Supporting Information

Graphene oxide regulates the bacterial community and exhibits property changes in soil

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NO.	Index	Value		
1	Particle-size distribution (%)			
	Clay (< 0.002 mm)	$3.11\pm0.04^{\rm a}$		
	Silt (0.002-0.05 mm)	85.07 ± 2.86		
	Sand (> 0.05 mm)	11.82 ± 0.16		
2	pH	7.74 ± 0.25		
3	CEC (cmol/kg)	4.25 ± 0.13		
4	Field capacity (%)	22.67 ± 2.06		
5	Organic matter (g/kg)	8.18 ± 0.78		
6	Total N (%)	1.05 ± 0.03		
7	Total P (%)	0.16 ± 0.02		
8	Total K (%)	0.068 ± 0.002		
9	Rapidly available N (mg/kg)	63.0 ± 1.34		
10	Rapidly available K (mg/kg)	72.0 ± 1.65		
11	Available P (mg/kg)	85.4 ± 2.06		
^a Mean \pm SD ($n = 3$)				

Table S1. The physicochemical properties of the collected soil.

The physicochemical properties of the collected soil was analyzed according to the routine analytical methods of agricultural chemistry in soil (R. Lu, *China Agricultural Science and Technology Press, Beijing*, 1999, 107-240).

Table S2. Richness and diversity of bacterial communities in the PGO-soil sample (PGOS) and control soil sample (CS), analyzed through pyrosequencing.

	Deeda	3% distance				
	Reads	OTUs	ACE	Chao	Shannon	
PGOS	$17,882 \pm 231^{a}$	702 ± 5	728 ± 4	731 ± 9	5.15 ± 0.01	
CS	$15,651 \pm 173$	691 ± 3	715 ± 5	713 ± 6	5.12 ± 0.01	
^a Mean \pm SD ($n = 3$)						

PGO, pristine graphene oxide; OTU, operational taxonomic unit; ACE, abundance coverage estimator; Chao, species richness estimator; Shannon, the shannon diversity index.



Figure S1. Photographs of SGO (soil-modified graphene oxide). (a) The status of SGO separation using an orbital shaker at 200 r/min for different oscillatory times (0 h, 2 h, 4 h, 6 h, 8 h, 10 h and 20 h); and (b) photographs of the SGO powders.



Figure S2. Rarefaction and Shannon-Wiener curves based on the OTUs (3% distance level) in the bacterial communities from PGOS (PGO-soil sample) and CS (control soil sample).



Figure S3. Venn diagram (a) showing the unique and shared OTUs (3% distance level) in two libraries composed of the PGOS (PGO-soil sample) and CS (control soil sample) bacterial communities. Pie graph showing the taxonomic identities of the unique OTUs for PGOS (b) and CS (c) at the phylum level. Phyla accounting for less than 1% of the total composition of the unique OTUs in each sample are represented by "others."



Figure S4. Scanning electron microscopy (SEM, a and b) and field-emission transmission electron microscopy (TEM, c and d) images of PGO (pristine graphene oxide) and SGO (soil-modified graphene oxide). Energy dispersive spectra (EDS, e) of the elemental composition of the black spot in the SGO TEM image.



Figure S5. Atomic force microscopy (AFM) images of PGO (pristine graphene oxide) and SGO (soil-modified graphene oxide).



Figure S6. X-ray photoelectron spectra (XPS) of PGO (pristine graphene oxide) and SGO (soil-modified graphene oxide).



Figure S7. Fourier transform infrared spectroscopy (FTIR) spectra of PGO (pristine graphene oxide) and SGO (soil-modified graphene oxide).



Figure S8. Total ions chromatogram of the organic molecules extracted from SGO (soil-modified graphene oxide). Fourteen organic molecules were detected repeatedly in triplicate samples of SGO. None of the 14 organic molecules was detected in triplicate samples of PGO (pristine graphene oxide). Some interference peaks came from the derivatization reagents.

NO.	Name	NO.	Name
1	Benzene	32	Benzeneethanamine
2	Butanoic acid	33	Decane
3	Benzoic acid	34	2-Pentadecanone
4	Propanoic acid	35	Dotriacontane
5	3-Methylbutyl	36	Octadecane
6	Glycine	37	Propenamide
7	Amino levulinic acid	38	N-Methyl-1-adamantaneacetamide
8	Glycerol	39	Ethanedioic acid
9	Hexadecane	40	2-Phenylbutyric acid
10	Octacosane	41	2-Butenoic acid
11	Octane	42	d-Mannose
12	L-(+)-Lactic acid	43	Tetracosane
13	Benzaldehyde	44	2-Cyclopenten-1-one
14	1-Butanol	45	Monopalmitin
15	Phenol	46	Myristic acid
16	Undecane	47	Aniline
17	Phosphonic acid	48	Benzamide
18	Pentacosane	49	Butane
19	Tetradecanoic acid	50	Propionic acid
20	d-Galactose	51	D-glucopyranoside
21	Hexanoic acid	52	Phosphenimidous amide
22	D-Mannitol	53	Hexadecanamide
23	Tetratetracontane	54	Anthracene
24	Heptacosane	55	Octadecanamide
25	2-Propenoic acid	56	Nonadecane
26	Hexadecanoic acid	57	5-Pentadecanone
27	Eicosane	58	1-Octacosanol
28	Hentriacontane	59	Cyclohexane
29	Docosane	60	L-Proline
30	Heptadecanoic acid	61	1-Penten-3-one
31	Octadecanoic acid		

Table S3. The organic molecules extracted from the raw soil sample

61 organic molecules were detected repeatedly in triplicate samples of SGO.



Figure S9. The size distribution (a) and surface charges (b) of the nanomaterials PGO (pristine graphene oxide) and SGO (soil-modified graphene oxide). The size distributions and zeta potentials were measured using a ZETAPALS/BI-200SM instrument equipped with a 30 mW, 635 nm laser (Brookhaven, USA). The surface charge was evaluated by measuring the zeta potential at various pH values. The concentration of the PGO and SGO suspensions was 1.0 mg/L. Error bars (b) represent the standard deviations of triplicate samples.