Graphdiyne: A new member of carbon family

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Abstract

Graphdiyne (GDY) is an ordered two-dimensional (2D) carbon allotrope comprising sp and sp^2 hybridized carbon atoms with high degrees of π-conjugation, which features a natural bandgap and superior electric properties. However, the synthesis of well-defined GDY remains challenging due to the free rotation around alkyne-aryl single bonds and the lack of thickness control. Herein, we developed several rational approaches to synthesize high-quality structure-controlled GDY. We first demonstrated that the morphology of GDY could be finely controlled by using a modified Hay-Glaser coupling reaction under optimized reaction conditions. Unique vertically grown γ-GDY nanowalls (~200 nm) were fabricated on either copper foils or foams[1,2]. β-GDY, another new member of graphyne family, was also explored using similar method with tetraethynylethene monomers[3]. Notably, we recently reported a facile synthetic route to synthesize ultrathin single-crystalline GDY, through a solution phase van der Waals (vdW) epitaxial strategy[4]. The as-grown GDY film has a tri-layer structure with a ABC stacking order as directly observed by electron microscopy. The high quality of the as-grown GDY film and the graphene-enhanced Raman scattering (GERS) effect ensure the predicted Raman fingerprints belonging to a perfectly ordered 2D GDY structure are experimentally observed. Finally, encouraged by the intriguing properties of such 2D acetylenic carbon allotropes, we designed various GDY-based hierarchical architectures and composites towards practical applications. As one example, a three-dimensional (3D) GDY foam was synthesized and further used for oil/water separation, exhibiting both high efficiency and good recyclability[2]. Considering the intriguing physicochemical properties of GDY, it also shows promise in various applications, such as water splitting cell[5] and solar steam generation[6].

References

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Figures

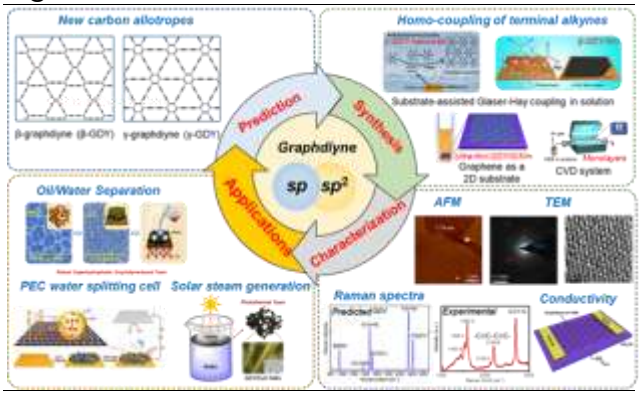

Figure 1: The synthesis and applications of grpahdiyne.