Atomic layer deposition of amorphous MoS_2 thin film for hydrogen evolution catalysis

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Recently MoS_2 has attracted great attention as an electrochemical catalyst for hydrogen evolution reaction (HER). Especially the amorphous phase of MoS_2 has been proved to be highly active for the HER. In this work, the amorphous MoS_2 thin films are grown at 100 °C on Au/Si or SiO_2/Si substrates by atomic layer deposition (ALD). The ALD-grown MoS_2 shows characteristic Raman modes for in-plane and out-of plane vibrations of the MoS_2 layer, although the film is amorphous in X-ray diffraction and transmission electron microscopy. Electrical conductivity of the amorphous MoS_2 is evaluated to be comparable to that in the parallel direction to the MoS_2 layers of crystalline phase. The amorphous film on Au substrate shows an excellent turnover frequency per active site for the HER. Here we discuss the origin of the high activity of the amorphous MoS_2 and the mechanism of the HER.