Economically Ultrafine Ruthenium Nanocrystals as Alternative Pt Candidate for pH-Universal Hydrogen Evolution Reaction

2022-06-12
Researchers designed a high-quality N-doped graphene aerogel supported Ru nanocrystals (Ru-NCs/N-GA) nanocomposites.

Currently, the electrocatalytic water splitting is one of the inexpensive, clean, reliable, quiet and affordable industrial-grade efficient hydrogen (H2) production technologies. However, the most effective platinum (Pt) based catalysts for hydrogen evolution reaction (HER, the cathodic reaction of water electrolysis) are subject to their high price and unsatisfactory stability. Therefore, low cost, high efficiency and high stability HER electrocatalyst are urgently needed to replace Pt based electrocatalysts.

Taking full account of the promising activity, robustness and reasonable price of ruthenium (Ru, the price of Ru metal is only ca. 1/4 ~ 1/20 of that of Pt metal), the high surface area and excellent conductivity of graphene-based advanced carrier, Ru-carbon nanocomposites can be a feasible option for HER. However, it is still a challenge to further improve the catalytic performance of Ru-carbon nanocomposites.

High-quality N-doped graphene aerogel supported Ru nanocrystals are constructed by employing an adsorption-pyrolysis strategy. Ultrafine size and uniform dispersion of Ru nanocrystals are highly attractive for excellent activity and durability in pH-universal hydrogen evolution reaction. Considering the high activity robustness and reasonable price, this article paves a new avenue for budget commercial electrocatalyst of hydrogen production.

Recently, a research team led by Prof. Yu Chen from Shaanxi Normal University, China designed a high-quality N-doped graphene aerogel supported Ru nanocrystals (Ru-NCs/N-GA)

nanocomposites. The reaction precursors of graphene oxide (GO) and ruthenium(III)-polyallylamine (RuIII-PAA) complex uniformly anchored at graphene aerogel, serving as N source and Ru source.

Specially, the uniform adsorption of RuIII-PAA complex can led to the homogeneous desperation and ultrafine size of Ru nanocrystals on the graphene aerogel under high-temperature processing. Ru-NCs/N-GA with porous structure and low Ru content (10 w.t.%) exhibit a comparable HER activity with 20 w.t.% Pt/C in both alkaline and acidic mediums. Overall, economically feasible Ru-NCs/N-GA nanocomposites with 10 wt.% Ru are highly promising substitutes for commercial Pt/C electrocatalyst for HER. The results were published in Chinese Journal of Catalysis .