Patterned Graphene Oxide Films by a Simple Method

Huifeng Li, Hengxing Ji, Yujie Ren, Yufeng Hao, Charles Amos, Yanwu Zhu, Richard Piner, Iskandar Kholmanov, Rodney S. Ruoff

Department of Mechanical Engineering and the Texas Materials Institute, University of Texas at Austin, Texas, 78712-0292

huifengli@mail.utexas.edu

Graphene oxide (G-O) material is of interest for numerous potential electronic applications, such as nonvolatile memory, transparent conductive film, energy storage, and polymer matrix composites [1-3]. The properties of G-O films composed of stacked and overlapped platelets can be tuned by controlling both the film thickness and the chemical reduction level. These properties can then be investigated by fabricating devices with difference sizes and on different substrates.

We report a simple process to fabricate patterned G-O films as depicted in Figure 1. The G-O used in this research was synthesized from purified natural graphite by the modified Hummers method [4]. The resulting graphite oxide powder was then dispersed in DI water with ultrasonic agitation and then further diluted with DI water to 0.01 wt%. The pattern on the SiO_2-on-Si wafer was made with photolithography. The G-O dispersion was dropped onto the pre-patterned substrate that was itself pre-heated on a hotplate held at 50 ˚C. The drying of the G-O dispersion left a thin G-O film about 15 nm thick (as measured with optical profilometry) on the substrate. The cooled sample was then briefly soaked in a glass beaker filled with acetone in an ultrasonic bath. Agitation was used to lift off the thin G-O film that was on the photoresist (while the resist simultaneously dissolved) leaving the patterned G-O film on the substrate.

Figure 2 shows an optical microscope image of the patterned G-O film. Our process allows for rapid creation of patterns on dielectric substrates without the need for dry etching and/or additional layer transfer. The patterned film can be reduced by chemical or possibly thermal treatments, for further studies. The process can likely be used to pattern G-O films on flexible substrates for flexible electronics. The effect of the G-O platelet size on the pattern resolution, and the surface chemistry that enhanced the pattern stability, will be discussed. The use of this process for nonvolatile memory devices and field effect transistors will be presented. *We appreciate support from the Semiconductor Research Corporation (Project # 2009-OJ-1873 AMD 1).*

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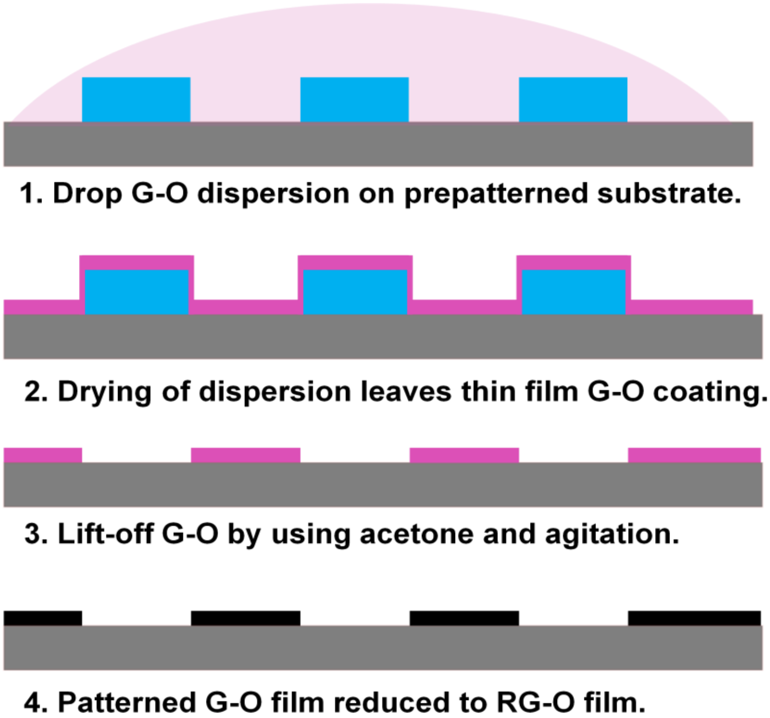

Figure 1. Schematic of the patterning of G-O film using a lift-off process. RG-O refers to reduced graphene oxide platelets in the film, such as by chemical and/or thermal treatment.

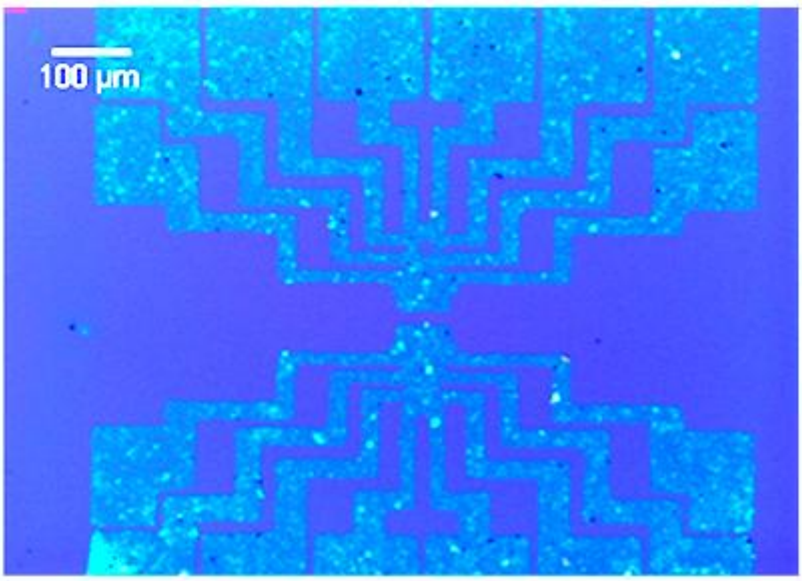

Figure 2. Image of patterned G-O film on a SiO_2-on-Si substrate.