.

SWCNTs produced by the arc-discharge method and purified by thermal treatment (purchased from Hanwha Nanotech Inc., AST) were used in this study. SWCNTs were dispersed by bath sonication for 30 min and horn sonication for 1 hr in a 1 wt% sodium dodecylbenzenesulfonate and sodium dodecyl sulfonate solution to a concentration of 1 g/L, followed by two rounds of centrifugation at 10000 rpm for 60 min. The supernatant solution was deposited onto GO surfaces using an automatic spray coater (NCS-400) with a 1.2 mm nozzle diameter. The surfactant was removed by dipping in deionized water twice for 10 min each, followed by air drying at 70°C for 10 min. Sheet resistance and transmittance are fitted by the following equation,

$$T(\lambda) = \left(1 + \frac{188.5}{R_s} \frac{\sigma_{Op}(\lambda)}{\sigma_{DC}} \right)^{-2}, \qquad (1)$$

where σ_{DC} and σ_{Op} are the DC and optical conductivities, respectively.

Images of the resulting films were obtained by scanning electron microscopy (FE-SEM, HITACHI S4800) and atomic force microscopy (AFM, DI, Nanoscope III). Sheet resistance measurements were collected using a four probe tester (Loresta, MCP-T610). The transmittance of each film was measured using a Varian Cary winRV spectrometer. To characterize the chemical composition of the film surface, X-ray photoelectron spectroscopy (XPS) measurements were performed on an ESCALAB 250 (VG Scientific) spectrometer with monochromatized Al Kα X-ray radiation as the X-ray source. The functionality changes of GO films after heating under vacuum were also confirmed by using Fourier Transform Infrared spectrometer (BioRad 4200UP).

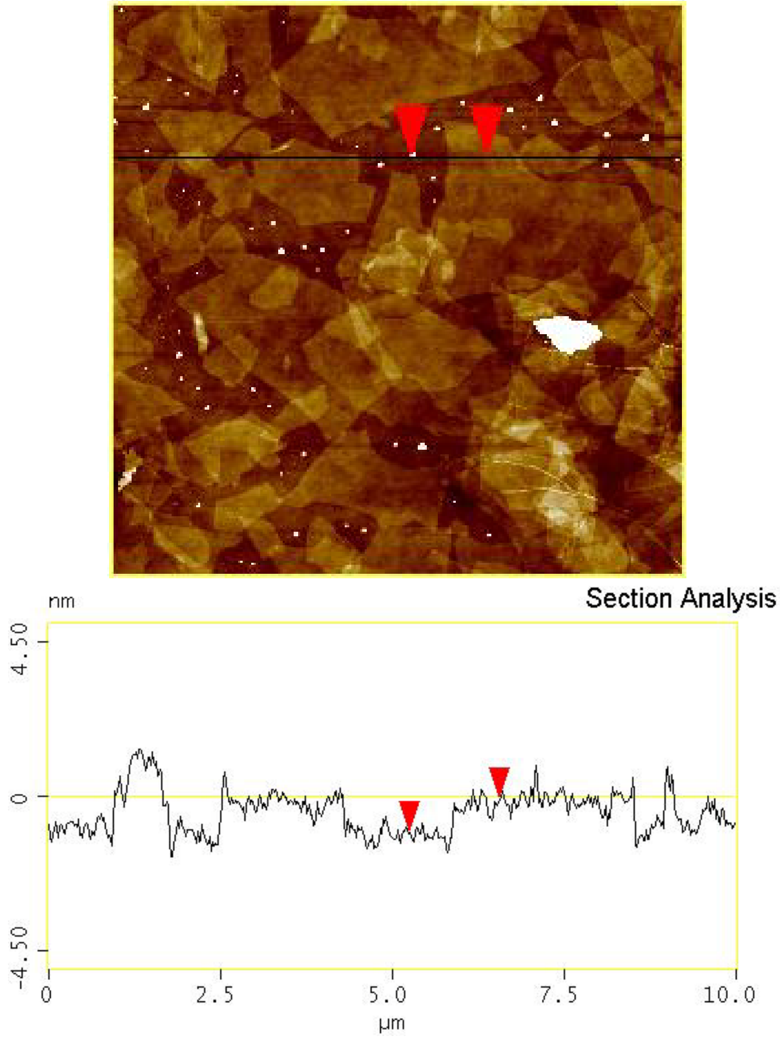

Figure S1. AFM image and height profile of GO film on the SiO_2 surface

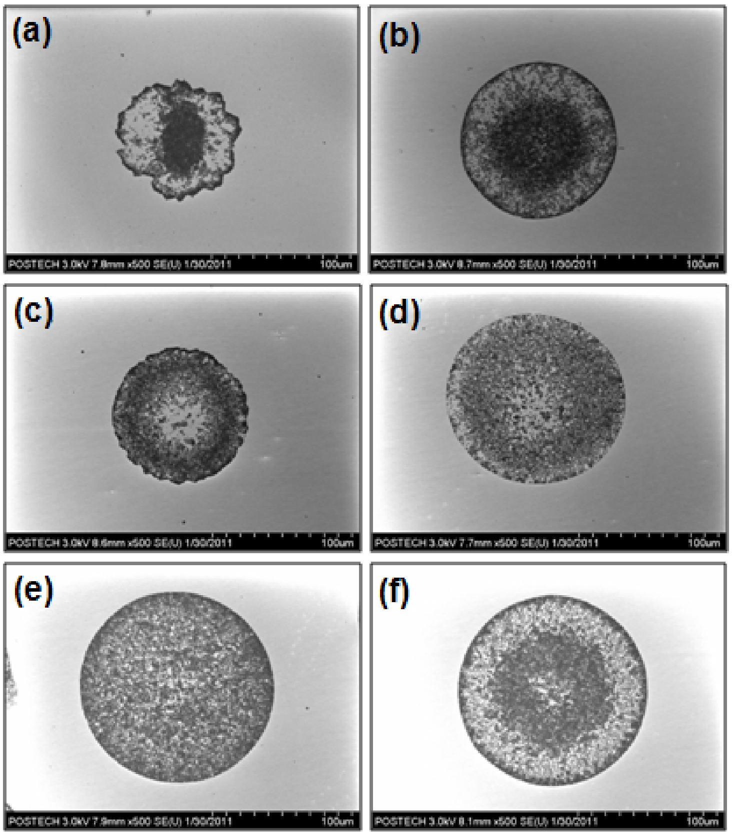

Figure S2. SEM images of GO dot patterns on UVO-treated SiO_2 surfaces prepared at different temperatures: (a) 20, (b) 40, (c) 50, (d) 60, (e) 70, and (f) 80 ^{o}C.