Electronic Supplementary Material (ESI) for RSC Advances.

Supporting Information

Trap states in chemically derived graphene oxide revealed by anomalous temperature-dependent photoluminescence

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Preparation of graphene oxide suspension: Graphene oxide suspension is prepared by a modified Hummers method. Briefly, 5.0 g graphite powder (325 mesh, 99.8%, *Alfa Aesar*) was preoxidized in 7.5 mL of 98% H_2SO_4 with 2.5 g $K_2S_2O_8$ and 2.5 g P_2O_5 over 6 hours at 80 ^oC. The product was rinsed several times by deionized water to be neutral. 3.0 g preoxidized graphite was stirred in 115 mL of 98% H_2SO_4 in an ice bath. $KMnO_4$ (15 g) was added slowly to the mixture, so that the system temperature was kept under 20 ^oC. The mixture was stirred at 35^oC for 2 hours and then diluted by deionized water (230 mL). After 15 minutes, large amounts of deionized water (~700 mL) and 30% H_2O_2 (12.5 mL) were added to terminated the reaction. The dark brown resulting solution turned to bright yellow, indicating excess MnO_4^- ions are eliminated. The mixture was washed several times by centrifugation with 5% HCl aqueous solution and deionized water alternately. After a sonication for 60 min, GO was considered to be highly exfoliated.

Characterization: The sample is prepared by drop-casting a drop of colloid GO suspension onto a freshly cleaved mica for AFM and Raman tests. The atomic force microscopy image was taken in tapping mode with a MultiMode SPM (Veeco). The Raman spectra was recorded by an HR800 JobinYvon Raman spectrometer with a514 nm excitation laser under ambient condition. The Fourier transform infrared (FTIR) spectrum was performed on a Bruker Tensor 27 FTIR spectrophotometer. The UV-*vis* spectrum of colloid GO suspension is acquired on an Agilent 3600 UV-*vis*-IR spectroscopy. The X-ray photoelectron spectroscopy (XPS) measurements were performed on a Thermo ESCALAB 250 with a monochromatized Al *Kα* source. Thermo gravimetric analysis (TGA) was carried out on an SDT-Q600 analyzer (TA Instruments). Temperature-dependent photoluminescence (PL) spectra were examined on a FLS920 fluorescence spectrometer (Edinburgh Instruments). Temperature was controlled by a closed cycle helium cryostat and a temperature controller. The sample was excited by 325 nm light from a He-Cd laser (nominally 200 mW).

Figure S1

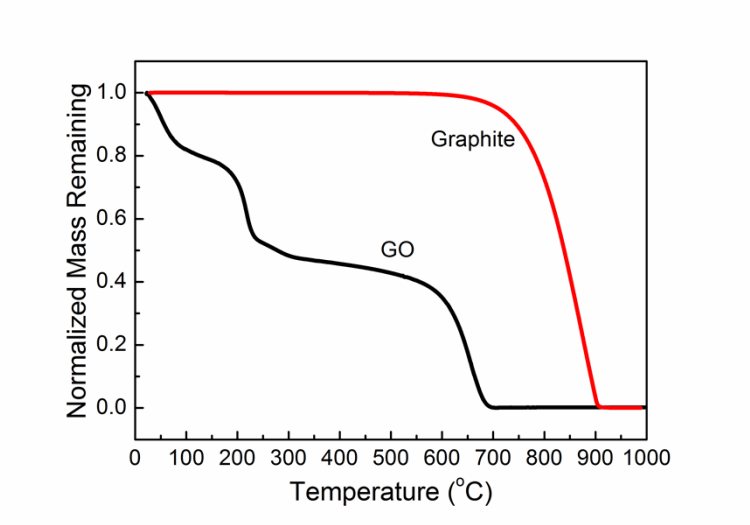

Figure S1 Comparison of TG curves of GO sheets and graphite powder.

Figure S2

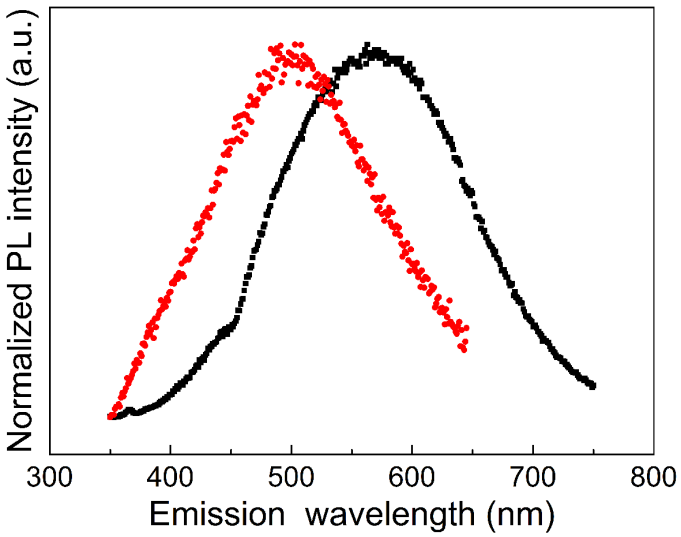

Figure S2 Comparison of normalized room temperature PL spectra of colloid GO suspension (red) and GO films (black).

Figure S3

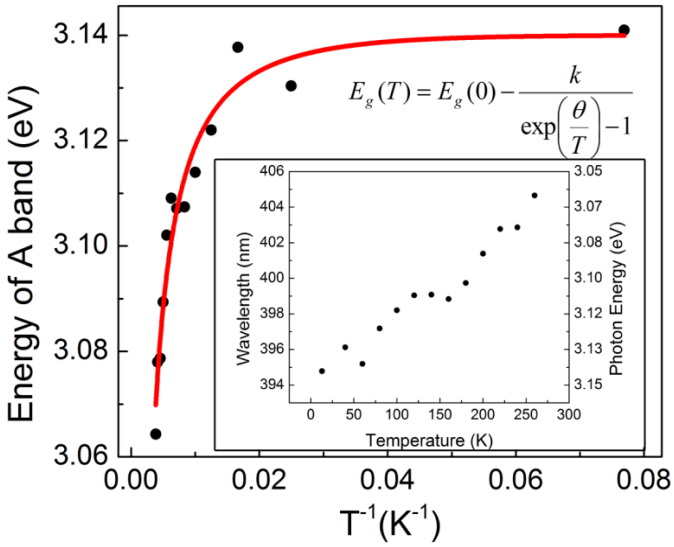

Figure S3 Photon energy of band *A* varies with inverse temperature (T^{-1}). Red curve is a fit result with a formula from ref. S1. Inset is a temperature dependence of PL emission wavelength (left) and energy (right).

Reference

[S1] L. J. Wang, N. C. Giles, J. Appl. Phys. 94, 973 (2003)