Controllable Growth and On-Site Domain Boundary Imaging of Monolayer MoS_2 on Au foils and Its Potential Application in Hydrogen Evolution Reaction

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Abstract

Controllable synthesis of monolayer MoS_2 is the basic premise both for exploring some fundamental physical issues, and for engineering its applications in nanoelectronics, optoelectronics, *etc*. Herein, we report the scalable growth of domain size tunable (edge length from~ 200 nm to 80 μm), strictly monolayer MoS_2 flakes or even complete films on commercially available Au foils, *via* low pressure chemical vapor deposition (LPCVD) method. By introducing H_2 as carrier gas, we report the successful synthesis of large domain monolayer MoS_2 triangular flakes on Au foils, with the edge length approaching to 80 μm. The growth process is proposed to be mediated by two competitive effects with H_2 acting as both a reduction promoter for efficient sulfurization of MoO_3 and an etching reagent of resulting MoS_2 flakes. By using low-energy electron microscopy/diffraction, we have further identified the crystal orientations and domain boundaries of MoS_2 flakes directly on Au foils for the first time. Of particular interesting, the nanosized triangular MoS_2 flakes on Au foils are proved to be excellent electrocatalysts for hydrogen evolution reaction (HER), featured by a rather low Tafel slope (61mV/decade) and a relative high exchange current density (38.1μA/cm^2). The excellent electron coupling between MoS_2 and Au foils is considered to account for the extraordinary hydrogen evolution reaction activity. These on-site and transfer-free characterizations should shed light on the initial growth and the aggregation of MoS_2 on arbitrary substrates, further guiding the growth towards large domain flakes or monolayer films. And the synthesis of monolayer MoS_2 with introducing metal foils as substrates presents a sound proof that monolayer MoS_2 assembled on a well selected electrode can manifest comparable HER property with that of nanoparticles or few-layer MoS_2 electrocatalysts.

References

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