Monolayer MoS_2 and MoS_2/Graphene heterostructures synthesized on Au foils by chemical vapor deposition method

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Controllable synthesis of monolayer MoS_2 on conducting substrates is essential for exploring the atomic-scale structure, intrinsic electronic property, and engineering its application in various aspects. Recently, we have achieved the domain size tunable (with the edge length of the triangular domains tunable from several hundred nanometers to a hundred microns) growth of monolayer MoS_2 directly on Au foils, *via* a facile low-pressure chemical vapor deposition (LPCVD) [1]. We also demonstrate an obvious substrate-crystal-facet-dependent growth behavior at relative high growth temperatures (>680 °C), where large-domain single-crystal MoS_2 triangles are more preferentially evolved on Au(100) and Au(110) facets than that on Au(111), and this substrate effect can be weakened at relative low growth temperature (~530 °C). The preferential growth behavior are then explained from the facet-dependent binding energy of MoS_2 according to density functional theory calculations[2]. We have also presented that the crystal orientations and domain boundaries of monolayer MoS_2 flakes as-grown on Au foils can be on-site identified by using low-energy electron microscopy/diffraction (LEEM/LEED) method [3]. Of particular interest, the nanosized MoS_2 flakes on Au foils are proven to be excellent electrocatalysts for hydrogen evolution reaction (HER).

By using a facile all chemical vapor deposition (all-CVD) approach, we have also realized the direct growth of monolayer MoS_2 on CVD graphene (Gr) (MoS_2/Gr) on the Au foil substrate. Spectroscopic characterizations reveal that the in-between Gr monolayer substantially weakens the interface interaction between MoS_2 and Au, leading to electronically quasi-freestanding MoS_2. This is evidenced by a very weak n-doping effect and an intrinsic bandgap of MoS_2 for MoS_2/Gr/Au sandwich by scanning tunneling microscopy/spectroscopy (STM/STS) characterizations. Moreover, the exciton binding energy is also obtained by combining variable temperature photoluminescence measurements[4].

Reference

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