Direct-Write Lithography on LBL Composite Films

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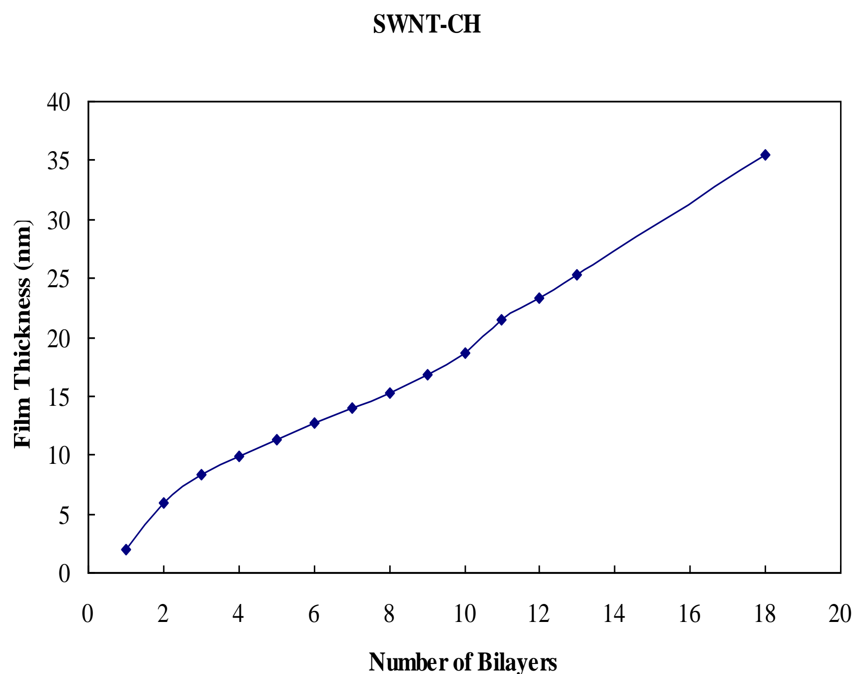

Figure S1. Ellipsometric thickness results for $(SWNT\text{-}CH)_n$ multilayer nanocomposite film for the first 18 deposition cycles.

Atomic force microscopy (AFM) images were obtained using a NanoScope IIIa atomic force microscope (AFM) from Veeco Instruments (Santa Barbara, CA). The instrument was operated in tapping mode with silicon nitride cantilever tips (NSC16/Cr-Au, MikroMasch) at a scan rate of 1Hz.

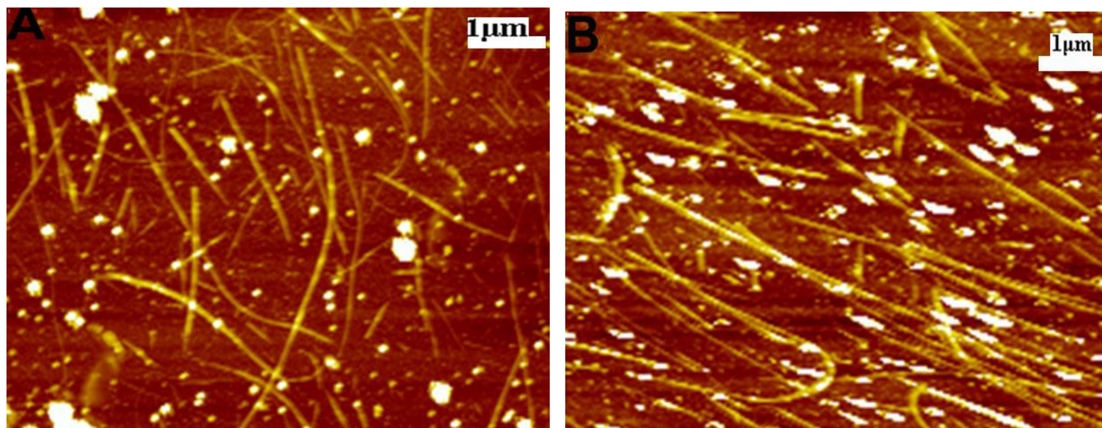

Figure S2. AFM images of SWNTs-CH films deposited on top of a silicon wafer: (A) 1 bilayer image of SWNTs-CH; (B) 2 bilayers image of SWNTs-CH.

The $(AuNPs/CH)_n$ film prepared process is the similar of the $(SWNTs\text{-}CH)_n$ films with the difference that the deposition was taking place on glass slides by 20 min dips into a dispersion of Au NPs in each cycle.

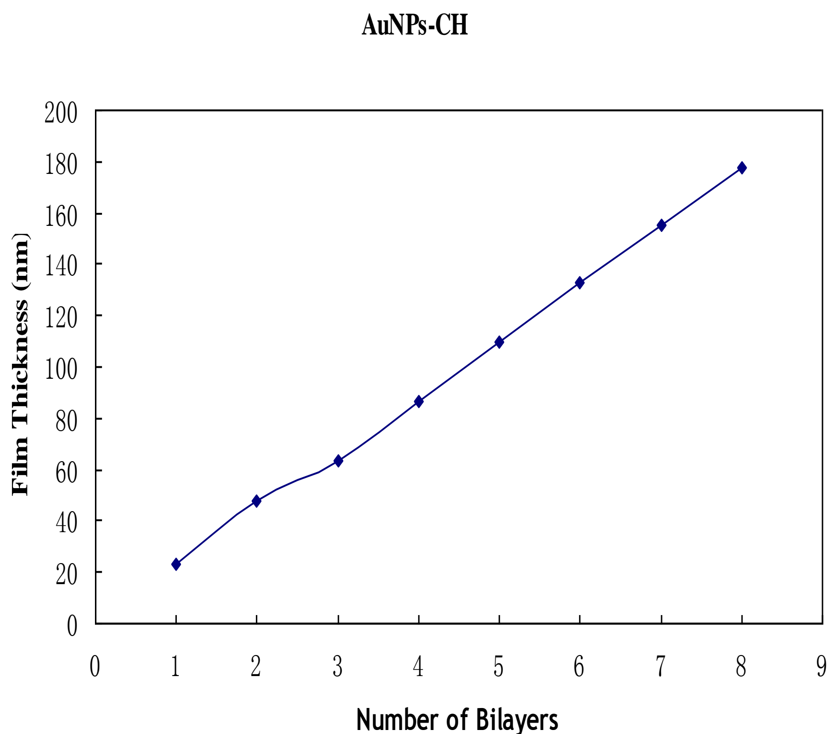

Figure S3. Ellipsometric thickness results for $(AuNPs\text{-}CH)_n$ multilayer nanocomposite film for the first 8 deposition cycles.

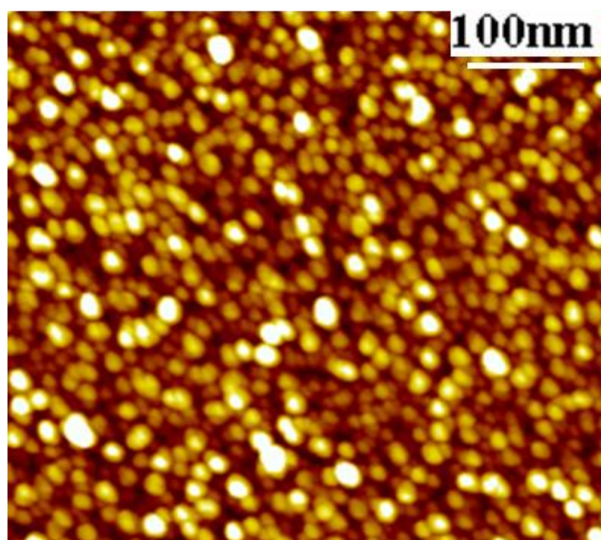

Figure S4. AFM images of one bilayer of AuNPs-CH LBL films deposited on a silicon wafer.

Figure S5. Photograph of $(AuNPs/CH)_{15}$ films deposited on a silicon wafer.

Conductivity measurements:

For the resistance measurements, Agilent 34401A digital multimeter was used for all the $(SWNT/CH)_n$ and $(AuNPs/CH)_n$ LBL slides at 20 ^{o}C.

Process of Pattern $(SWNT/CH)_n$ and $(AuNPs/CH)_n$ Films

Before etching, a protective pattern was created on the surface using a photolithography process. First, the glass slides were baked at 110 ^{o}C for 10 minutes on a hot plate to drive off any moisture. Next, each slide was coated with AZ 9260 photo resist to a depth of ~12

μm using a spin coater (Laurell Technologies model WS-400, spread at 500 RPM for 10 seconds, final spin at 2000 RPM for 30 seconds). Each slide was then baked on a hot plate at 110 ^{o}C for 3 minutes to reduce solvent content (soft bake). After the soft bake, the resist film was allowed to rehydrate by sitting at room temperature for a minimum of 35 minutes. Exposure was performed on an HTG manual aligner (350 Watt broad band UV source, i-line intensity ~ 17mW/cm^2) with an exposure time of 16 seconds. Prior to exposing the slides, an exposure series was performed on an AZ 9260 sample of the same thickness to determine optimal exposure time. Following a post exposure delay of five minutes, each sample was developed by immersion in a 1:4 AZ 400K:H_2O solution for 3 minutes. Samples were rinsed with DI water and blown dry. Before reactive ion etching, the film thickness was measured using a stylus profiler (AS500, KLA Tencor). This served to confirm the lithography results and to provide a baseline for tracking removal of the resist mask during etching. Films were etched via oxygen plasma in a reactive ion etcher (RIE 2000, South Bay Technologies), using a chamber pressure of ~ 30 mTorr and a forward power of 100 Watts. Etch times varied with film thickness and composition, but the AZ 9260 was removed at a rate of ~ 400 nm per minute under this condition. Argon plasma was also tested, but the results did not indicate any film removal. When etching was completed, the remaining resist mask was removed using acetone, Baker PRS 2000 Remover, or UV exposure followed by an immersion developing as outlined above. Some resist residue was notice on one sample even after all three removal methods were tried.