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Iron phosphide nanoparticles anchored on 3D nitrogen-doped graphene as an efficient electrocatalysts for hydrogen evolution reaction in alkaline media

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Abstract

Electrocatalysts play a crucial role in hydrogen evolution reaction (HER), facilitating a clean and sustainable generation of hydrogen energy. To promote the HER process, it is imperative to employ highly efficient, stable, and cost-effective electrocatalysts. This research focuses on the design of iron phosphide nanoparticles anchored onto a porous three-dimensional nitrogen-doped graphene (FeP@3DNG). The porous framework of 3DNG serves a multifaceted purpose: it prevents the aggregation of FeP nanoparticles during phosphidation, safeguards the FeP electrocatalyst from oxidation during the HER, and simultaneously enhances electrical conductivity and stability. Notably, the FeP@3DNG nanocomposite demonstrated the efficient activity and highest HER activity with an overpotential of 76 mV to achieve 10 mA cm^{-2} and a small Tafel slope of 40.2 mV dec^{-1} as well as good long-term durability for 20 h in 1.0 M KOH solution. The high performance of the FeP@3DNG nanocomposite can be primarily corresponded to the synergistic effects of the highly active of FeP nanoparticles and advantages of porous three-dimensional graphene with excellent electrocatalytic activity, high specific surface area, and chemical stability, thus, resulting in the improvement the overall electrocatalytic activity.

Graphical Abstract