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Nickel-rich zeolitic imidazolate framework: Novel platform for highly robust multi-functional electro-catalysts

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Here, we report a novel strategy for synthesizing bimetallic Zeolitic Imidazolate Frameworks (ZIFs) with a hierarchical nanostructure. In this approach, pre-designed nickel-rich bimetallic solid precursors are directly converted into bimetallic ZIFs with controlled shapes and sizes. The hierarchical structure of the bimetallic ZIFs strongly deviates from the typical polyhedral-shape of zinc or cobalt based ZIFs (ZIF-8 or ZIF-67). The bimetallic ZIFs can then be directly converted to versatile types of electro-catalysts with catalytic nanocrystals-encapsulating carbon nano-cage nanostructure. Among them, a ternary nickel-cobalt phosphide bulk catalyst, which is grown directly on nickel foam, shows excellent bi-functional catalytic activity and durability toward the oxygen and hydrogen evolution reactions, suggesting its practical application as a robust alkaline water electrolyzer. Simultaneously, a carbon-rich catalyst with metallic NiCo nanocrystals-encapsulated in carbon nano-cage nanostructure is found to exhibit excellent activity towards Oxygen Reduction Reaction (ORR). The high potential of these precious metal-free electro-catalysts is demonstrated by employing them as decoupled air electrodes for rechargeable Zinc-Air Batteries (ZABs). The ZABs with a bmZIFs-NxC ORR electrode and bmZIFs-P as Oxygen Evolution Reaction (OER) electrode exhibit ultra-small charge-discharge over-potentials at 10 mA cm⁻² current density, surpassing the performance of the counterpart Pt/C ORR electrode and Ir/C OER electrode.

Biography

Sung Hoon Ahn has completed his BS in Chemical Engineering from Yonsei University, South Korea and has obtained his PhD from the same university. He is working as an Assistant Professor in Chosun University in South Korea and he was a Post-doctoral Fellow of Stanford University and Texas Materials Institute. His research interests are Electrocatalysts: Oxygen Reduction Reaction (ORR), Hydrogen/Oxygen Evolution Reaction (HER & OER) catalysts, Energy Materials: Design, synthesis, characterization, and prototype fabrication, Energy Storage Devices: Post Li-ion batteries, supercapacitors, Nanomaterials: nanoalloys, nanooxides, nanocarbons and nanocomposites.

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