Electronic Supplementary Material (ESI) for Chemical Communications

Support Information

Chemically Modified Graphene Oxide as Hole Transport Layers in Oganic Solar Cells

Dong Yang, Lingyu Zhou, Lingcheng Chen, Bin Zhao, Jian Zhang,* Can Li*

[*] Dr. J. Zhang, Prof. C. Li, D. Yang, L. Y. Zhou, Dr. L. C. Chen
State Key Laboratory of Catalysis, Dalian Institute of Chemical Physics, Chinese Academy of Sciences
Dalian National Laboratory for Clean Energy
457 Zhongshan Road, Dalian 116023, PR China
Graduate University of Chinese Academy of Sciences
Beijing 100049, PR China
E-mail: jianzhang@dicp.ac.cn
canli@dicp.ac.cn
Dr. B. Zhao
Key Laboratory of Advanced Functional Polymeric Materials of College of Hunan Province, Xiangtan University
Xiangtan 411105, P R China

To evaluate the fundamental structural properties of the commercial GO, we conducted several characterizations including Fourier transform infrared spectroscopy (FT-IR) and atomic force microscopy (AFM). Figure S1a shows an AFM height image of a GO film on mica substrates. The thicknesses of GO is between 0.8 to 1.1nm. These values are well consistent with the thicknesses of single sheets of GO shown in the previous reports. Then, the chemical functional groups on graphene sheets were further characterized by FT-IR spectroscopy. As shown in Figure S1b, the characteristic features are the broad, intense band at 3410 cm^{-1} (O-H stretching vibrations) and the bands at 1735 cm^{-1} (C=O stretching vibrations from carbonyl and carboxylic groups), 1226 cm^{-1} (C-O stretching vibrations), and 1065 cm^{-1} (C-O stretching vibrations). The peak at 1625 cm^{-1} can be assigned to the vibrations of the adsorbed water molecules and also the contributions from the skeletal vibrations of unoxidized graphitic domains.

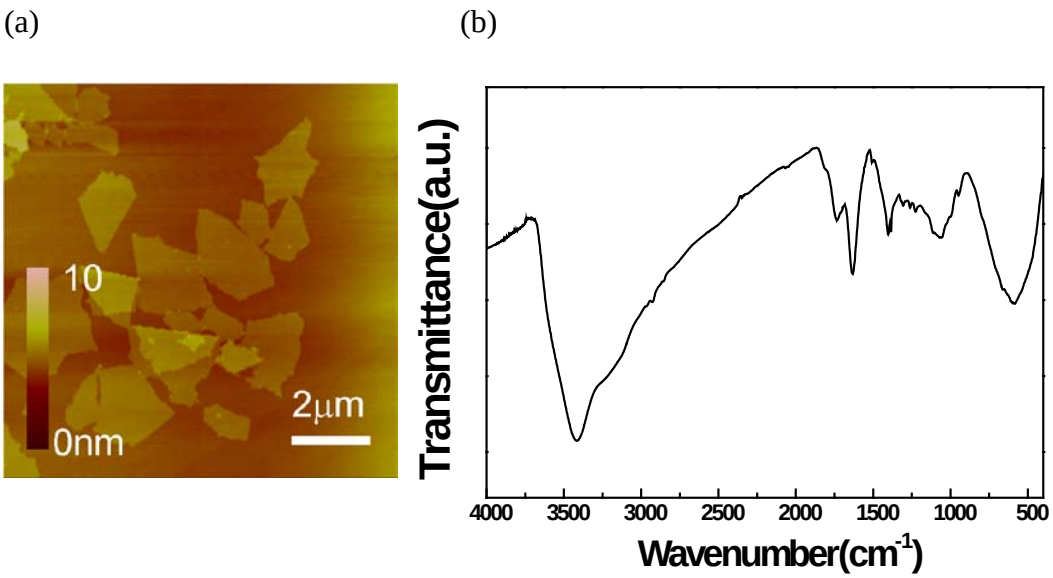

Fig. S1 (a) AFM height image of GO film. (b) FT-IR spectroscopy of GO film.

Combining the thickness of GO layers on atomically flat mica substrates with samples prepared under the same deposition conditions, the average thicknesses of the the GO film on ITO are estimated to be ~3 nm.

In terms of the relation between treatment time and amounts of the C=O species, XPS is used to characterize the GO layers with oxygen plasma treatment for 30s and 60s. As shown in the Fig. S2, concentration of the C=O sharply decreased (7%) after treatment for 30s and is not detectable after treatment for 60s. The GO film has been totally damaged after treatment for 60s, which make P3HT directly contact with ITO in organic solar cells and make the efficiency quickly decreased to around 2% that is similar to the efficiency of devices with O2 plasma treated ITO as anodes.

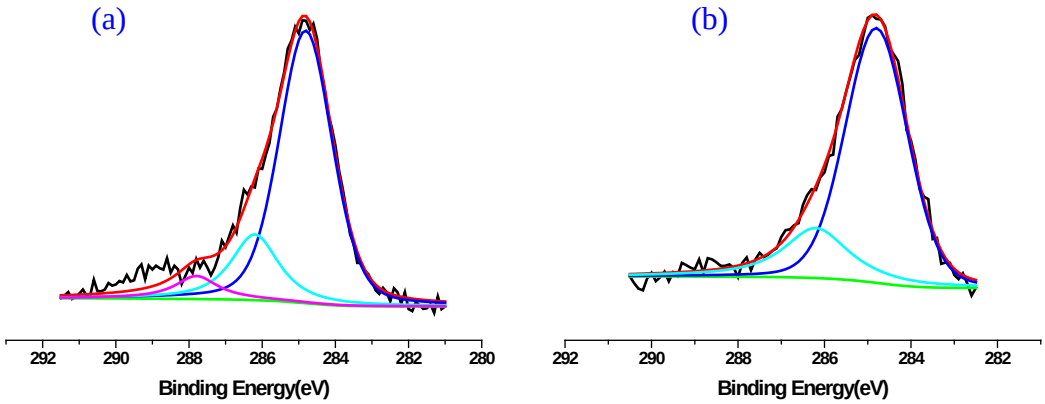

Fig. S2 XPS analysis of the GO films with O_2 plasma treatment for 30s (a) and 60s (b). Deconvolution reveals the presence of C-C (～284.8 eV), C-O (~286.2), C=O (~287.8 eV) species in the films.