Electronic Supplementary Material (ESI) for Nanoscale.

Supporting Information

Oxidation and Degradation of Graphitic Materials by Naphthalene-degrading Bacteria

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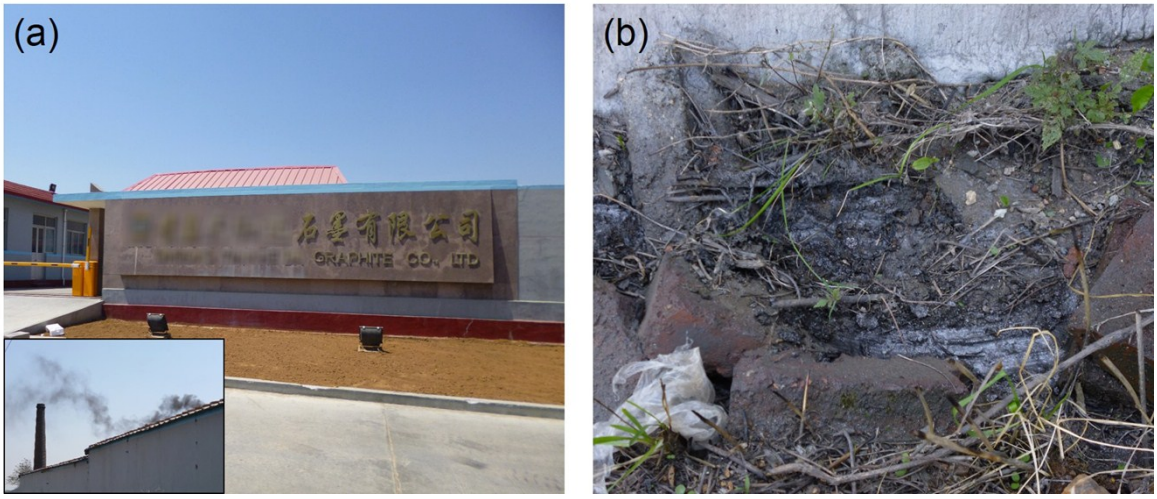

Figure S1. Photos of sampling location.

To obtain the strain feeding on graphitic materials, we collected soil from graphite mine (Figure S1a) as the source of bacteria for further isolation. One of the sampling points was contaminated by graphite as Figure S1b shows. The soil was collected about ten centimeters deep under the ground where both water and air are adequate.

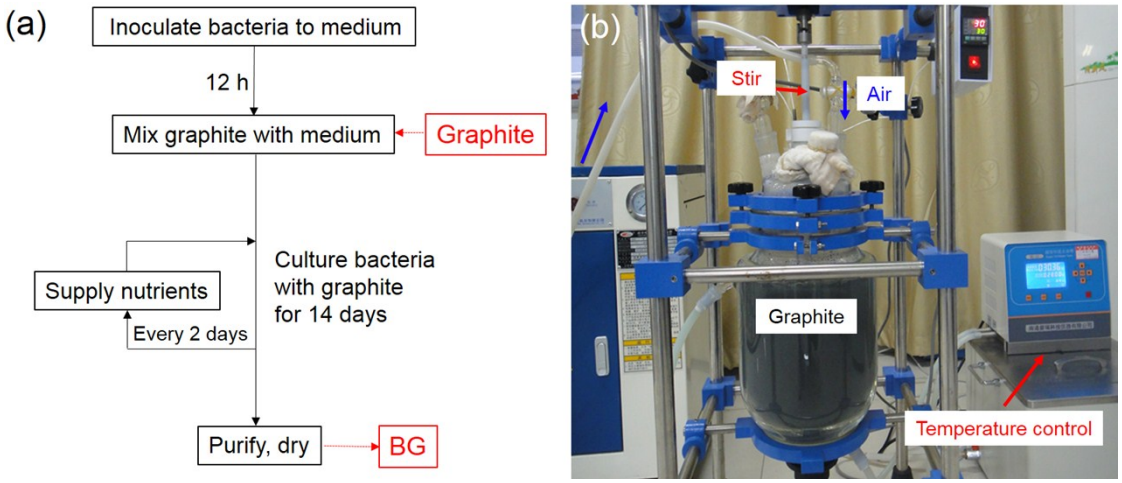

Figure S2. (a) Flow diagram of producing BG. (b) The reactor for bacterial oxidization of graphite.

As shown in Figure S2a, 1-2 days are spent for pre-cultivation of bacteria before the addition of graphite. Graphite is mixed with liquid medium for 14-day co-cultivation and sufficient air is pumped into the tank to keep the biological oxidation active. Medium is supplemented every two days to make up for the consumption of nutrients and evaporation of water.

Table S1. Physiological and biochemical indices of the isolated strain.

Test	Observation	Test	Observation	Substrate Utilization	
				Carbon Source	Observation
Gram's reaction	-	Nitrogen fixation	-	Glucose	+
Shape	Moderate rod	Nitrate reduction	-	Saccharose	+
Flagellum	+	Reducing nitrate to nitrite	+	Starch	+
Colony configuration	Round	Oxidation/Fermentation	O	Inositol	-
Surface	Smooth	Oxidase	+	D-Galactose	-
Elevation	Convex	Catalase	+	Fucose	-
Pyocyanin	-	Lecithase	-	Sorbitol	-
Fluorescein	+	Amylolytic enzyme	-	L-Phenylalanine	+
Anaerobic growth	-	Arginine dihydrolase	+	L-Alanine	+
Growth at 4℃	+	Gelatin hydrolase	-	L-Arginine	+
Growth at 41℃	-			L-Proline	+

The strain is determined to Pseudomonas consulting Bergey's Manual of Determinative Bacteriology. The physiological and biochemical indices are mostly in agreement with that of Pseudomonas.

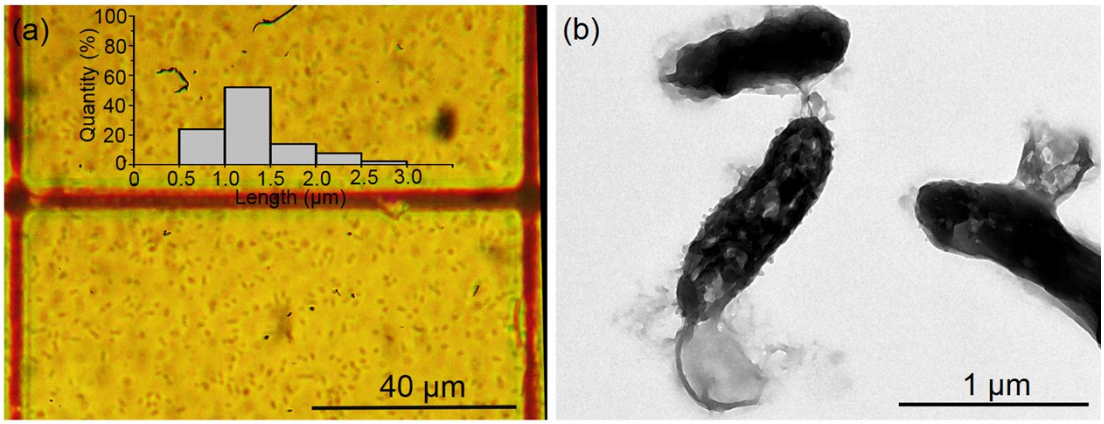

Figure S3. (a) Optical micrograph image of the bacteria in the MSM. Inset shows the size (length) distribution of bacterial cells. (b) HRTEM image of the bacterial cells in the MSM.

The length distribution based optical micrograph shows 75.9% of the bacterial cells cultivated in the naphthalene-containing MSM have the size between 0.5-1.5 μm. The average bacterial size is 1.3 μm on the basis of estimate of the size distribution.

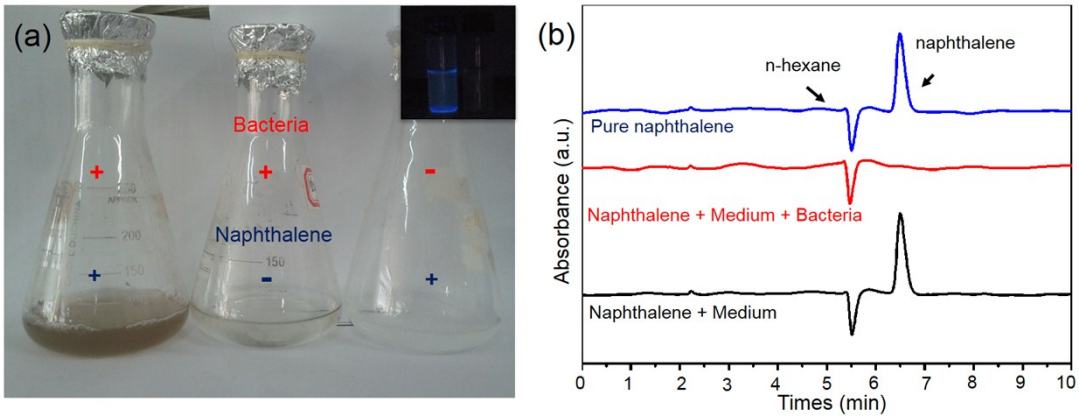

Figure S4. (a) Growth status of bacteria under different conditions. (b) HPLC chromatograph of naphthalene.

After 2 days of cultivation, only the medium containing both bacteria and naphthalene turns brown (Figure S4a) and bacteria can be observed through optical microscope (Figure S3a). The growth of bacteria can also be proved by fluorescein produced by bacteria (inset of Figure S4a). The consumption of naphthalene is confirmed by high performance liquid chromatography (HPLC). As presented in the Figure S3b, 1 g L^{-1} naphthalene is mostly degraded after being cultivated with bacteria for 24 h while the blank control shows the peak as strong as the one of pure 1g L^{-1} naphthalene.

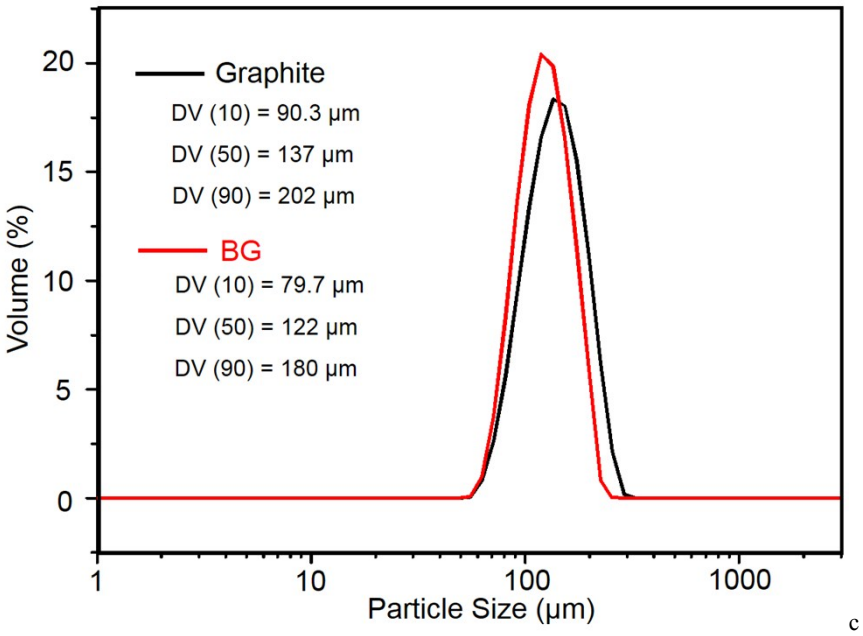

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Figure S5. Size distribution of graphite (black) and BG (red).

The average particle size of graphite and BG is 137 and 122 µm, respectively. The slight decrease of particle size after cultivation with bacteria demonstrates that the surface of graphite particles probably split off from the particles.

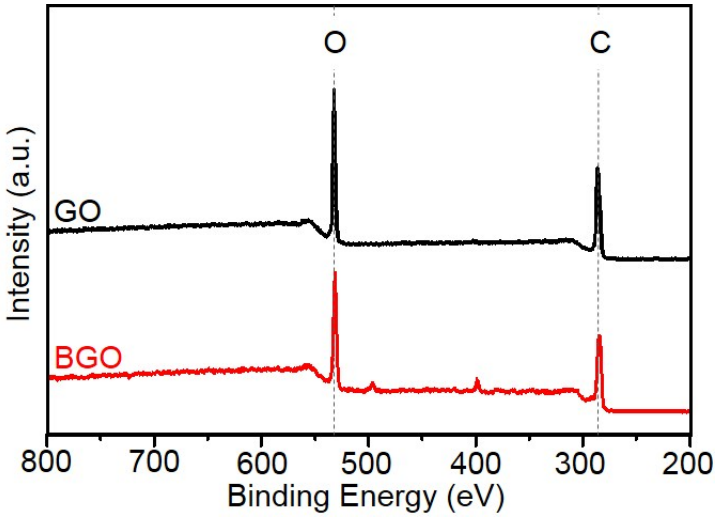
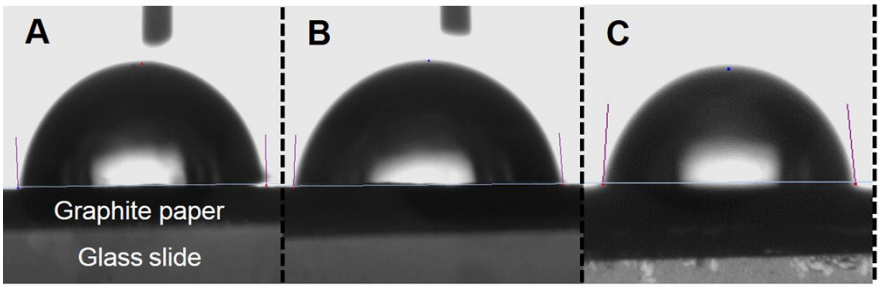


Figure S6. XPS spectra of GO and BGO.

Calculated from XPS data, oxygen content decreases from 34.1 to 30.4 mol% after cultivation with bacteria. The results support the conclusion that GO is reduced as stated in 3.1.3, illustrating the bacterial oxidation of graphitic materials probably has a limitation.



	A	B	C
Naphthalene	+	+	+
Bacteria	-	+	+
Graphene	-	-	+
Contact angle	90.44°	86.86°	85.51°

Figure S7. Contact angles between graphite paper and medium cultivated for 20h under different conditions.

We test the affinity between graphite and medium which is collected after 20h-cultivation under different culture conditions. Results show that medium where bacteria grows with naphthalene gives smaller contact angle than the bacteria-free control sample. Addition of graphene contributes to a minimal contact angle between medium and graphite paper. The naphthalene-degrading bacteria probably produce some metabolites serving as the surfactant to help bacteria to contact insoluble substrates and the addition of graphitic materials may accelerate this metabolic process.

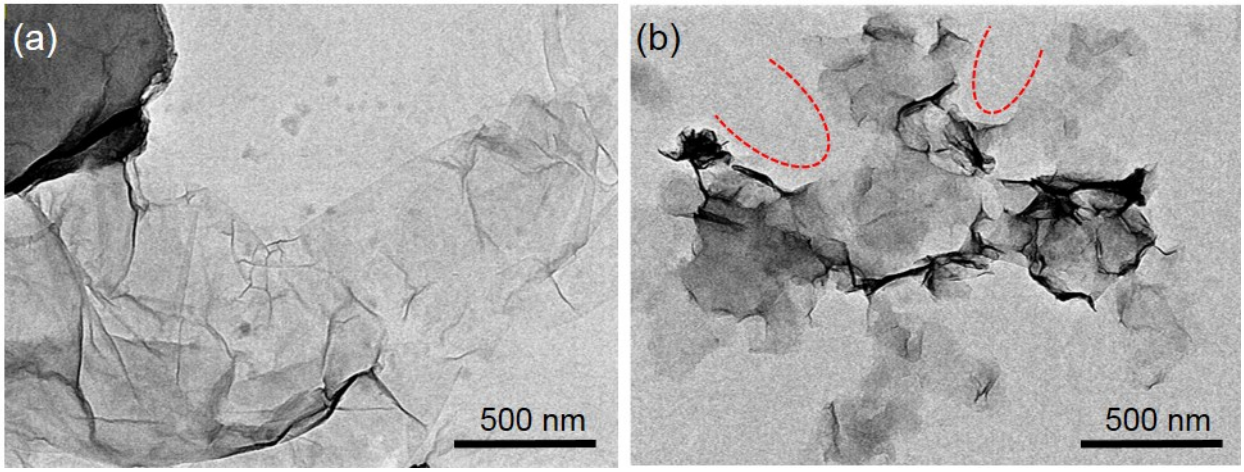


Figure S8. HRTEM images GO sheets before (a) and after (b) cultivation with bacteria.

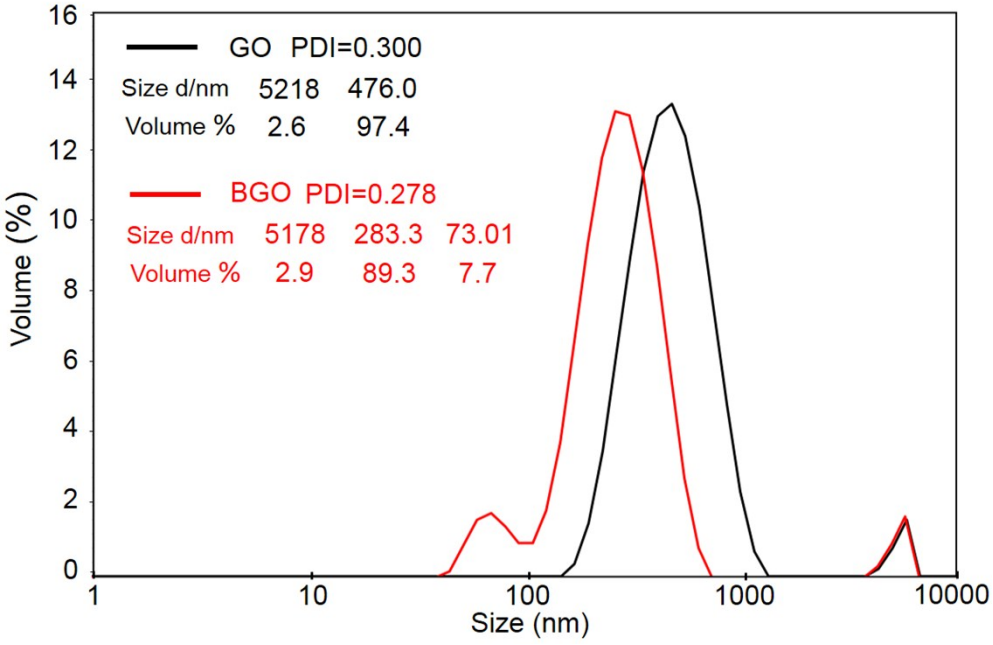


Figure S9. Size distribution of GO before (black) and after (red) cultivation with bacteria.

Compared to GO, the major peak of BGO shifts from 476 to 283.3 nm and the volume percent of the major distribution decreases from 97.4% to 89.3%. Besides, another smaller size distribution appears at 73.01 nm. The decrease of the particle size of GO demonstrates the break of GO.