Electronic Supplementary Material (ESI) for RSC Advances.

Oxidation-Degree-Dependent Moisture-Induced Actuation of Graphene Oxide Film

Waka Nakanishi,*[a] Yoshihiro Yamauchi,[a] Yuta Nishina,[b] Masafumi Yoshio[c,d] and Masayuki Takeuchi[a,e]
[a]Molecular Design and Function Group, National Institute for Materials Science, 1-2-1 Sengen, Tsukuba, Ibaraki 305-0047, Japan
[b]Research Core for Interdisciplinary Sciences, Okayama University, 3-1-1 Tsushimanaka, Okayama 700-8530, Japan
[c]Research Center for Functional Materials, National Institute for Materials Science, 1-2-1 Sengen, Tsukuba, Ibaraki 205-0047, Japan
[d]Graduate School of Chemical Sciences and Engineering, Hokkaido University, Kita 13, Nishi 8, Kita-ku, Sapporo, Hokkaido 060-8628, Japan
[e]Institute of Multidisciplinary Research for Advanced Materials (IMRAM), Tohoku University, Sendai 980-8579, Japan
*E-mail: NAKANISHI.Waka@nims.go.jp

Table of Contents

1. Structure of 1GO film fabricated by vacuum-assisted filtration.

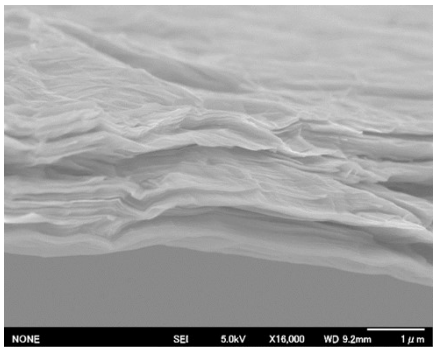


Figure S1. Cross-sectional SEM image of a 1GO film viewed from a fracture edge. Bar = 1 μm
The 1GO film was fabricated by vacuum-assisted filtration using MF-Millipore MCE membrane.

2. Moisture responsive actuation of 1GO film from freeze-dried 1GO sample.

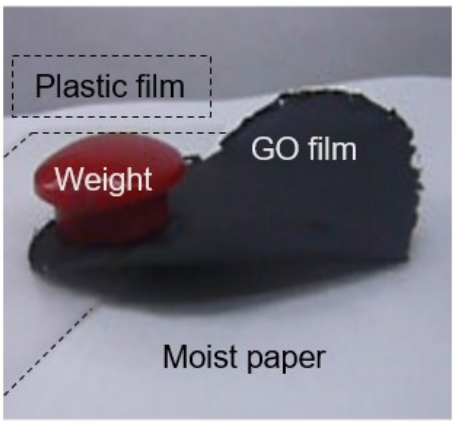
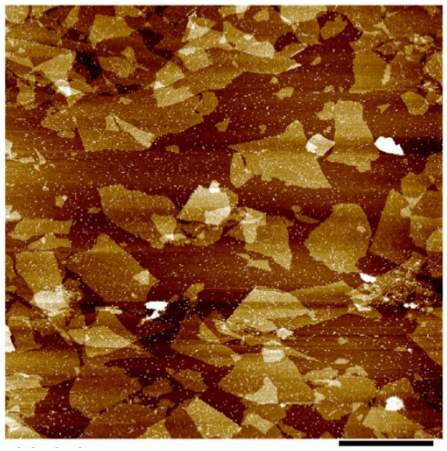


Figure S2. Moisture assisted actuation of 1GO thin film prepared from solution of dried 1GO sample.

One side of GO film was fixed on plastic film by weight and placed on wet paper.

3. Size of 1GO monolayers sonicated for 1hr.

a



b

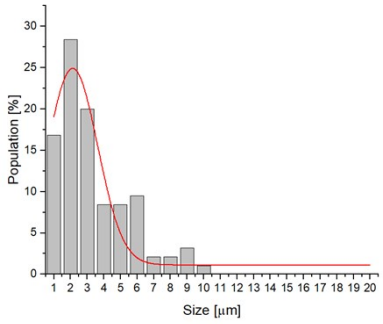


Figure S3. (a) AFM image of 1GO sonicated for 1 h. (b) The histograms (N ≥50) of size distribution of 1GO (a). Bar = 7 μm

4. UV-vis absorption spectra

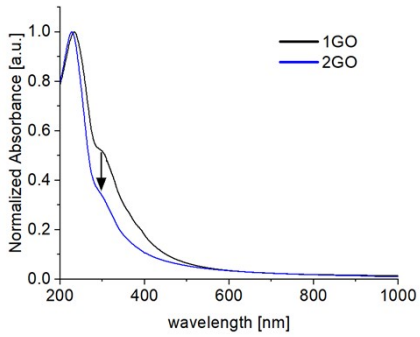


Figure S4. UV-vis absorption spectra of aqueous suspension of 1GO (black line) and 2GO (blue line). a.u. = arbitrary unit

UV-vis spectra of aqueous dispersions of 1GO and 2GO are shown in Fig.S4. Stronger absorption intensity of 1GO at visible to near IR wavelength indicates the fused rings is maintained more in 1GO compared with 2GO.

5. XRD patterns of 1GO and 2GO in water

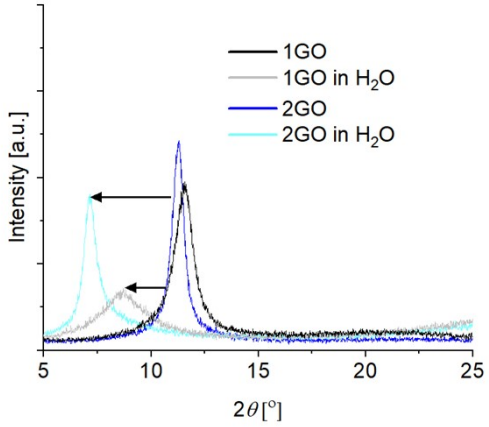


Figure S5. XRD patterns of 1GO (black line) and 2GO (blue line) thin films at ambient conditions and those in distilled water (gray and sky blue, for 1GO and 2GO, respectively).

The peaks for 1GO and 2GO at ambient conditions counted as 7.6 Å and 7.8 Å, respectively. The interlayer distances increase in water to 10.2 Å and 12.4 Å for 1GO and 2GO, respectively.

6. Distortion of GO films.

Table S1. Distortion ε and related values

	1GO	**2GO**	**2GO**
Weight (mg)	20	20	50
ε (%)	0.025 ± 0.006	0.012 ± 0.004	0.015
***d* (mm)**	0.012 ± 0.001	0.018 ± 0.001	0.017
δ (mm)	13 ± 3	3 ± 1	4.5

Distortion ε (%) was calculated as $\varepsilon = 2d\delta/(L^2 + d^2)$

where d is thickness of the film (mm), δ is the displacement of the film in the vertical direction (mm), and L is the distance from the fulcrum (= 32 mm).