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Tungsten carbide electrocatalysts prepared from metallic tungsten nanoparticles for efficient hydrogen evolution

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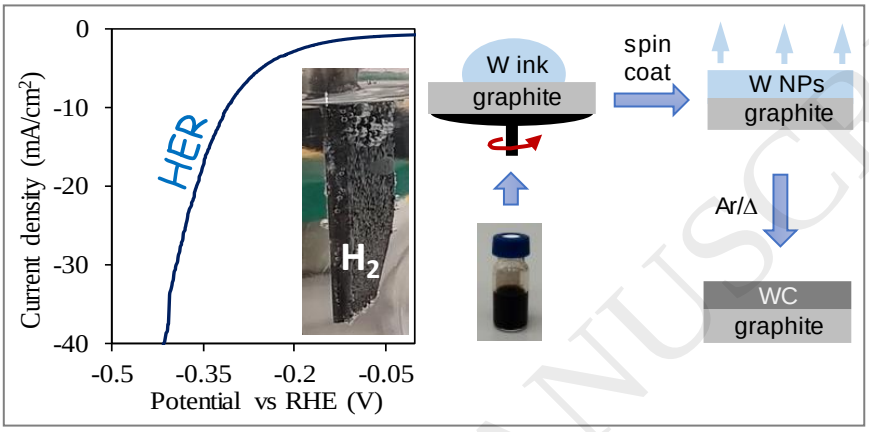

Graphical abstract

Highlights:

- W nanoparticles were synthesized via a wet-chemistry method
- Spin-coated of W nanoparticles onto graphite substrates yielded uniform W films
- Heat treatment of W films at high temperature allowed the preparation of textured tungsten carbide films
- The tungsten carbide films were used as catalyst for efficient hydrogen evolution via water electrolysis

Abstract
Pyrolysis of hexacarbonyl tungsten, $W(CO)_6$, in 1-octadecene has been used to prepare colloidal tungsten, W, nanoparticles (NPs). The obtained W NPs has been spin-coated on graphite (C) electrodes. Heat treatment of the W/C electrodes at elevated temperatures (≥ 900°C) allows the preparation of metallic W and tungsten carbide (W_2C@WC) thin films. The obtained W_2C@WC electrodes were used for hydrogen evolution studies (HER) in 0.5M H_2SO_4. Cyclic voltammetry tests for 1000 cycles showed that W_2C@WC exhibit long term stability without significant drop in current density. The overpotential defined at 10 mA/cm^2 is 310 mV vs. RHE giving an excellent catalytic activity for HER. Materials characterization has been achieved using transmission electron microscopy (TEM), scanning electron microscopy (SEM), and electrochemical impedance spectroscopy (EIS). Here, EIS studies were used to access the charge-transfer resistance of tungsten carbide electrodes.

Keywords: tungsten carbide, colloid, hydrogen evolution, overpotential, electrocatalyst