From Graphene to 2D Transition Metal Carbides: Synthesis and Applications

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Abstract

Two-dimensional (2D) materials show many fascinating properties, however, different 2D materials are required for different applications. The controlled synthesis and applications of graphene materials will be first discussed, including chemical vapor deposition (CVD) growth of large-area high-quality graphene single crystals, films and their applications in flexible touch panels and OLEDs[1-3], large-scale production of highly conductive pristine graphene nanosheets by intercalation-exfoliation method and their applications in lithium ion batteries (LIBs), lithium sulfur batteries, anti-corrosion coatings, and thermal management[1,4-7], and CVD growth of highly conductive flexible three-dimensional graphene network structures and their applications in elastic conductors, flexible LIBs with ultrafast charge and discharge rates, lightweight and flexible electromagnetic interference shielding materials, and flexible high-energy lithium sulfur batteries[8-12].

In addition to graphene, we have realized the self-limited catalytic surface growth of uniform millimetre-sized monolayer WS_2 single crystals and large-area continuous films by ambient-pressure CVD on flexible Au, and developed a low-cost roll-to-roll/bubbling method for production of large-area flexible films of monolayer, double-layer WS_2 and WS_2/graphene heterostructures, and batch fabrication of flexible monolayer WS_2 film transistor arrays[13]. We also developed a CVD method, with a bilayer of a Cu foil sitting on a transition metal foil as the substrate at a temperature above the melting point of Cu, to grow large-size high-quality ultrathin 2D transition metal carbide (TMC) crystals such as Mo_2C, WC, and TaC[14]. For instance, the 2D α-Mo_2C crystals obtained are a few nanometers thick, over 100 μm in lateral size, very stable under ambient conditions, and show 2D superconductivity[14]. These ultrathin TMC crystals further expand the large family of 2D materials.

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