

Supporting information

Highly-dispersed Boron-doped Graphene Nanoribbons with Enhancing Conductibilities and Photocatalysis

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Experimental Section:

Preparation of GO: Graphite oxide (GO) was synthesized from natural graphite powder using a modified Hummers methods.¹ The detail experimental procedures were referring to the report published by Li et al.²

Preparation of GR and B-GNRs by a vacuum activation method: 5 mL GO (2.0 mg/ml) was dispersed into 20 mL double distilled water and ultraphonic for 1 hour, and then 0.4 g H₃BO₃ was added to the above solution and vigorous stirring for 1 hour. The solution was drying at 60 °C for 12 h. Obtained brown flaky solid was heated at 300 °C for 3 hours in the vacuum condition. The color of flaky solid was changing from brown to black. This black solid was dispersed into 20 mL double distilled water again and ultraphonic for 1~6 hours. 30 mL HCl (1M) was added to the above mentioned solution and stirring for 12 hours to washing out the boron oxides coverage on the surface of graphene. After HCl washing, the solid products were washed by the double distilled water for 5 times and dispersed into 5 mL double distilled water. Finally, it was transferred to a plastic bottle and denoted as B-GNRs. The GR was prepared by the above similar method without the adding of H₃BO₃.

Preparation of boron doped graphene by a hydrothermal method: 5 ml GO (2.0 mg/ml) was mixtured with 20 mL of double distilled water and ultrasonic dispersion for 1 hour. And then 0.4 g H₃BO₃ was added to the above solution and vigorous stirring for 1 hour. Subsequently, the mixture was hydrothermally treated at 150 °C for 12 h. After it cooled to the room temperature, the precipitate was collected by centrifuging for 40min and blended with 30 mL of 1 M hydrochloric acid, which was stirred for 12 h. The resulting solution was washed with deionized water for 5 times and the solid was dried in a vacuum oven at 60 °C for 12 h. The final sample was denoted as B-GR-H ("H" represents hydrothermal method).

Characterization:

X-ray diffraction (XRD) patterns of all samples were collected in the range 10-80° (2θ) using a Rigaku D/MAX 2550 diffractometer (Cu K radiation, λ = 1.5406 Å), operated at 40 kV and 100 mA. The morphologies were characterized by transmission electron microscopy (TEM, JEM2000EX). The instrument employed for XPS studies was a Perkin-Elmer PHI 5000C ESCA system with Al Kα radiation operated at 250 W. The shift of the binding energy due to relative surface charging was corrected using the C1s level at 284.6 eV as an internal standard. Raman measurements were performed at room temperature using a Via+Reflex Raman spectrometer with the excitation wavelength of 514 nm. All the electrochemical experiments included electro-chemical impedance spectroscopy and photocurrents measurements were carried out on an electrochemical analyzer (CHI 660 D electrochemical station, CHI Instruments Inc.) at room temperature. A standard three-electrode system consisting of a working electrode (as-prepared samples as the working electrodes with an active area of ca. 0.5 cm²), a Pt wire as the counter electrode and a saturated Ag/AgCl as the reference electrode was employed. The PL emission spectra of solid catalysts were also measured on luminescence spectrometry (Cary Eclipse) at room temperature under the excitation light at 280 nm. The conditions were fixed as far as possible to compare the photoluminescence intensity directly.

Photocatalytic Activities:

The UV light-driven photocatalytic activity of each sample was evaluated in terms of the degradation of Rhodamine B (RhB, 5 mg/L). The photocatalyst (1 ml, 2.0 mg/ml) was dispersed into a 100 mL quartz

photoreactor containing 50 mL of an RhB solution. The mixture was stirred for 120 min in the dark in order to reach the adsorption–desorption equilibrium. A 300-W high-pressure Hg lamp (the strongest emission wavelength is 365 nm) was used as a simulated UV light source, respectively. At the given time intervals, the analytical samples were taken from the mixture and immediately centrifuged, then filtered through a 0.22 μm millipore filter to remove the photocatalysts. The filtrates were analyzed by recording variations in the absorption in UV-vis spectra of RhB using a Cary 100 ultraviolet visible spectrometer.

References:

1. W. S. Hummers and R. E. Offeman, *J. Am. Chem. Soc.*, 1958, **80**, 1339.
2. Z. Li, J. Wang, X. Liu, S. Liu, J. Ou and S. Yang, *J. Mater. Chem.*, 2011, **21**, 3397.

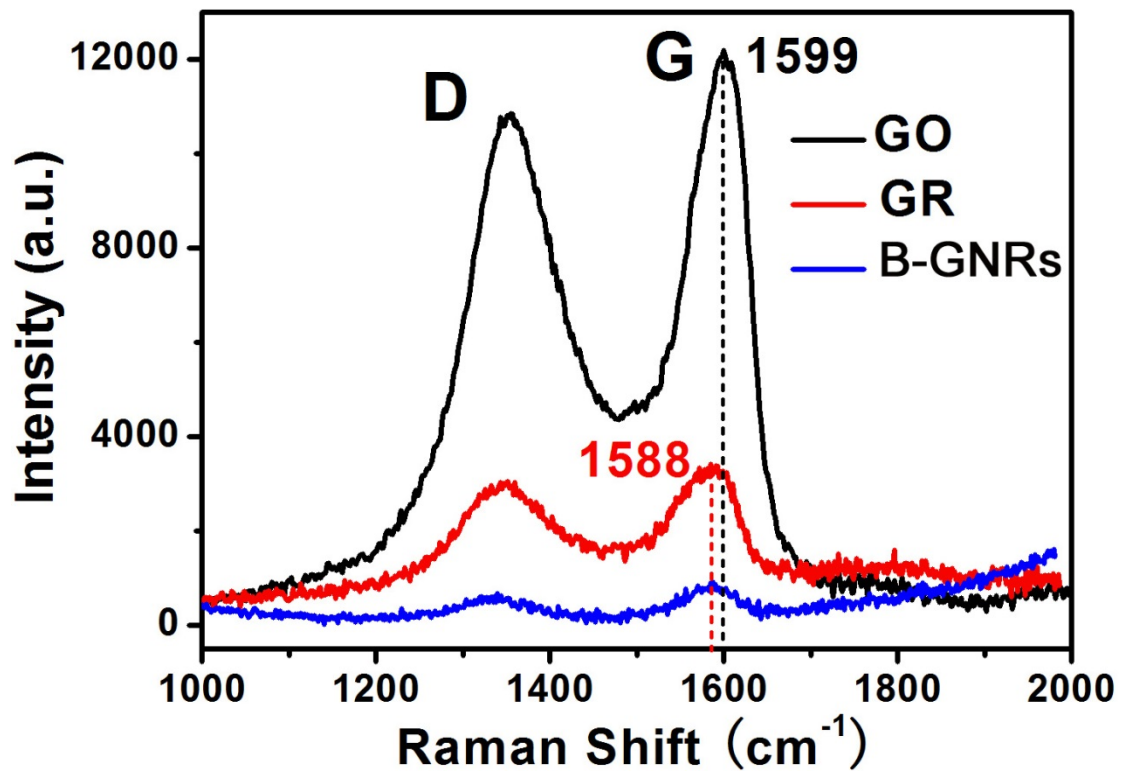


Fig. S1 Raman spectra for GO, GR and B-GNRs.

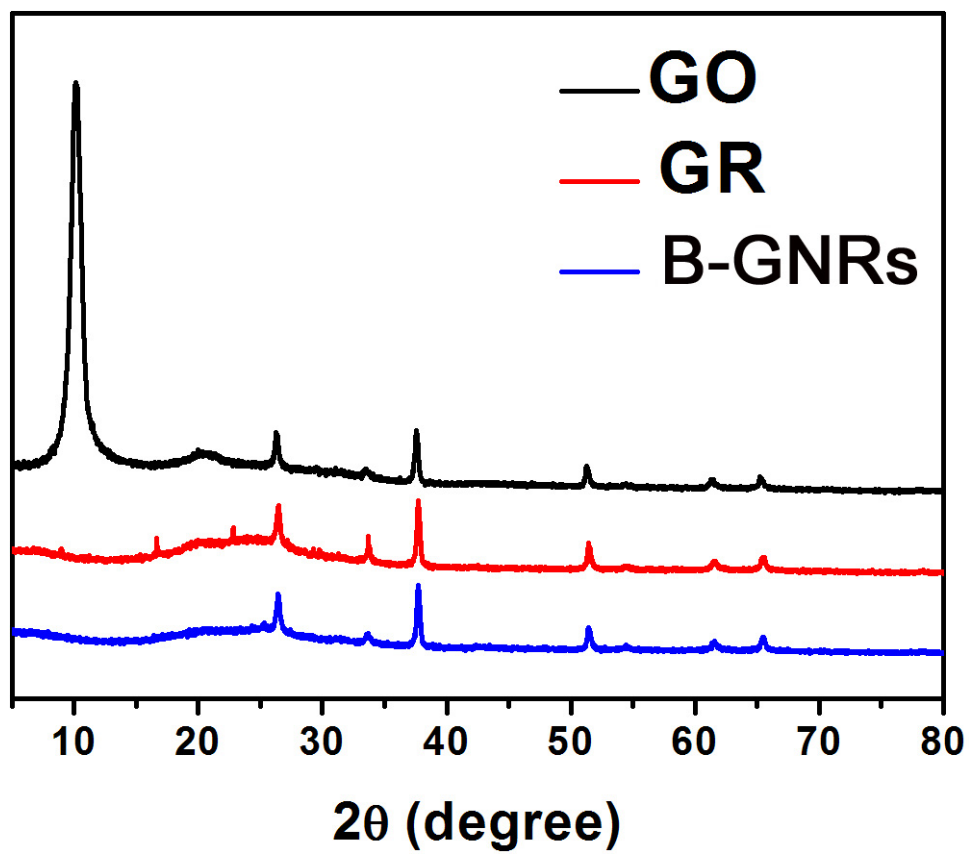


Fig. S2 XRD spectra for different samples.

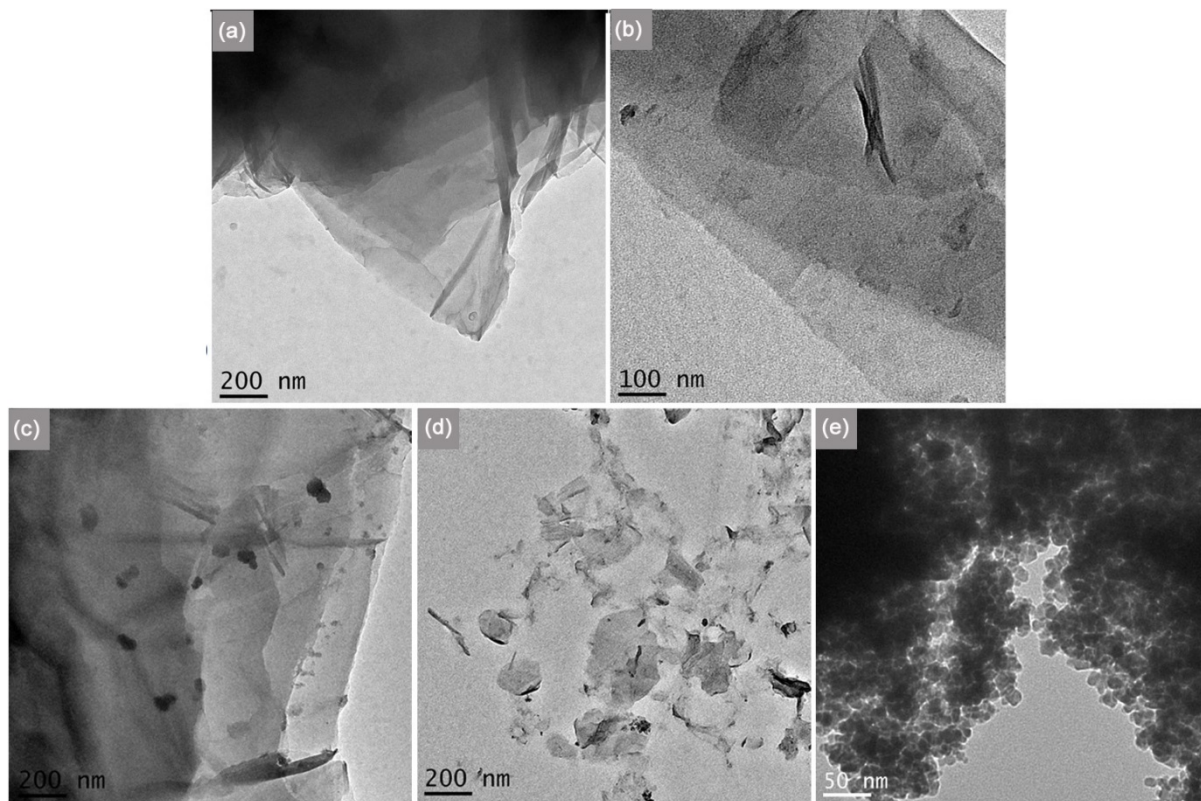


Fig. S3 The vacuum activated GR under the ultrasonic for 30 min (a), 60 min (b), 120 min (c), 240 min (d), and 360 min (e) in the absence of H_3BO_3 .

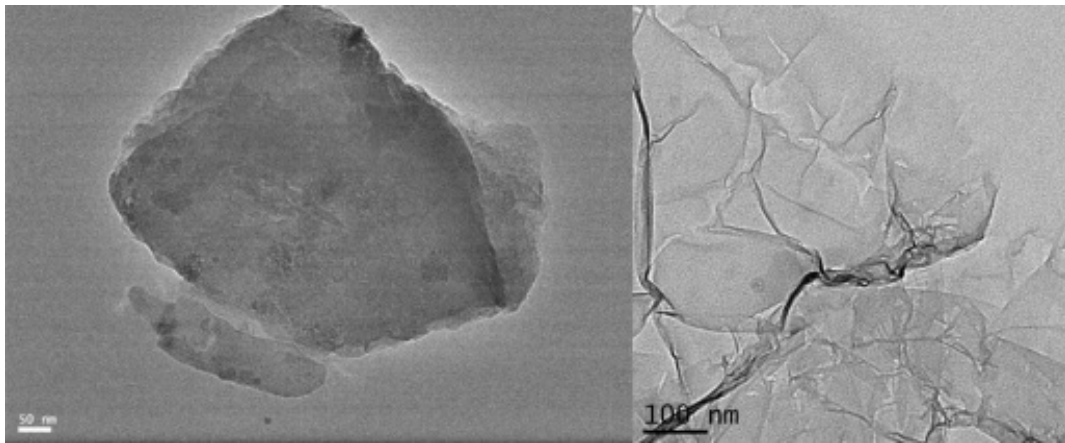


Fig. S4 TEM spectra of the boron doped graphene prepared by a hydrothermal method (B-GR-H).