Scalable synthesis of polymer-based atomically dispersed electrocatalysts for rechargeable zinc-air batteries

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The escalating global demand for clean energy has encouraged extensive research into advanced energy storage technologies, with rechargeable zinc-air batteries (RZABs) standing out due to their high voltage, energy density, low cost and eco-friendliness.[1] However, challenges persist regarding sluggish kinetics of the oxygen reduction reaction (ORR) and the oxygen evolution reaction (OER) at the air electrode, often mitigated with costly and scarce precious metal-based catalysts.[2] Transition metals offer more sustainable alternative, with recent focus on atomically dispersed catalysts (ADCs) to address issues of agglomeration and enhance efficiency.[3] While promising, ADC synthesis methods and scalability pose many challenges. Polymer-derived carbons have emerged as a scalable solution, offering tailored metal environments conducive to efficient catalyst production. This study presents a novel approach to synthesise atomically dispersed bimetallic catalysts for oxygen electrocatalysis from transition metal-embedded polymer frameworks. The STEM image indicates the uniform dispersion of single-atom sites (Figure 1a). The resulting FeCoN-PDF-T_2-2 catalyst exhibits good bifunctional activity (ΔE = 0.75 V) and electrochemical stability for ORR/OER showing potential for RZAB application with superior performance (P_{max} = 258 mW cm^{-2}) compared to PtRu/C (P_{max} = 185 mW cm^{-2}) (Figure 1b), thus highlighting the feasibility of large-scale production and offering new avenues for further exploration in catalyst synthesis methods.

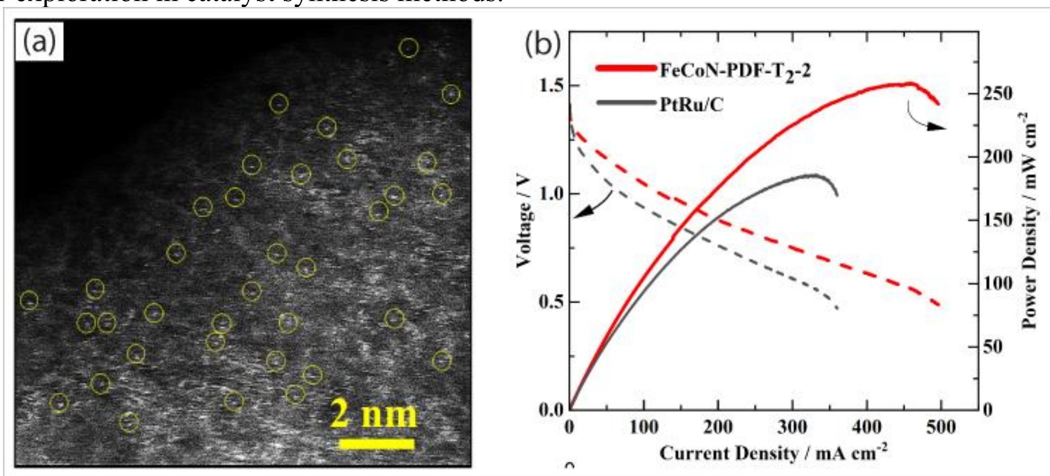

Figure 1. (a) STEM image of a FeCoN-PDF-T_2-2 catalyst, (b) discharge polarisation and power density curves of Zn-air battery with FeCoN-PDF-T_2-2 and PtRu/C air electrode.

References:

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