

Production of Two-Dimensional Layered Materials Beyond Graphene

Dr. Ali Shaygan Nia

Sheng Yang, Huanhuan Shi, Martin. R. Lohe and Xinliang Feng

Center for Advancing Electronics Dresden (cfaed) & Department of Chemistry and Food Chemistry, Chair of Molecular Functional Materials, Technische Universität Dresden, 01062 Dresden, Germany

ali.shaygan_nia@tu-dresden.de

2D materials received intensive attention due to their potential application in different fields such as electronics and energy storage. The era has started with graphene[1] by its unique properties and during the past decade different methods have been invented for production of high quality graphene[2]. However, graphene possesses a zero-bandgap which limits its applications in electronic and energy devices. Therefore, different 2D semiconducting materials have been investigated and studied to tackle this problem. Among them, Black Phosphorous BP with broad band gap (0.3 eV to 2.0 eV)[3], MXenes with good electrical conductivity[4] and MoS₂ are the most promising 2D semiconductors. However, it is still a challenge to prepare large amount of these materials. Electrochemical exfoliation has recently emerged a promising strategy for producing large scale of graphene. Therefore, we have also investigated and established electrochemical production procedures for high quality BP flakes (Figure 1) and Fluoride-Free MXene (Ti₃C₂) (Figure 2).[5-6] The established methods are facile, scalable (gram scale in lab) and environmentally friendly with high yield (80%). This method is further exploring for exfoliation of other semiconductors like In₂Se₃ and MoS₂.

- [1] K. S. Novoselov, V. I. Fal'ko, L. Colombo, P. R. Gellert, M. G. Schwab, K. Kim, Nature 490 (2012), 192.
- [2] S. Yang, A. G. Ricciardulli, S. Liu, R. Dong, M.R. Lohe, A. Becker, M. Squillaci, P. Samorì, K. Müllen, X. Feng, Angew. Chem., Int. Ed. 56 (2017), 6669.
- [3] N. Youngblood, C. Chen, S. J. Koester, M. Li, Nat. Photonics 9 (2015), 247
- [4] B. Anasori, M. R. Lukatskaya, Y. Gogotsi, Nat. Rev. Mater. 2 (2017), 16098
- [5] S. Yang, P. Zhang, F. Wang, A.G. Ricciardulli, M.R. Lohe, P.W.M. Blom, X. Feng, Angew. Chem. Int. Ed. 57 (2018) 15491.
- [6] S. Yang, P. Zhang, F. Wang, A. G. Ricciardulli, M. R. Lohe, P. W. M. Blom and X. Feng, Angew. Chem., Int. Ed., 130 (2018), 130

Figures

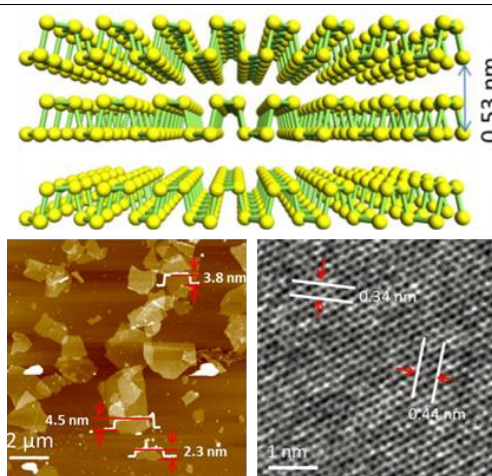


Figure 1: The result of free-defeat and few-layer BP flakes by electrochemical exfoliation

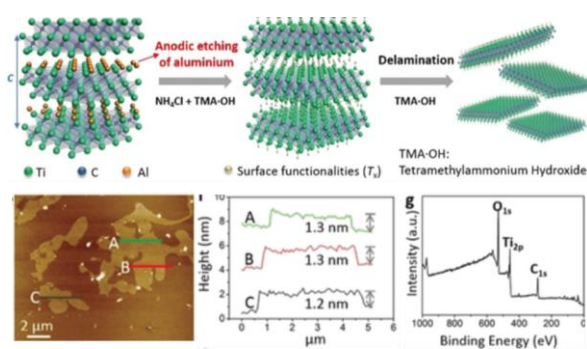


Figure 2: Delamination process and characterization of Fluoride-Free MXene

References