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Supporting Information

Influence of SiO_2 or h-BN substrate on the room-temperature electronic transport in chemically derived single layer graphene

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Experimental Section

1. Synthesis of oxo-G

Oxo-G was prepared by the optimized oxidation of graphite at low temperature (< 4 °C), using potassium permanganate as oxidant in sulfuric acid, as reported before by our group.[1]

2. Langmuir-Blodgett films of oxo-G

Flakes of oxo-G were deposited onto the Si/SiO_2 substrate by Langmuir–Blodgett technique[2] (LB, Kibron µtrough, 3 mN m^{-1} with the surface tension of water as reference value of 72.8 mN m^{-1}). Reduction was performed by vapor of hydriodic acid and trifluoroacetic acid (1/1 mixture by volume) at 80 °C (10 min). Subsequently, the surface of graphene was cleaned with doubly distilled water (Carl Roth) to remove iodine species, which are adsorbed on $^{0.5\%}$G flakes.

3. Fabrication of h-BN/$^{0.5\%}$G heterostructures device

In order to make h-BN/$^{0.5\%}$G heterostructures, a h-BN flake (obtained from Taniguchi group, Japan) was mechanically exfoliated onto the Si/SiO_2 substrate by scotch tape method.[3] The $^{0.5\%}$G flake was transferred onto Si/SiO_2/h-BN surfaces with Polydimethysiloxane (PDMS, Gel-pack) as a carrier.[4] Then, the h-BN/$^{0.5\%}$G heterostructure with the same monolayer $^{0.5\%}$G flake partially covered on SiO_2 and h-BN surfaces was

finished. Patterning of the electrode structure was achieved by standard electron beam lithography processing (Raith PIONEER TWO). The 5/70 nm Cr/Au electrodes were deposited by thermal evaporation (Kurt J. Lesker NANO 36).

4. Measurements

Optical imaging was performed using a Nikon LV100ND. Scanning tunnelling microscopy (STM) and Scanning tunnelling spectroscopy (STS) were performed with an ultra-high vacuum (< 10^{-10} mbar) STM (Omicron-STM1). AFM characterization was performed using a JPK Nanowizzard 4 atomic force microscope in tapping mode at room temperature. Statistical Raman spectroscopy was recorded using a confocal Raman microscope (Horiba Explorer, 532 nm excitation wavelength). Electrical measurements were carried out at ambient conditions using a probe station with micromanipulated probes and two source-measurement units (Keithley 2450). In addition, comparing experiments were carried out at vacuum (HI-CUBE) using Lakeshore probe station.

Results

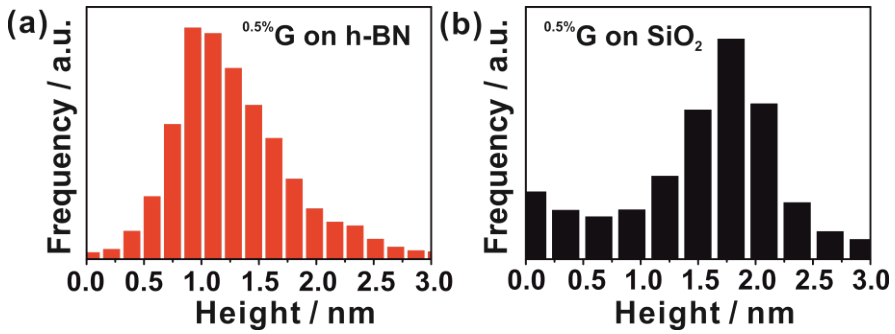

Fig. S1. (a) and (b) Histogram of the height distribution measured by AFM for the $^{0.5\%}$G on h-BN and SiO_2.

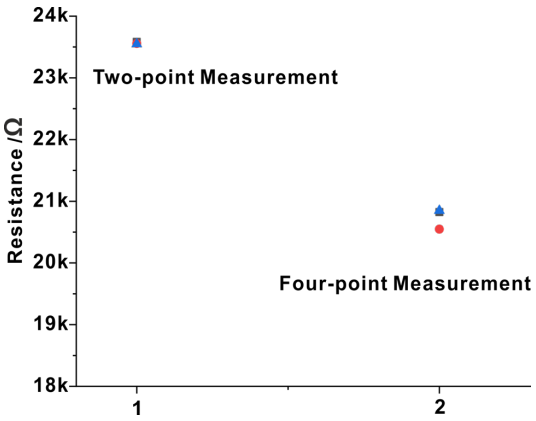

Fig. S2. Measurements of resistance of monolayer $^{0.5\%}$G in two-point and four-point configuration, respectively.

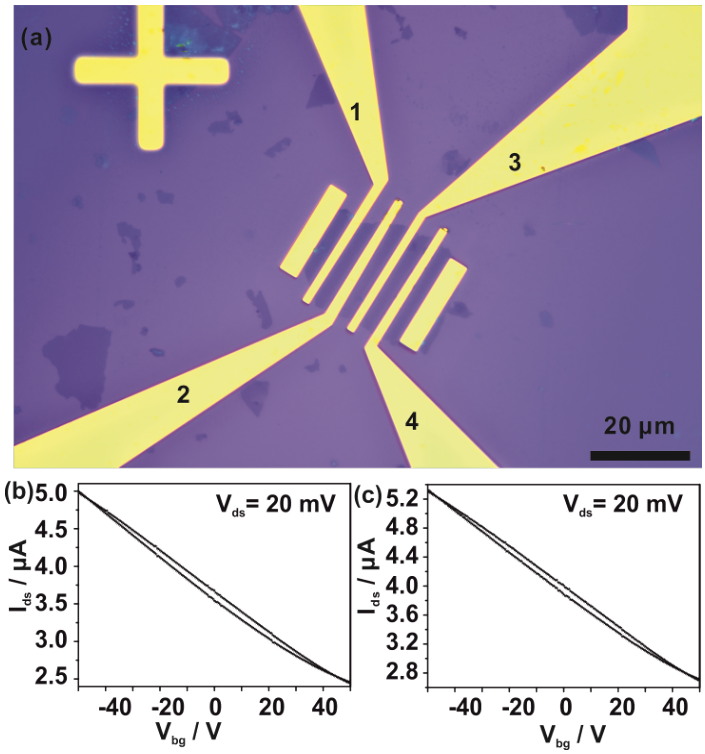

Fig. S3. (a) Optical image of the fabricated monolayer $^{0.5\%}$G device with back-gate. (b) Electrodes 1 and 2 were measured for transfer characteristics for the $^{0.5\%}$G on SiO_2. Channel length and width between 1 and 2 is 3 µm and 24 µm, respectively. (c) Electrodes 2 and 3 were measured for transfer characteristics for the $^{0.5\%}$G on SiO_2. Channel length and width between 2 and 3 is 3 µm and 24 µm, respectively.

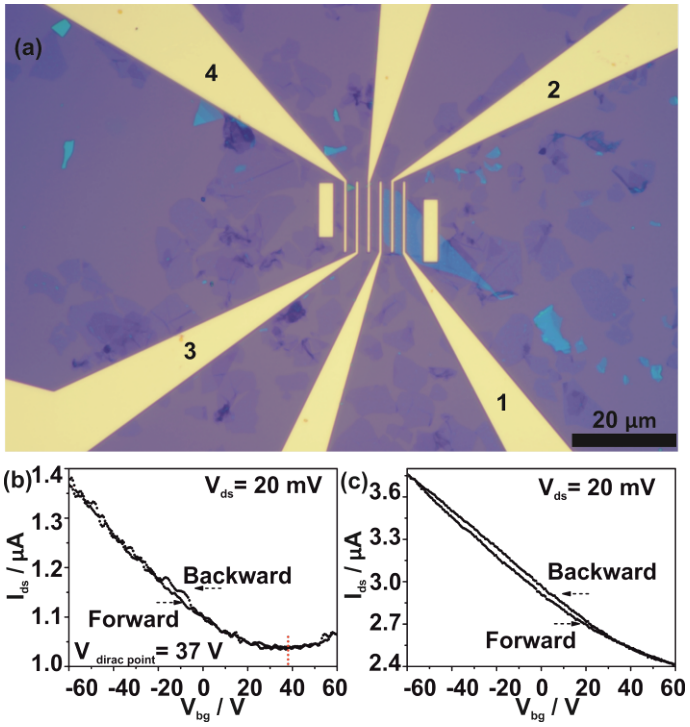

Fig. S4. (a) Optical image of the fabricated h-BN/$^{0.5\%}$G and SiO_2/$^{0.5\%}$G heterostructures device with back-gate. (b) Electrodes 1 and 2 were measured for the $^{0.5\%}$G on h-BN. Channel length and width between 1 and 2 is 2 μm and 15 μm, respectively. Electrodes 3 and 4 are measured for the $^{0.5\%}$G on SiO_2. Channel length and width between 3 and 4 is 2 μm and 15 μm, respectively.

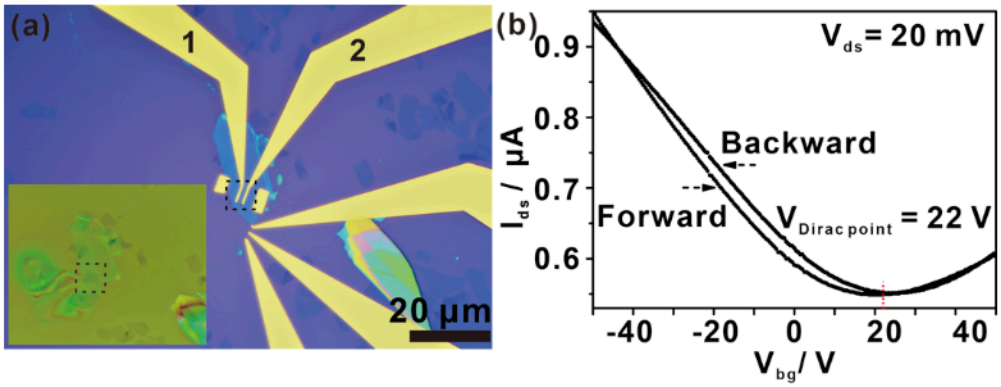

Fig. S5. (a) Optical image of the fabricated h-BN/$^{0.5\%}$G (the $^{0.5\%}$G is completely deposited onto the h-BN) heterostructures device. Channel length and width is 1.5 μm and 5 μm, respectively. The inset shows that the $^{0.5\%}$G flake is completely deposited on h-BN, which can fully avoid the effect of SiO_2 substrate on the electrical transport properties of the $^{0.5\%}$G. (b) Transfer characteristics for the $^{0.5\%}$G on h-BN.

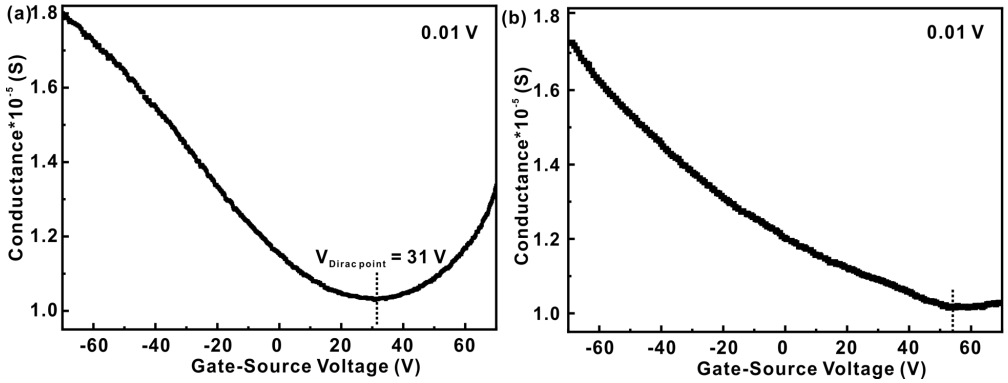

Fig. S6. Transfer curves of the reduced oxo-G with 0.8% defects in vacuum and air by two-probe configuration.

Reference

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