A straight forward approach to electrodeposit tungsten disulfide/poly(3,4-ethylenedioxythiophene) composites onto nanoporous gold for the hydrogen evolution reaction

1.1nm tungsten disulfide/poly(3,4-ethylenedioxythiophene) (PEDOT) was successfully electrodeposited on the surface of dealloyed nanoporous gold (NPG) surface to form uniform nanocomposites and offers an excellent electrocatalysis for the electrochemical dihydrogen evolution reaction (HER) in acidic media. The approach is straight forward and does not require any expensive equipment or intensive energy. The morphology and composition of the nanocomposites were structurally mapped by high-resolution transmission electron microscopy (HRTEM), X-ray photoelectron spectroscopy (XPS) and Fourier transform infrared spectrometry (FTIR). The roles of both the NPG substrate and PEDOT in the observed enhanced HER activity compared to planar Au-electrode surfaces and pure single-component WS$_2$ have been deconvoluted experimentally. PEDOT itself is inert for the HER, but was found to improve significantly the conductivity and operating stability of the WS$_2$ catalyst. The prepared nanocomposites reach the best in 2D WS$_2$ catalyst family, exhibiting excellent electrochemical catalytic activity for the HER. The optimal electrode showed an onset potential of -164 mV vs. reversible hydrogen electrode (RHE), an apparent exchange current density as high as 0.04 mAcm$^{-2}$, and a very low Tafel slope of 53mV dec$^{-1}$. These catalysts are promising electrocatalysts for generation a large amount of H$_2$ from water.