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Design of Fe, N-doped hierarchically porous carbons as highly active and durable electrocatalysts for both PEM fuel cells and Zn-air battery

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Faced with the increasingly serious energy crisis, polymer electrolyte membrane (PEM) fuel cells, together with various batteries as clean and efficient power sources, have become the most promising energy conversion devices, which have evoked significant attention during the last decades. Oxygen reduction reaction (ORR) both in alkaline solution (i.e., $2H_2O + O_2 + 4e^- \rightarrow 4OH^-$) and in acidic solution (i.e., $4H^+ + O_2 + 4e^- \rightarrow 2H_2O$), significantly affects the electrochemical performances of these technologies. Although a large thermodynamic driving force (E=1.2V RHE) is available, the ORR is kinetically slow even in the presence of Pt-based nobel metal eleccatalysts. In this work, we pioneer the fabrication of heteroatom (N and Fe) co-doped hierarchically porous carbons (N-Fe-HPCs) catalysts for ORR with nitrogen-enriched polyquaternium as the precursor of both N and C source. The obtained N-Fe-HPCs catalysts possess the unique hierarchically porous structure composed of micro-, meso and macro porous with three-dimensional nanoarchitectures, thus leading to a large specific surface area larger than 1000 $m^2\ g^{-1}$, which contributes to high exposure of the ORR active sites and excellent transport properties. Besides the perfect ORR performances in PEM fuel cells, such N-Fe- HPCs catalysts can give a discharge peak power density as high as 536 mW cm^{-2} with a current density of 317 mA cm^{-2} at 1.0 V of cell voltage and an energy density > 900 Wh kg^{-1}, when used for constructing the zinc–air battery cathode. The outstanding ORR activity and durability, significantly outperforms the state-of the-art platinum-based catalyst and the most recently reported Zn-air battery in literature.

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Investigation into acoustic characteristics of proton exchange membrane fuel cell

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Proton exchange membrane fuel cells (PEMFCs) have great potential for wider adoption in both static and mobile applications. For the purposes of optimizing their design, control and reliability, a number of parameters have to be precisely measured and interpreted. To date, none of these parameters could serve as an ideal tool for the above-mentioned purposes. However, it is believed that their dynamic induced variables carry the information sought for. Acoustics is among the parameters and thus, more work is required in this direction to gain better understanding of the acoustical characteristics of PEMFCs. This work is an attempt to provide rigorous investigation into the generation mechanisms and characteristics of the acoustic signatures emitted by PEMFCs. An experimental acoustic model was derived to describe the nature of the generated acoustic signals and its outcomes are validated via a number of experiments carried out using a purposely designed and implemented 0.5W PEM single fuel cell. A proper sensor was placed on the PEMFC to capture AE signals. Different loads are used to evaluate the AE levels. The results indicate that increasing the load value leads to increasing intensity of AE. In addition to the experimental model, a simulation model for the PEMFC is constructed and designed in MATLAB. A good agreement is achieved between the modelling and experimental outcomes.

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