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 140

Tuning the thickness of black phosphorus via hydrogen plasma treatment

Wan Li[1], Zhinan Guo[2], Xue-Feng Yu[2], Paul K. Chu[1]

[1]Department of Physics & Materials Science, City University of Hong Kong, Tat Chee Avenue, Kowloon, Hong Kong, China
[2]Institute of Biomedicine & Biotechnology, Shenzhen Institutes of Advanced Technology, Chinese Academy of Sciences, Shenzhen, China

Keywords: Black phosphorus, plasma etching, thickness control

Introduction:

Black phosphorus (BP), consisting of a weak van der Waals interlayer interaction and strong in-plane bonds, has high carrier mobility and tunable band gap (0.3-2.0 eV), offering properties for electric and optoelectronic devices [1-3]. Here, we report a controllable thinning method by using hydrogen plasma etching to thin down mechanically exfoliated BP flakes.

Materials and Methods:

BP flakes were mechanically exfoliated from bulk BP crystals onto Si substrates consisting of a 300nm-thick SiO_2 layer. After exfoliation, the H_2 plasma treatment was carried out on the BP flakes by using a plasma ions immersion implantation (PIII) system. Atomic force microscope, optical microscopy and Raman techniques was used to identify process conditions.

Results and Discussion:

After hydrogen plasma treatment, the BP flake display a uniform color change, which indicates decreasing thickness (Figure 1) [4]. Figure 2 shows the Raman spectra before and after 15 min hydrogen plasma treatment. While no significant variations of the peak positions are observed, the crystallinity of the BP flake remains intact after plasma treatment.

Conclusion:

Not only the thickness of the BP flakes can be controlled, but also the defects of the exposed BP surface are removed after plasma treatment. It is expected to improve the electrical performance of BP based field-effect transistor (FET). This method provides a new way to fabricate BP-based electronic and optoelectronic devices in the future.

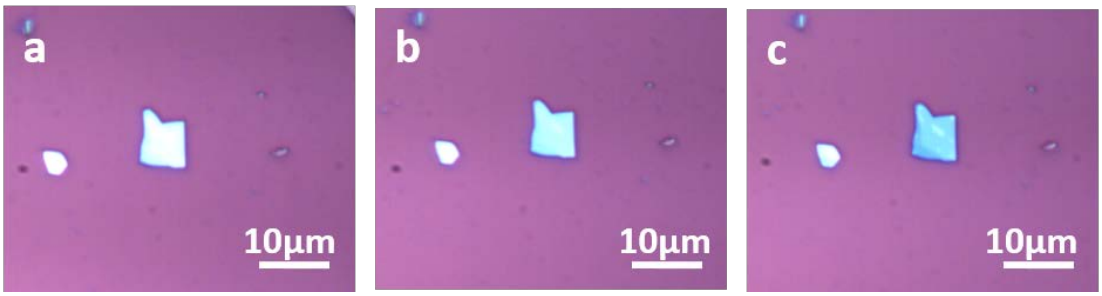

Figure 1 OM images of a BP flake (a) as-exfoliated, under (b) 2 min and (c) 4 min H_2 plasma treatment.

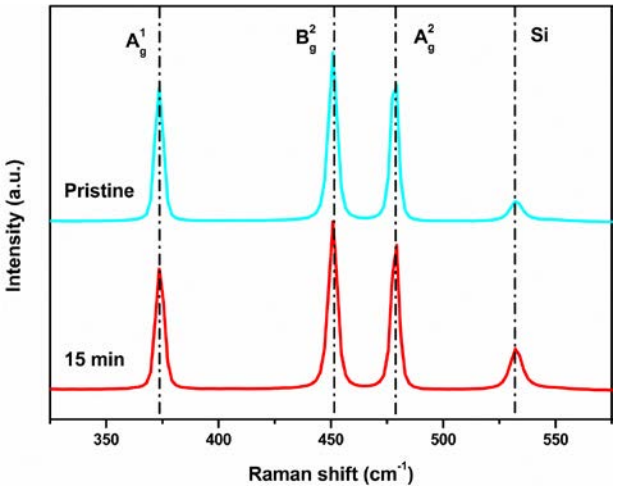

Figure 2 Raman spectra of a BP flake before and after 15 min hydrogen plasma etching.

References:

[1]J. Kim, S. S. Baik, S. H. Ryu, Y. Sohn, S. Park, B. G. Park, J. Denlinger, Y. Yi, H. J. Choi, K. S. Kim, Science, 2015, 349, 723.

[2]L. K. Li, Y. J. Yu, G. J. Ye, Q. Q. Ge, X. D. Ou, H. Wu, D. L. Feng, X. H. Chen, Y. B. Zhang, Nature Nanotech. 2014, 9, 372.

[3]S. H. Lin, S. H. Liu, Z. B. Yang, Y. Y. Li, T. W. Ng, Z. Q. Xu, Q. L. Bao, J. H. Hao, C. S. Lee, C. Surya, F. Yan, S. P. Lau, Adv. Funct. Mater. 2015, 26, 864.

[4]G. Lee, J. Y. Lee, G. H. Lee, J. Kim, J. Mater. Chem. C 2016, 4, 6234.

Corresponding:

E-mail addresses: xf.yu@siat.ac.cn (X.-F. Yu), paul.chu@cityu.edu.hk (P.K. Chu).