14th International Conference on

Plasma Based Ion Implantation & Deposition

PBII&D 2017

New World Shanghai Hotel

October 17-20, 2017, Shanghai, China

Program

Organized by

Shanghai Institute of Ceramics, Chinese Academy of Sciences (SIC CAS)
Shanghai Institute of Microsystem and Information Technology, Chinese Academy of Sciences (SIMIT CAS)

14th PBII&D Committees

Organizer

Shanghai Institute of Ceramics, Chinese Academy of Sciences
Shanghai Institute of Microsystem and Information Technology, Chinese Academy of Sciences

International Organizing Committee

P. K. Chu (Chairman)	Hongkong, China
M. Bilek	Australia
N. Huang	China
S. Mändl	Germany
A. Márquez	Argentina
L. Pichon	France
X. B. Tian	China
M. Ueda	Brazil
R. H. Wei	USA

Local Organizing Committee

Xuanyong Liu (Chair)	Shanghai Institute of Ceramics, CAS
Zengfeng Di (Co-Chair)	Shanghai Institute of Microsystems and Information Technology, CAS
Yongfeng Mei	Fudan University
Zhenghua An	Fudan University
Zhongying Xue	Shanghai Institute of Microsystems and Information Technology, CAS
Huiliang Cao	Shanghai Institute of Ceramics, CAS

ID 45

Black phosphorus: a two-dimensional reductant for in situ nanofabrication

Hao Huang[1], Xue-Feng Yu[1], Paul K. Chu[2]

[1] Center for Biomedical Materials and Interfaces,
Shenzhen Institutes of Advanced Technology, Chinese Academy of Sciences,
No.1068 Xueyuan Avenue, Nanshan District, Shenzhen, 518055, China
[2] Department of Physics & Materials Science, City University of Hong Kong, Tat Chee Avenue, Kowloon, Hong Kong, China

Keywords: Black phosphorus, two-dimensional materials, reduced graphene oxide

Introduction: Since 2014, Black phosphorus (BP) has attracted tremendous research interest because of its unique properties such as layer-dependent direct bandgap, anisotropy, hinge-like structure, and quasi-one-dimensional excitonic nature, all of which contrast markedly with those of other types of two-dimensional (2D) materials. Nevertheless, BP degrades under ambient conditions as a result of the reaction with oxygen ($P \rightarrow P_xO_y$) and subsequent transformation to PO_4^{3-} in the presence of water.[1,2] Degradation leads to compromised electronic and optical performance and has generally been considered a serious obstacle hampering the application of BP. On the other hand, the high chemical reactivity of BP with respect to oxidation may be exploited and in the work, we investigate the reducibility of BP.

Materials and Methods: The BP sheets were prepared by a simple liquid exfoliation method utilizing bath sonication. The reducibility of BP was studied by reacting with $HAuCl_4$ and graphene oxide (GO) under a certain condition, respectively. The characterization was conducted by using transmission electron microscope (TEM), X-ray photoelectron spectroscopy (XPS), high-resolution confocal Raman microscope and digital microscope.

Results and Discussion: The results demonstrated that the BP@Au composites can be synthesized by controlling BP-induced reduction in which only a portion of the outer BP reduces Au^{3+} to Au nanoparticles *in situ* (Figure 1) through adjusting the amount of water in the reaction. And owing to the high reducing ability of BP, the GO in the area covered by the BP sheets were gradually reduced to rGO (Figure 2). These results confirmed the controllability of the BP-induced reduction reaction.

Conclusion: The high reducing ability and unique 2D morphology not only facilitate in situ synthesis of Au nanoparticles and BP@Au composites, but also enable multiscale control in local reduction of GO to rGO. The novel 2D reductant has large potential in various *in situ* nanofabrication applications and this study also provides better understanding of the exciting properties of BP and how they can be exploited in practice.

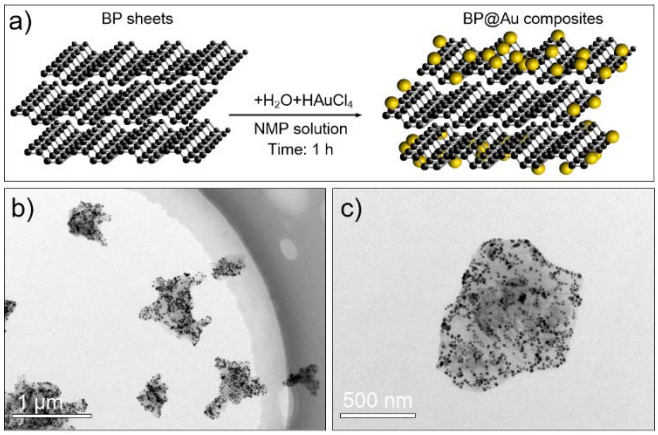

Figure 1 synthesis of BP@Au composites by controlling BP-induced reduction [3]

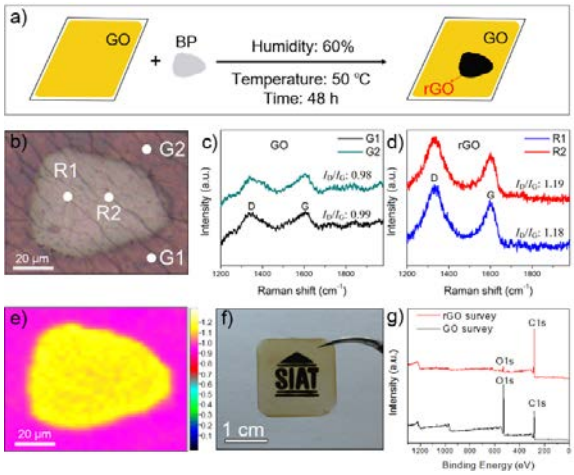

Figure 2 BP-induced local reduction of the GO film [3]

References:

[1] JD Shao, HH Xie, H Huang, ZB Li, ZB Sun, YH Xu, QL Xiao, XF Yu, YT Zhao, H Zhang, HY Wang, PK Chu. Biodegradable black phosphorus-based nanospheres for in vivo photothermal cancer therapy. Nature Communications 2016, 7, 12967–12979.

[2] YT Zhao, HY Wang, H Huang, QL Xiao, YH Xu, ZN Guo, HH Xie, JD Shao, WJ Han, ZB Sun, X-F Yu, PH Li, P K Chu. Surface coordination of black phosphorus for excellent air and water stability, Angewandte Chemie International Edition, 2016, 55, 5003–5007.

[3] H Huang, Q Xiao, J Wang, X-F Yu, H Wang, H Zhang, PK Chu. Black phosphorus: a two-dimensional reductant for in situ nanofabrication. npj 2D Materials and Applications 2016 (accepted)

Corresponding:

Email: xf.yu@siat.ac.cn
Tel: 86-755-86392212
Fax: 86-755-86585222