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2D Layered Pnictogenenes Rediscovered for Electrochemical Applications

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The bulk form of orthorhombic black phosphorus (BP) layered structure was first synthesized in 1914 but received sparse attention until it was rediscovered in 2014 in the new wave of 2D layered nanomaterials. Nevertheless, the development of BP applications has been hampered by its surface degradation, thus efforts to achieve effective BP passivation are ongoing. Subsequently, interest has turned onto other 2D mono-elemental monolayer structures of the pnictogens group: arsenene, antimonene and bismuthene. Their properties differ significantly upon crystal structure and delamination. It cte envisage their future applications in several research fields, such as self-propelled micro/nanodevices for on-demand delivery in electronic and biological systems.

Herein we demonstrate that aqueous shear exfoliation can be used to obtain pnictogen (P, As, Sb and Bi) exfoliated nanosheets. Morphological and chemical characterization of the exfoliated materials shows a decrease in thickness, sheet to nanosheet scale and partial oxidation due to the higher surface area. Nanosheets degradation can be minored with functionalization strategies. Electrochemical performancesare tested in terms of inherent electrochemistry and heterogeneous electron transfer. Potential energy-related applications are evaluated in the hydrogen evolution reaction (HER), oxygen evolution reaction (OER) and oxygen reduction reaction (ORR) with shear exfoliated Sb having the best electrochemical performance overall. These findings can have a profound impact on the preparation and energy applications of pnictogen 2D materials.

Biography:

Rui Gusmão received his PhD degree in Chemistry from the University de Barcelona, Spain (2012). As a postdoctoral researcher, he firstly worked at University of Porto, Portugal, and University of Minho, Portugal. In 2016, he joined Professor Pumera's group at Nanyang Technological University (Singapore). He is currently a Research Fellow at the Center for Advanced Functional Nanorobots, in Prague, Czech Republic. His research interests include the fundamental electrochemical studies of 2D layered materials for sensing and energy related application. He has authored more than 20 publications in international peer-review journals and has an h-index of 9.