Scalable Synthesis of Heterogeneous W–W2C Nanoparticle-Embedded CNT Networks for Boosted Hydrogen Evolution Reaction in both Acidic and Alkaline Media

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Abstract

Practical hydrogen production via the hydrogen evolution reaction (HER) is reported as a clean and sustainable strategy for future energy demands. Tungsten (W)-based compounds are reported as promising alternatives to Pt-based electro catalyst for HER. However, inefficient charge transfer, high onset over potential, and particularly the lack of a reliable synthetic method still restrict its widespread application. Herein, for the first time, W–W2C nanoparticle-embedded CNT (W–W2C/CNT) composite, constructed by heterogeneous ultrafine W–W2C nanoparticles uniformly embedded into highly conductive CNT networks, was prepared via a spray-drying process followed a carbonization method. The optimized W–W2C/CNT electro catalyst exhibits excellent HER performance in both acidic and alkaline media; it shows a small onset over potential of only 40 (or 20) mV and a small Tafel slope of 56 (or 51) mV dec–1 in 0.5 M H2SO4 (or 1 M KOH). Moreover, it simultaneously shows remarkable long-term stability, particularly over 50 h under alkaline medium. The boosted HER performance in acid or alkaline solution is mainly attributed to the ligand effect of metallic W and W2C, and the synergistic effect of the unique porous nano architecture, which affords abundant active catalytic sites, enhances the transfer ability of electrons/ions and thus significantly improves its HER activity. This work presents a scalable synthesis approach to synthesize noble-metal-free electro catalysts with controllable nano architecture and boosted HER performance.