Supplementary Materials for

Achieving high-yield and scalable synthesis of ultrastable nanoscale graphene oxide via photochemical defect engineering and oxidative cleavage

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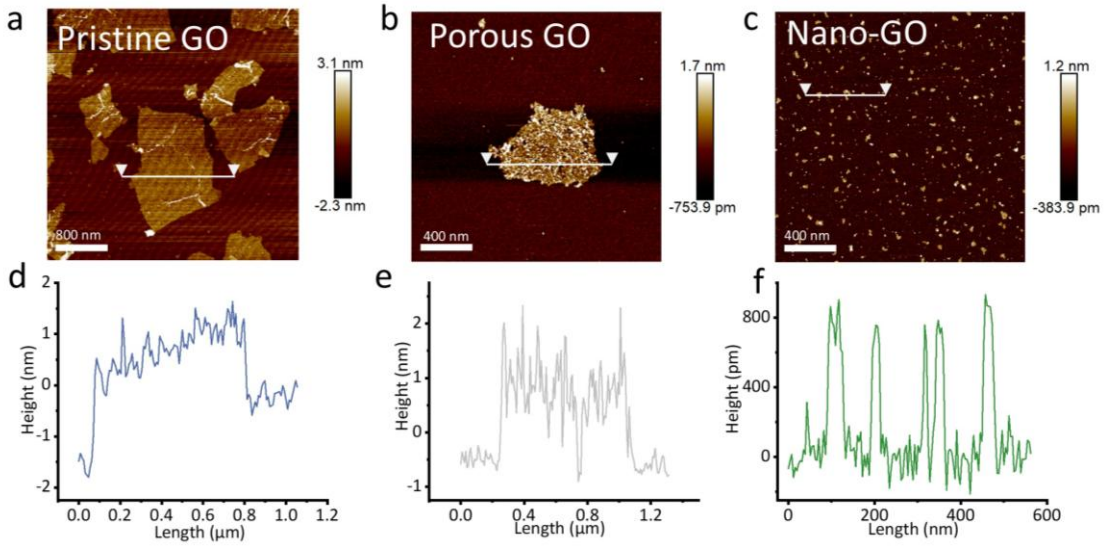
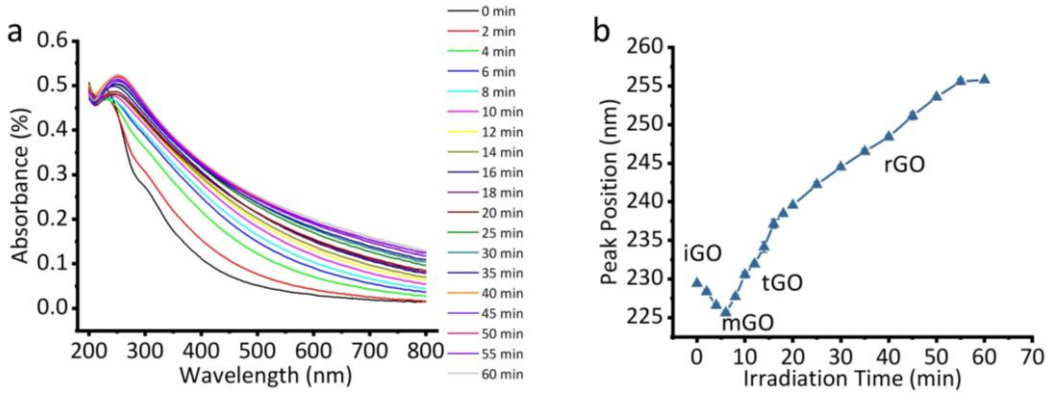
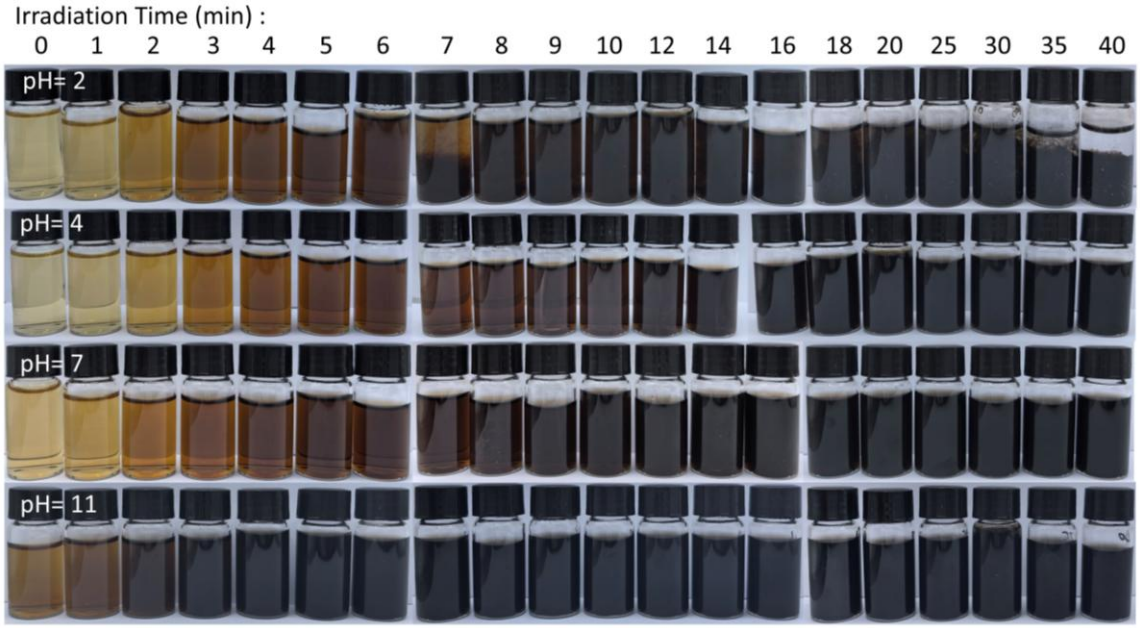


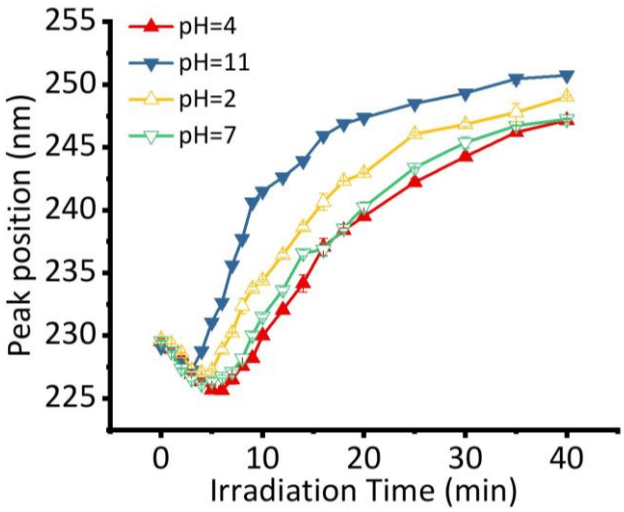
Supplementary Figure 1. Height measurement of three types GO. a-c, AFM images and measurement position of GO, Porous GO and Nano-GO. **d-f,** Height distributions of samples.



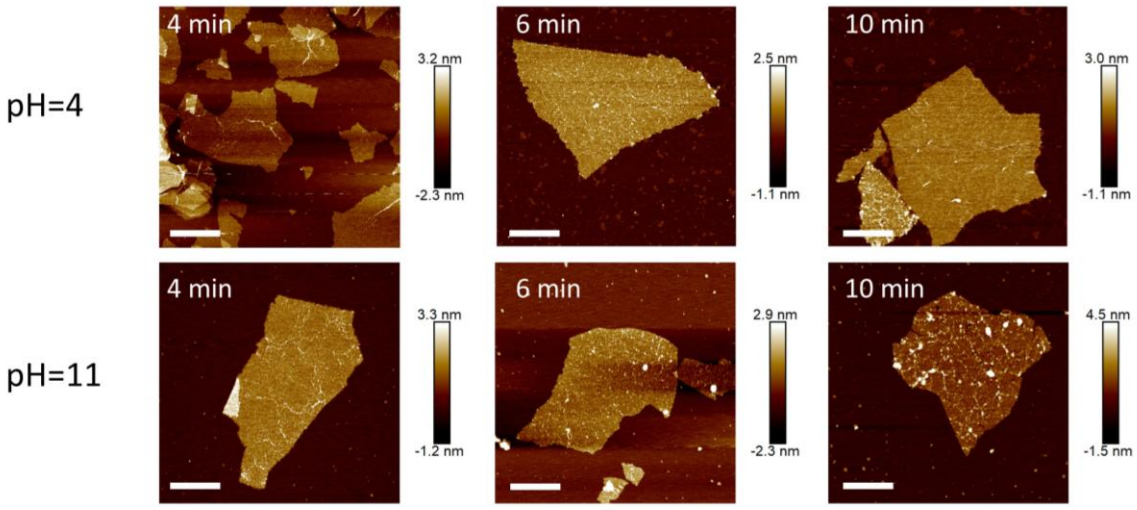
Supplementary Figure 2. UV-Vis absorbance evolution of GO during irradiation. a, 200-800 nm evolution of GO. **b,** Maximum absorption peak position evolution of GO.



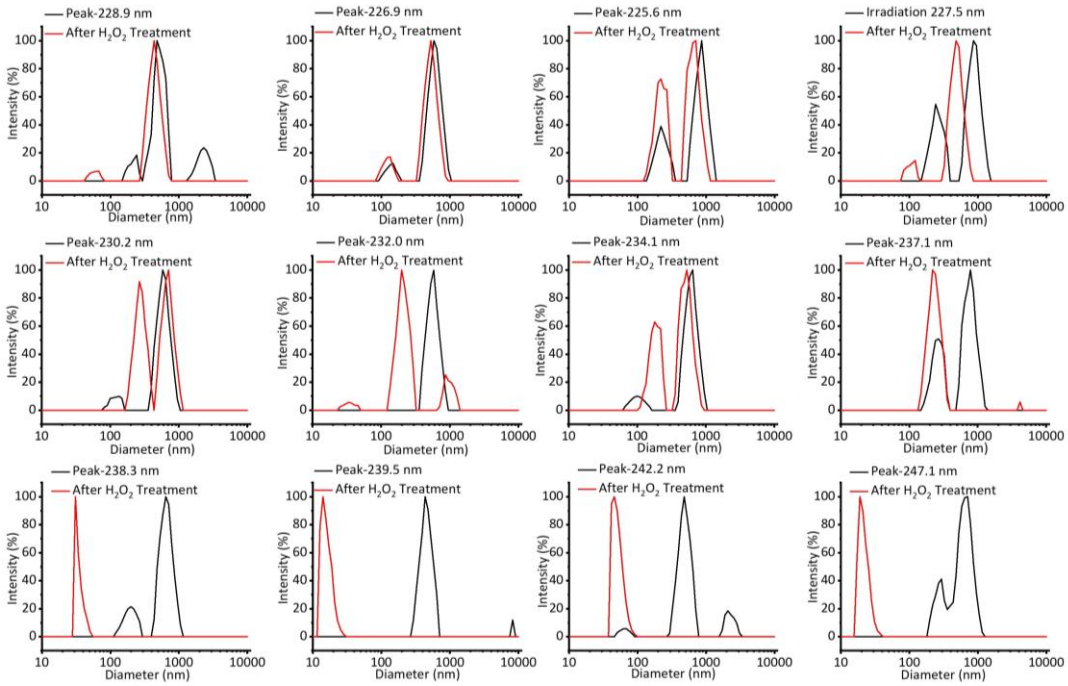
Supplementary Figure 3. Photographs showing the evolution of GO dispersions under irradiation at different pH levels.



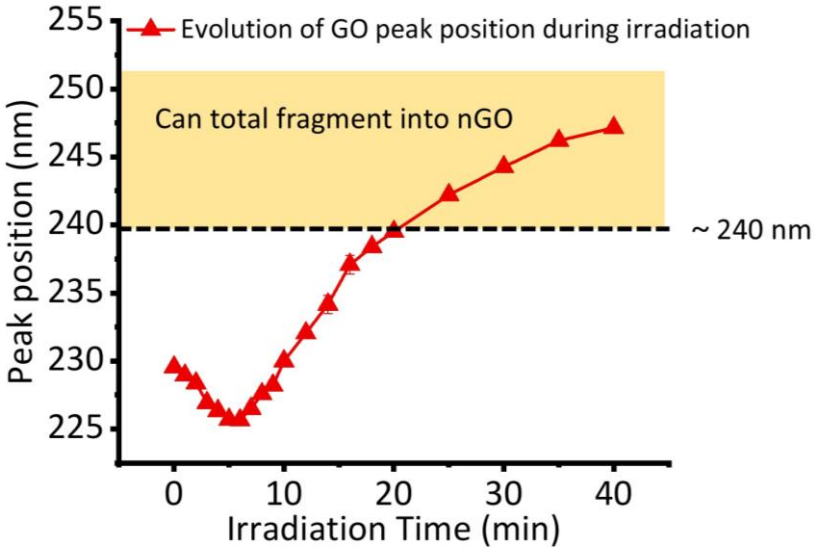
Supplementary Figure 4. Evolution of the maximum absorbance peak of GO under irradiation at different pH levels.



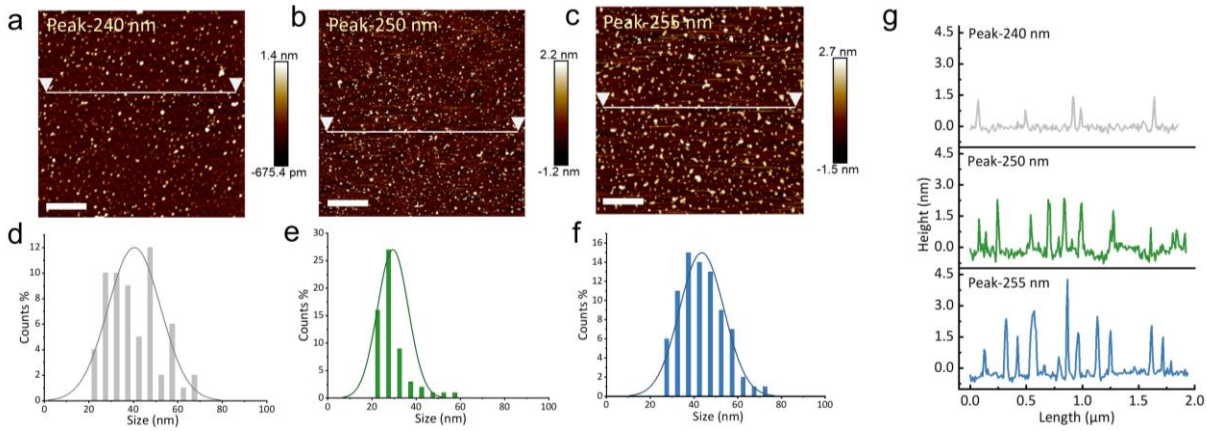
Supplementary Figure 5. AFM images showing the evolution of GO under irradiation at pH 4 and pH 11.



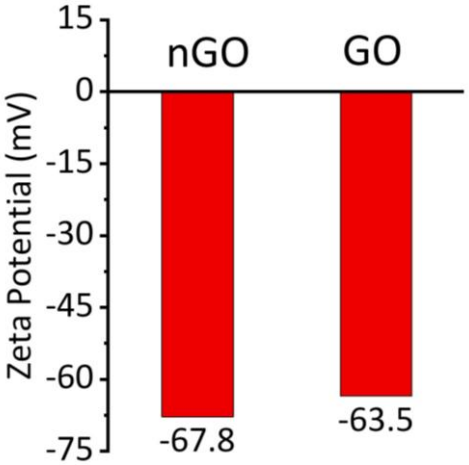
Supplementary Figure 6. DLS measurements of GO at different irradiation levels (maximum absorbance peak position) before and after H_2O_2 treatment.



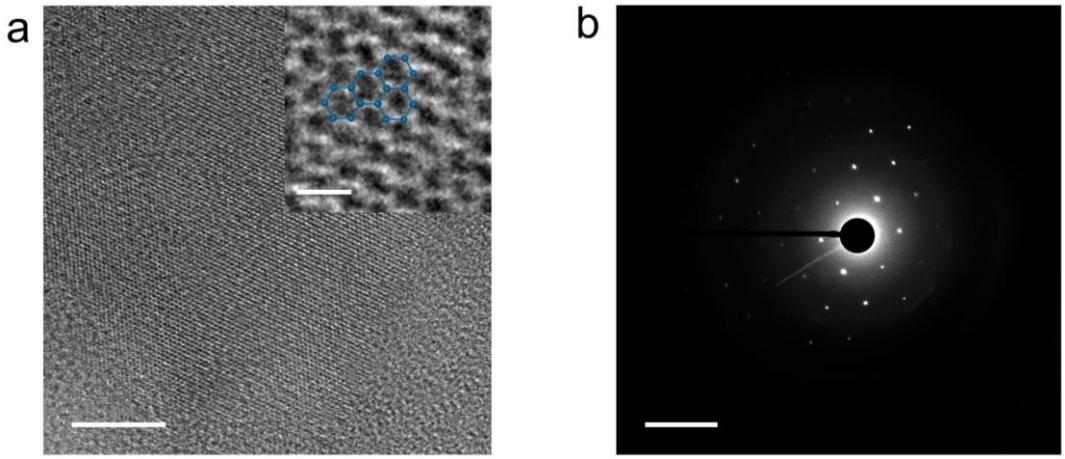
Supplementary Figure 7. Relationship between irradiation levels (maximum absorbance peak position) and the transformation of GO to nGO.



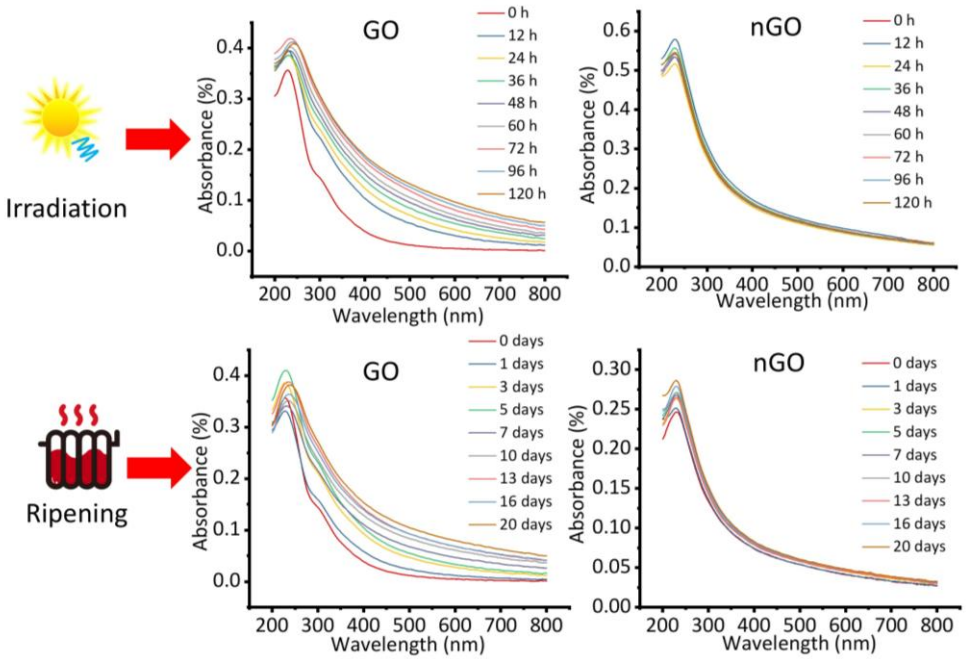
Supplementary Figure 8. nGO prepared at different irradiation levels (maximum absorbance peak position). a-c, AFM images of sample. **d-f,** size distribution analysis of sample. **g,** Thickness of sample. Scale bars: (**a-c**) 400 nm.



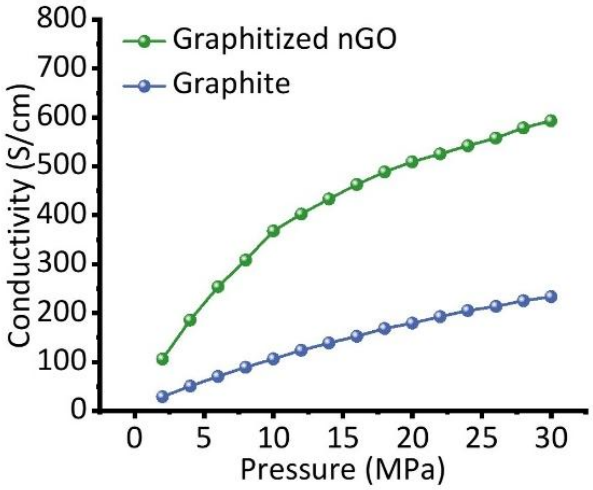
Supplementary Figure 9. Zeta potential distribution analysis of GO and nGO.



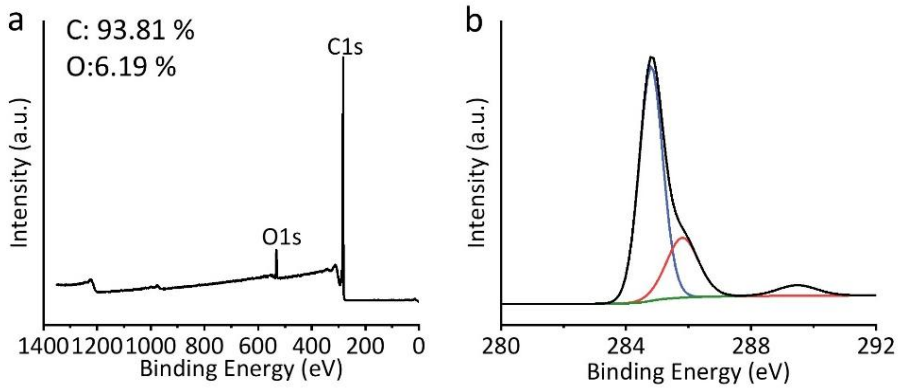
Supplementary Figure 10. AC-TEM characterization of nGO. a, Bright-field TEM image. **b,** Selected-area electron diffraction (SAED) pattern. Scale bars: **a** 10 nm (inset, 0.5 nm); **b** 0.5 nm.



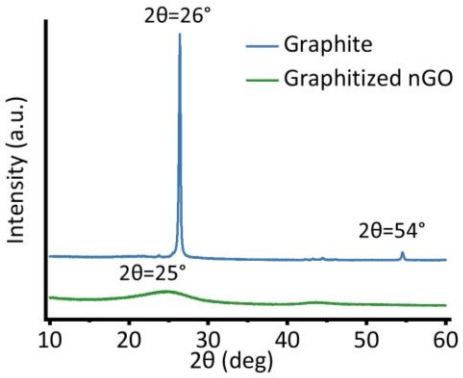
Supplementary Figure 11. UV-Vis absorbance spectra of GO and nGO during thermal ripening and light irradiation.



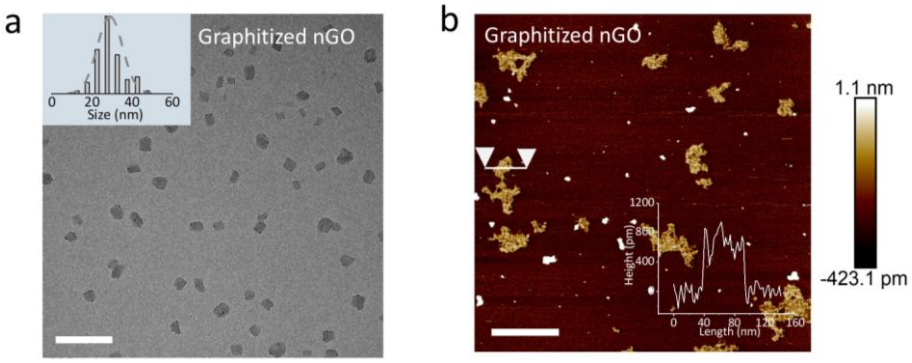
Supplementary Figure 12. Electrical conductivity of graphitized nGO compared to pristine graphite.



Supplementary Figure 13. XPS characterization of graphitized nGO. a, Survey spectrum. **b,** High-resolution C1s spectrum.



Supplementary Figure 14. XRD result of graphitized nGO and pristine graphite.



Supplementary Figure 14. Structural characterization of graphitized nGO. a, TEM images. **b,** AFM images. Scale bars: (**a**) 100 nm; (**b**) 200 nm.

Supplementary Table 1. Conductivity of GO and nGO after chemical and thermal reduction.

	Pristine	$NaBH_4$	Ascorbic acid (VC)	$N_2H_4 \cdot H_2O$	HI-AcOH	H_2/Ar
GO (S/cm)	1.04×10^{-3}	1.56×10^{-1}	6.09	2.5×10^{1}	1×10^{2}	1.42×10^{2}
nGO (S/cm)	6.98×10^{-5}	2.14×10^{-4}	5.22×10^{-4}	5.22×10^{-4}	1.20×10^{-3}	1.67

Supplementary Video 1. Filtration test of GO

5ml of 0.2 mg/ml GO solution in the syringe is fixed on the iron frame, and the push rod applies a force of 20 N vertically downwards. The GO solution could not through the 0.22 μm membrane. Play speed is 1X.

Supplementary Video 2. Filtration test of nGO

The same measurement and concentration of nGO filtration test, but nGO could gently pass through the membrane. Play speed is 1X.