

High Conductance, Large Area, Single Layer Graphenes from Graphene Oxide

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The major route for low cost and large-scale production of graphene-like materials is chemical conversion via exfoliation of graphene oxide (GO). Unfortunately this method suffers from aggregation problems when the graphene is to be regenerated via reduction (deoxygenation). As a consequence its relatively high oxygen content has limited the quality of chemical converted graphene. Here we demonstrate a chemical conversion of single layer graphene oxide back into single layer highly reduced graphene. This is done by trapping reduced graphene oxide (RGO) sheets in two dimensions on a surface with the Langmuir-Blodgett technique before aggregation occurs [1]. The RGO is then further deoxygenated by multiple reduction steps including hydrazine treatment, acid treatment and annealing [2]. We have achieved single sheet conductivities up to 2.1×10^4 S/m. This is slightly lower than [3], but without the use of the extremely toxic pure hydrazine. The field effect has been examined by using the wafer as a gate and the RGO has been determined to be p-type. Coating of large areas with high quality single sheet graphene can be used for several purposes, e.g. preparation of transparent electrodes. The electrical and AFM characterization is supplemented with Raman analysis on individual single layered sheets to confirm the quality.

References

- [1] L. J. Cote et al., **JACS**, (2009), 131, 1043-1049.
- [2] Gao, W. et al., **Nature Chem.**, (2009), 1, 403-408.
- [3] Tung, V.C. et al., **Nature Nanotech.**, (2008), 4, 25-29.
- [4] Q. Tang et al., **Adv. Mat.**, (2008), 20, 1511-1515.

Figures

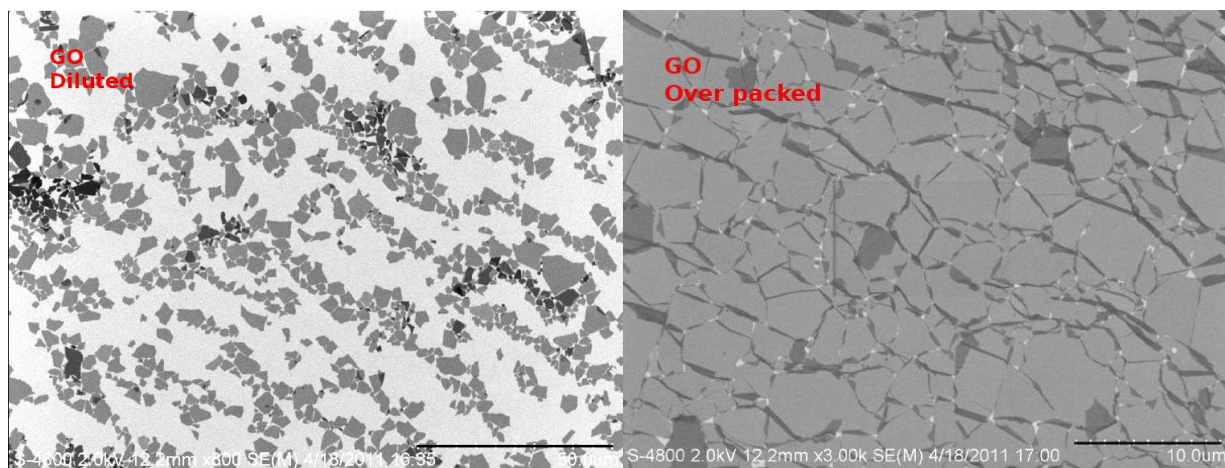


Figure 1. LB-assembly of graphene oxide transferred to Si-wafer at different packing densities. On the left: diluted packing of GO resulting in isolated sheets which could be contacted. On the right: over packed GO resulting in a coherent film consisting of primarily single sheets.

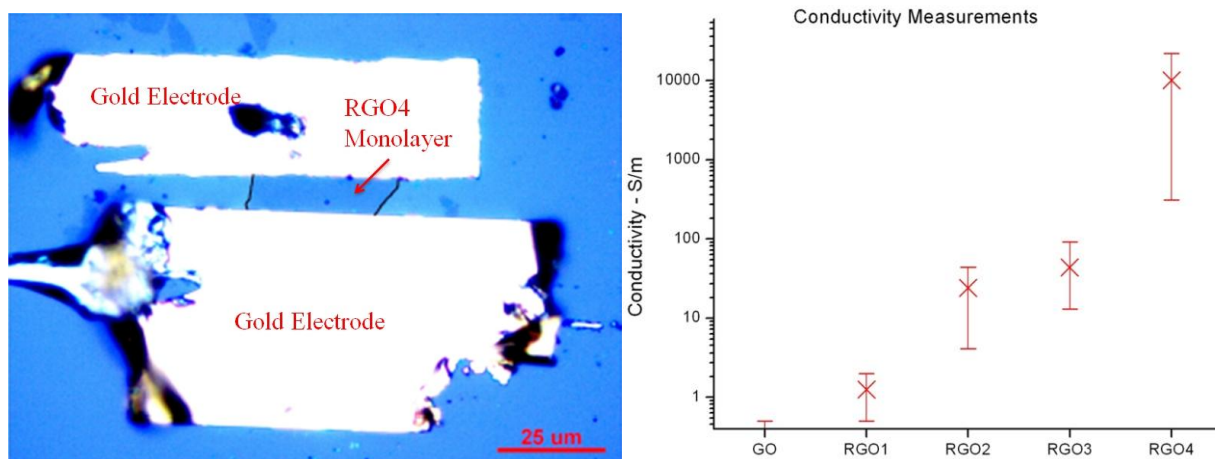


Figure 2. Electrical characterization of monolayered single graphene sheets. On the left: optical microscope image of a device fabricated from a single sheets of monolayered highly reduced graphene oxide in the middle with two gold electrode [4]. On the right: Plot of the conductivities measured for the reductions steps used as described in the text. The top and bottom bar represents the highest and lowest measured values respectively while the cross is the mean value.