Electro-reduced graphene oxide nanosheets coupled with RuAu bimetallic nanoparticles for efficient hydrogen evolution electrocatalysis

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Abstract
Electrocatalytic Hydrogen Evolution Reaction (HER) in water electrolysis holds a great promise for sustainable hydrogen production but the preparation of an efficient and stable catalyst is remained challenging. Herein, a simple one-step simultaneous electro-reduction of graphene oxide, ruthenium chloride, and gold chloride precursors without involving any pre-/or post- mechanical, hydrothermal, or carbonization step, is reported to prepare homogeneously anchored ruthenium (Ru) and gold (Au) nanoparticles on reduced graphene oxide (RGO) as an efficient electrocatalyst for HER. The highly dispersed RuAu bimetallic nanoparticles on RGO sheets induce faster reaction kinetics with high turnover frequency, associating with strong electronic coupling interaction between RGO, Ru, and Au nanoparticles which improve the intrinsic HER activity of the catalyst as revealed by combined experimental and theoretical results. The as prepared RuAu-RGO catalyst demonstrates excellent HER activity with an overpotential of 56 mV at the current density of 10 mA cm^{-2} outperforming the monometallic Ru-RGO and Au-RGO catalysts in 1 M KOH solution. The RuAu-RGO catalyst exhibits utmost stability in the practical water splitting, far surpassing the benchmark Pt/C-IrO_2 system. Furthermore, the catalyst was employed as a cathode coupling with zinc (Zn) anode in an aqueous Zn-CO_2 system to generate hydrogen, it demonstrated positive shift in the onset potential of HER by 0.24 V than for HER in typical three-electrode testing configuration broadening its applicability.

Author keywords
Electro-reduced RGO
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Zn-CO_2 system