

Supporting information (SI)

A simple and feasible in-situ reduction route for preparation of graphene lubricant films applied to a variety of substrates

*Yongjuan Mi,^{ab} Zhaofeng Wang,^a Xiaohong Liu,^a Shengrong Yang,^{*a} Honggang Wang,^a Junfei Ou,^{ab} Zhangpeng Li,^{ab} and Jinqing Wang,^{*a}*

^aState Key Laboratory of Solid Lubrication, Lanzhou Institute of Chemical Physics, Chinese Academy of Sciences, Lanzhou, 730000, P. R. China.

^bGraduate University of Chinese Academy of Sciences, Beijing, 100080, P. R. China

E-mail: jqwang@licp.cas.cn; sryang@licp.cas.cn; Fax: +86-931-8277088;

Tel: +86-931-4968076

1. Comparative experiment details

For comparison, we also employed hydrazine hydrate ($\text{N}_2\text{H}_4\cdot\text{H}_2\text{O}$) and hydroiodic acid (HI) as reducing reagents to reduce the surface GO films.

$\text{N}_2\text{H}_4\cdot\text{H}_2\text{O}$ Vapor Reduction. APTES-GO modified silicon substrates were placed in a perfectly cleaned glass Petri dish inside a larger glass beaker containing 1 mL of $\text{N}_2\text{H}_4\cdot\text{H}_2\text{O}$ (80%). The beaker was sealed with Parafilm tape and kept in a water bath at 40 °C for 18 h, then the samples were taken out, rinsed with ultrapure water and blown by N_2 followed by heating to 80 °C in vacuum, the obtained sample was labeled as APTES-rGO- $\text{N}_2\text{H}_4\cdot\text{H}_2\text{O}$.

HI Reduction. APTES-GO modified silicon substrates were immersed into HI aqueous solution (45%) in a sealed glass vessel placed in a oil bath at 100 °C and kept for 30 min, and then the samples were taken out, washed repeatedly with ethanol, the obtained sample was coded as APTES-rGO-HI.

The powder products reduced by $\text{N}_2\text{H}_4\cdot\text{H}_2\text{O}$ and HI were prepared using the same experimental conditions as mentioned above.

2. Photographs and WCA of various films

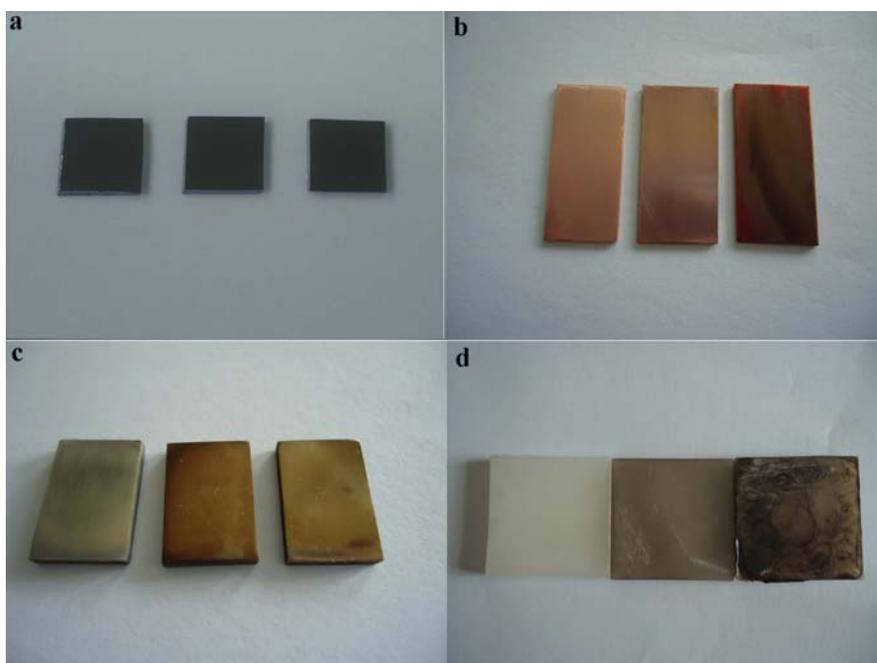


Fig. S1. Photographs of the cleaned substrates, PDA coated substrates and GO treated substrates pre-modified by PDA from left to right in every picture, and the substrates were silicon wafer (a), copper (b), titanium alloy (c), and PE (d) sheets, respectively.

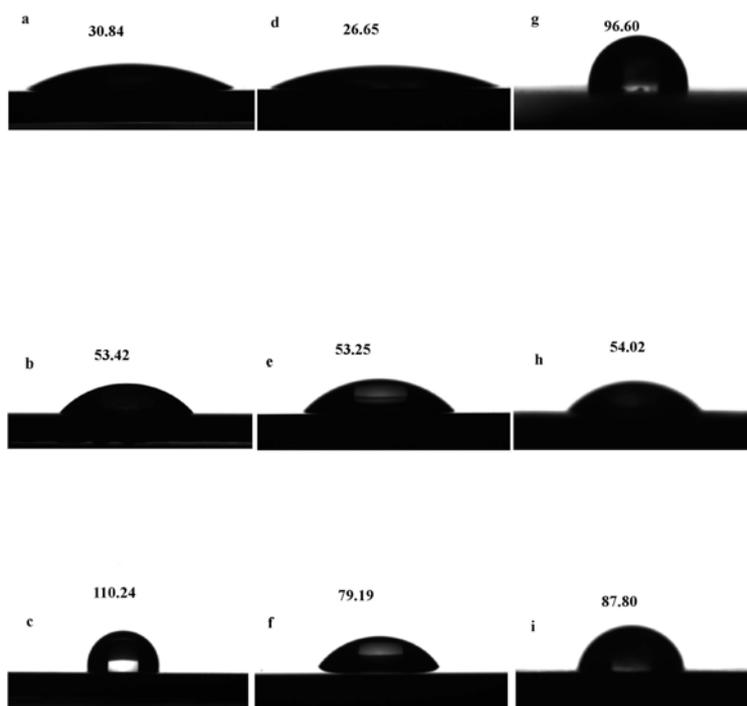


Fig. S2. The water contact angles (WCA) of preliminary treated substrates (a, d, and g), PDA coated substrates (b, e, and h) and GO treated substrates pre-modified by PDA (c, f, and i), and the substrates were copper, titanium alloy, and PE sheets in turns.

Table S1. The surface WCA for the silicon substrate and samples modified with different materials

Samples	WCA/ ^o
Si/SiO ₂	~ 0
APTES-SAM	49.6 ± 1.7
APTES-GO	43.6 ± 0.9
APTES-rGO-N ₂ H ₄ • H ₂ O	97.5 ± 0.8
APTES-rGO-HI	84.2 ± 1.0

3. FTIR, Raman, XPS spectra and AFM images of samples.

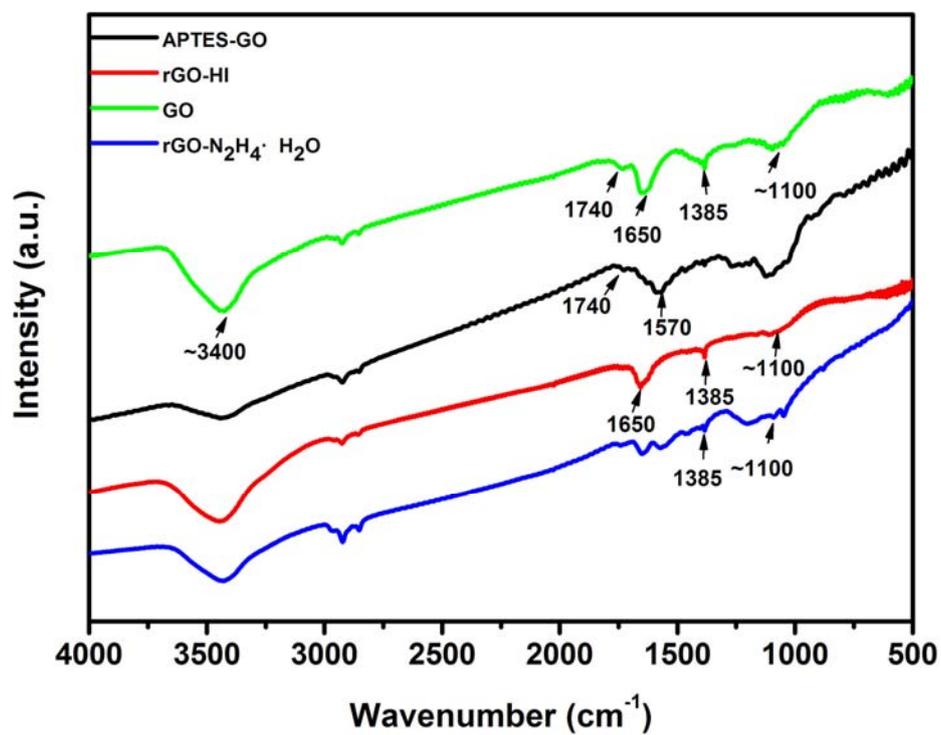


Fig. S3. FTIR spectra of GO and rGO reduced by $\text{N}_2\text{H}_4 \cdot \text{H}_2\text{O}$ and HI (named rGO- $\text{N}_2\text{H}_4 \cdot \text{H}_2\text{O}$ and rGO-HI).

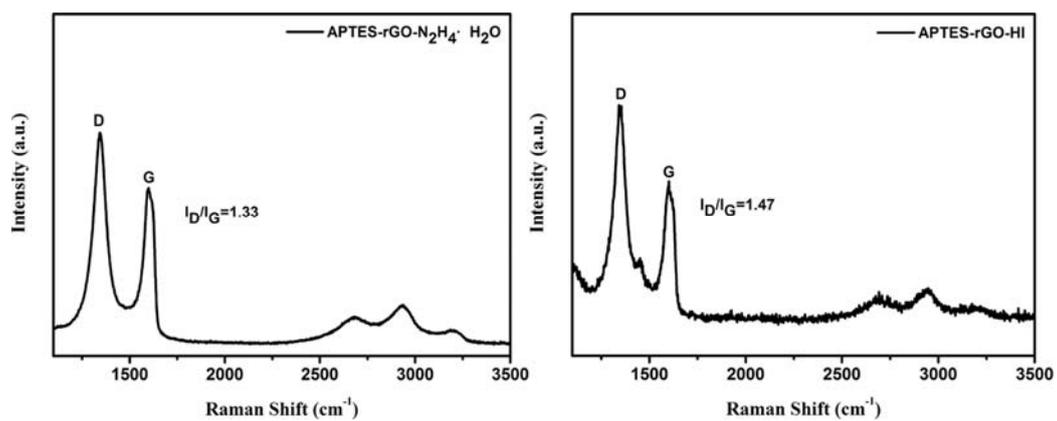


Fig. S4. Raman spectra of APTES-rGO reduced by N₂H₄·H₂O and HI.

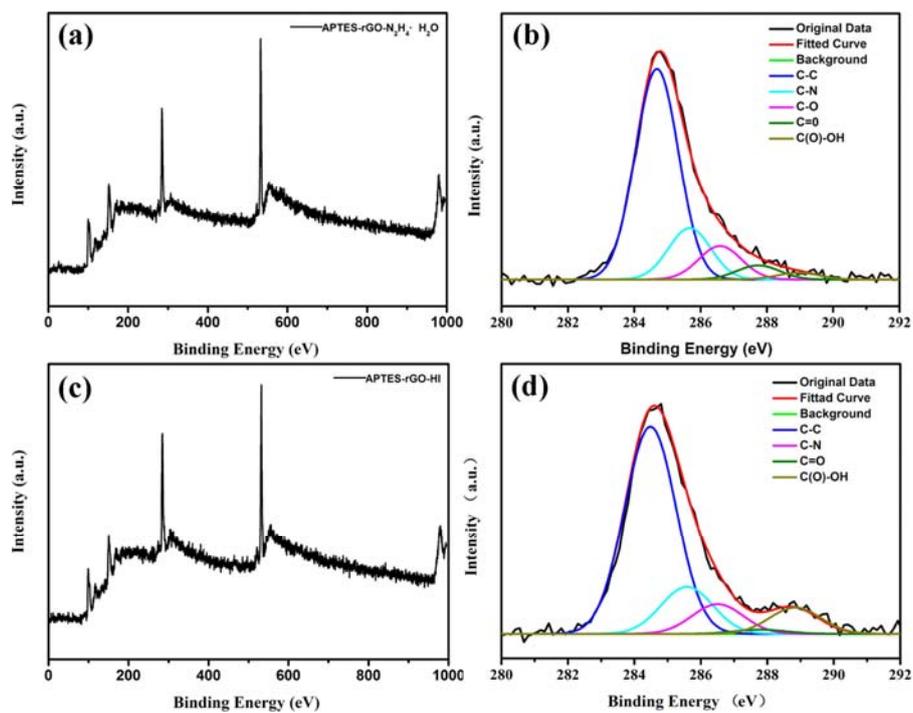


Fig. S5. Survey XPS spectra and C 1s core-level spectra of APTES-rGO reduced by $N_2H_4 \cdot H_2O$ (a and b) and HI (c and d).

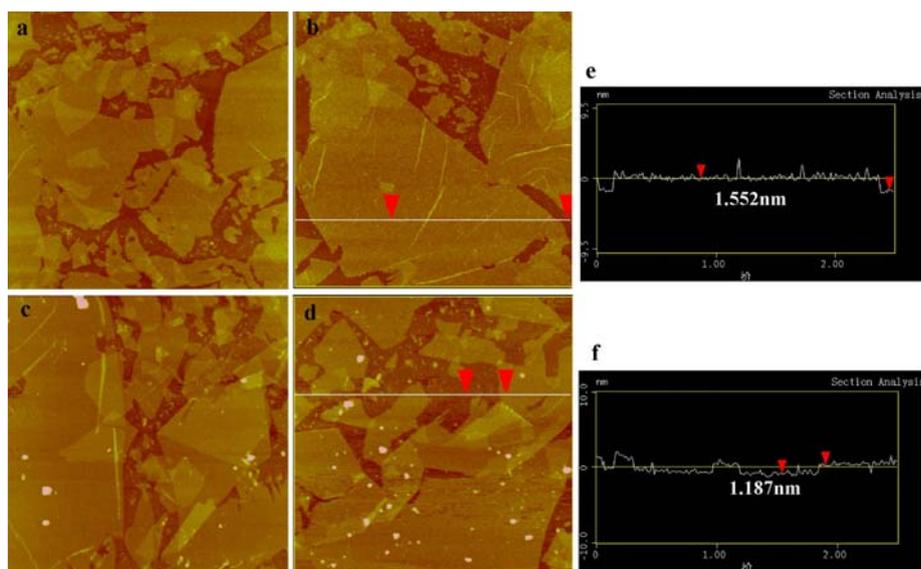


Fig. S6. AFM images of APTES-rGO reduced by N₂H₄·H₂O (a and b) and HI (c and d), and the corresponding section analyses (e and f). The scanning area of a and c is 5 × 5 μm², and b and d is 2.5 × 2.5 μm². The Z range of samples is 20 nm.

4. Tribological Property

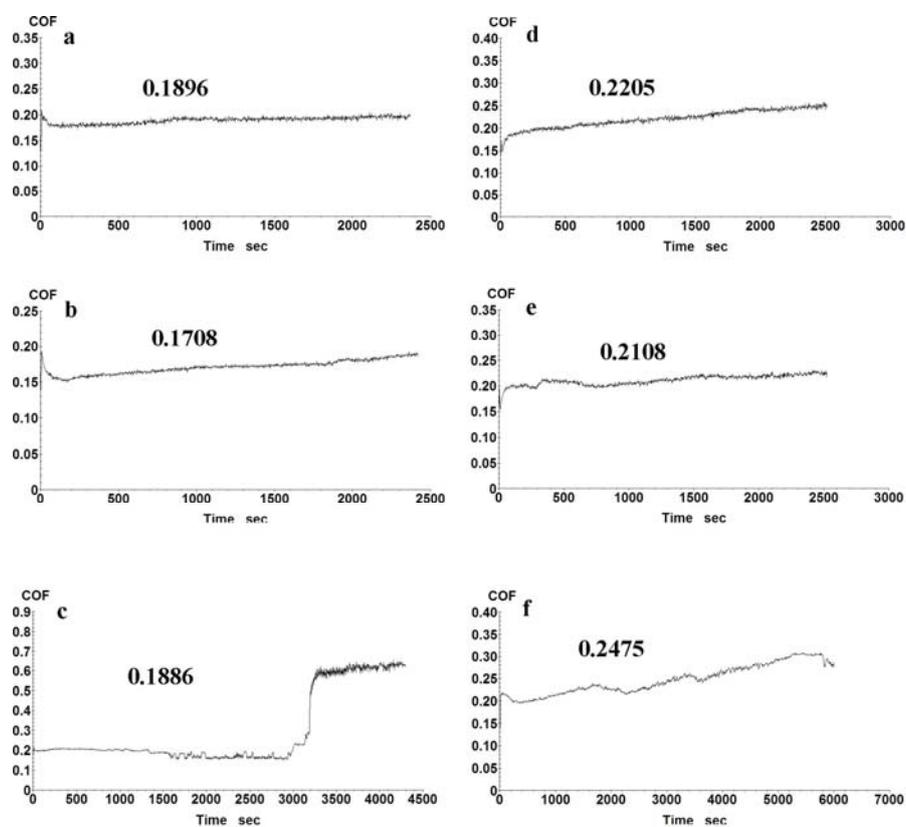


Fig. S7. Variation in friction coefficient with time of various film samples on silicon substrates under different applied loads at the fixed sliding frequency of 1 Hz: (a, b, c) APTES-rGO reduced by $\text{N}_2\text{H}_4 \cdot \text{H}_2\text{O}$ at the applied load of 0.1 N, 0.2 N, and 0.3 N, respectively. (d, e, f) APTES-rGO reduced by HI under the same conditions as (a, b, and c). The average friction coefficient (FC) was given above the corresponding curve.