

Supplementary Information

Facile graphene transfer directly to target substrate with metal catalyst reusable

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Experimental details

Graphene synthesis. Graphene synthesis was carried out by putting a 3 in. x 1 in., 25 μm -thick copper foil (99.8% of purity, Alfa Aesar) in a horizontal tube furnace. The Cu foil was cleaned before the first growth using Ni etchant. A fused quartz tube with 1 in. in diameter (Technical Glass Products) was used as a reactor chamber, connecting to a gas flow line and an exhaust line. We used a low pressure CVD process in which the exhaust line was connected to a vacuum pump where the base pressure could reach down to 70 mTorr. The process was performed at 1000 °C with 10 sccm of hydrogen of feedstock in the heating, annealing and cooling step while 70 sccm of hydrogen and 4 sccm of methane were flowed in the growth step. The heating,

annealing, growth, and cooling step took 20 minutes, 30 minutes, 30 minutes and ~10 minutes, respectively.

Graphene Transfer. The graphene grow on both sides of the copper foil. For the traditional transfer using Cu etchant and PMMA film, first, poly(methyl methacrylate) (PMMA) (950 PMMA A9, Micro Chem, mixed with anisole (99%, Alfa Aesar) with 1:1 (v:v) was spun on the sample, which result in ~300 nm thick layer. After baking at 80 °C for 5 minutes, the sample was put into copper etchant (CE-100, TRANSENE) for 40 minutes at room temperature. Afterwards, the sample was carefully rinsed with DI water for 10 minutes and finally transferred onto a 300 nm-thick SiO₂/Si substrate. The PMMA layer used on the traditional transfer and in the electrochemical delamination onto Si/SiO₂ transfer was removed by annealing the substrate at 500 °C in hydrogen (700 sccm) and argon (400 sccm) mixture for two hours.

Characterization. AFM (DI-3100, Digital Instruments) measurement was carried out using an aluminum coated cantilever (Budget Sensors) in tapping mode in air ambient at room temperature. The tip velocity was typically 20 μm/s. For optical microscopy, bright field images were obtained using an optical microscope (AxioChem MR5, Zeiss) in air at room temperature. Raman measurements were taken with a 532nm Verdi laser with ~1.4mW and a 100x objective. For each spectrum, one accumulation of 10 seconds was taken.

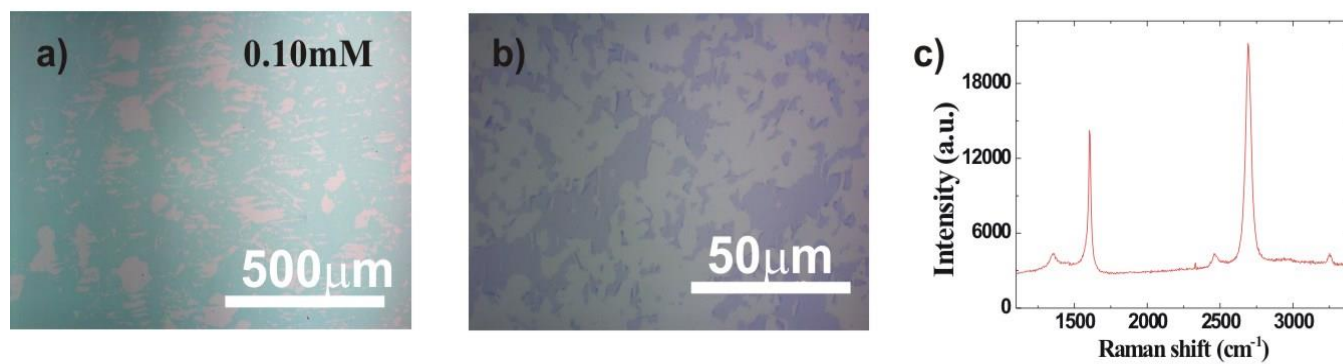


Figure S1 – (a) and (b) Optical images of graphene on Si/SiO₂ substrate transferred by electrochemical delamination process using PMMA and 0.10 mM NaOH electrolyte with 5V power supply. (c) Raman spectrum taken with 532nm laser line of the graphene sample.