Preface: Special topic on electrocatalysis & energy science

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Citation: Wu C, Wu G, Yu G. Preface: Special topic on electrocatalysis & energy science. *Sci China Chem*, 2020, 63: 1515–1516, <https://doi.org/10.1007/s11426-020-9894-9>

Electrocatalysis is one type of catalysis. The catalysts at the electrode/electrolyte interfaces can facilitate electrochemical reactions with high rates and stability *via* selective pathways at potentials close to their thermodynamic limits (*i.e.*, minimum overpotentials). The first elaborated study for electrocatalysis can be dated back to the 1920s when Bowden and Rideal examined the electrolytic behaviors of a series of metal films for hydrogen evolution. However, it is not until 1963 that Grubb used the word “electrocatalysis” for the first time to name the electrochemical processes in fuel cells.

Over the last decades, capturing and utilizing transient renewable energies such as solar and wind energy to offset the fast depletion of fossil fuels is becoming one of the mainstreams towards a clean and sustainable energy supply. Among these new energy technologies, energy conversion and storage are the critical steps in which electrocatalysis plays an indispensable role. In contrast to the traditional fossil fuel industry highly relying on high temperature/pressure reactions, electrocatalysis usually operates at ambient temperature and pressure, significantly reducing large-scale investment on the inflexible heat/pressure management equipment. Based on the above considerations and the witness of the growing commercialization of rechargeable battery/fuel cell-powered products, it can be predicted that electrocatalysis-related technologies will dominate the further development in many chemical/energy industries.

So far, the most widely studied electrocatalysis reactions include oxygen evolution reaction (OER), hydrogen evolution reaction (HER), oxygen reduction reaction (ORR), hydrogen oxidation reaction (HOR), CO₂ reduction reaction (CRR), nitrogen reduction reaction (NRR), and methanol oxidation reaction (MOR). These electrocatalysis reactions lay the basis for chemicals/fuels production and utilization, *e.g.*, hydrogen production by water splitting, electricity generation via fuel cells, carbon-based chemicals/fuels production, and ammonium electrosynthesis. The rechargeable batteries and supercapacitors involved electrochemical reactions (*e.g.*, oxygen evolution/reduction and metal plating in metal-air batteries and polysulfides redox reactions in Li-sulfur batteries) are another essential branch of electrocatalysis which paves the way toward efficient and high-density energy storage. A third booming development of electrocatalysis is the electrochemical synthesis of organic compounds based on electrocatalytic C–H oxidation, C=C reduction, dehalogenation reduction, C=O reduction, providing alternative and green routes to traditional organic compound synthesis.

In this special topic of the “*Science China Chemistry*” journal, we collect two reviews, two articles, and one communication to track the most recent progress in electrocatalysis in energy science. The first review by Hu *et al.* summarizes the development of M/N/C based non-noble oxygen reduction electrocatalysts from three aspects: (1) strategies for intrinsic activity improvement; (2) porous

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structure engineering; (3) scale-up and cost-effective synthesis of M/N/C electrocatalyst. The second review by Wu *et al.* highlights the significance of local structure engineering for precious and non-precious metal catalysts for oxygen reduction in proton exchange membrane fuel cells. The first article by Wang *et al.* reports an O doped Ni_3N electrocatalyst for highly efficient hydrogen evolution in alkali conditions. Both experimental and theoretical investigations reveal the oxygen incorporation facilitates water adsorption and dissociation. The second article by Yu *et al.* demonstrates a 3D macroporous carbon-supported Mo_2C nanodots electrocatalyst for nitrogen reduction with high faradaic ef-

ficiency. Detailed electrochemical characterizations reveal the beneficial role of enhanced electron transfer and increased electrochemical surface area from the 3D macroporous carbon framework. Finally, the communication from Wang *et al.* discloses the detrimental effect of electrolyte additive on Na metal plating/stripping for thick Na metal electrodes in rechargeable Na metal batteries and the importance of strong adhesion between the thin Na layer and Cu current collector for thin Na metal electrodes. They further introduce a gold interlayer between Cu current collector and Na layer to realize high-energy-density, high-efficiency, and stable-cycling in $\text{Na}||\text{Na}_3\text{V}_2(\text{PO}_4)_3$ batteries.

Changzheng Wu obtained his B.S. degree (2002) and his Ph.D. degree (2007) in the Department of Chemistry from the University of Science and Technology of China (USTC). He then worked as a postdoctoral fellow in the Hefei National Laboratory for Physical Sciences at the Microscale. He is now a full professor at the Department of Chemistry, USTC. Prof. Wu's current research interests focus on the synthesis of inorganic 2D nanomaterials, as well as on the regulation of their intrinsic physical properties for wide applications in energy conversion.

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