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ABSTRACT:

Non-Chemical Approach for the Formation of PGM-Free Material via N+ Ion Implantation

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Cost-effective nanomaterials for energy conversion in Fuel Cells, Zinc-Air batteries, and Electrolyzers rely on platinum-group-metal-free (PGM-free) electrocatalysts based on C, N, O, and non-noble transition metals. Traditionally, these materials are synthesized by mixing organic and inorganic precursors, then pyrolyzing them at high temperatures (>900°C) under non-oxidative conditions, often with acid-washing steps to remove unwanted species and create porosity [1–4].
Building on this approach for PGM-free catalysts, we investigated replicating active-site formation via a cleaner physical method instead of pyrolysis. Our new recipe involves N+ low-energy ion implantation using a Kaufman apparatus, followed by iron evaporation in an ultra-high-vacuum chamber. Vertically Aligned Carbon Nanotubes (VA-CNT) were used as a model structure due to their predominantly sp2 hybridization.
Simply tuning the ion beam energy was also possible to maximize the pyridinic N content minimizing all other moieties. Lastly, electrochemical tests performed on a representative sample showed catalytic activity towards the oxygen reduction reaction (ORR), confirming the feasibility of the process. The preliminary results are thus paving the way to the limitless and nitrogen-compound-free synthesis of critical raw material-free nanoelettrocatalysts.[5]

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