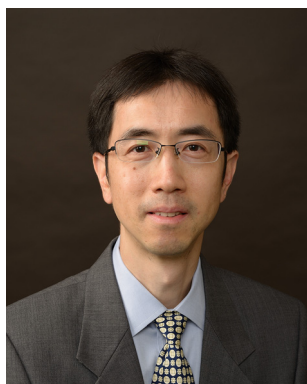


org/10.1039/D4NR00796D, <https://doi.org/10.1039/D4NR01191K> and <https://doi.org/10.1039/D4NR00975D>). In addition, high-entropy materials (<https://doi.org/10.1039/D4NR00474D> and <https://doi.org/10.1039/D4NR01538J>) offer significant advantages in catalysis due to their broader compositional design and flexible, diverse microstructures.

Regarding electrocatalysis, Wu *et al.* (<https://doi.org/10.1039/D4NR02519A>) developed intermetallic NiCo electrocatalysts to enhance the efficiency of the hydrogen evolution reaction in alkaline

conditions. Wang *et al.* (<https://doi.org/10.1039/D4NR01320D>) employed an effective piezoelectric method to enhance catalytic water splitting activity significantly, without altering the material's morphology or composition, by modulating bulk charge separation. Yang *et al.* (<https://doi.org/10.1039/D4NR01071J>) enhanced hydrogen evolution efficiency by partially substituting nitrogen with oxygen in the Ni₃N catalyst, thereby tuning its electronic structure. In particular, Song *et al.* (<https://doi.org/10.1039/D4NR00170B>) acceler-

ated the kinetically sluggish oxygen evolution reaction in water electrolysis by leveraging the photothermal effect. To enable overall water electrolysis for hydrogen production, Rajeshkhanna *et al.* (<https://doi.org/10.1039/D4NR01196A>) developed two non-precious metal materials, each designed to efficiently catalyze the hydrogen evolution and oxygen evolution reactions. Alongside water electrolysis for hydrogen production, CO₂ reduction is considered a promising method for decarbonization and sustainable energy conversion. This



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Zhiqun Lin is currently a professor of chemical and biomolecular engineering at the National University of Singapore (NUS). He received his BS degree in materials chemistry from Xiamen University in 1995, his master's degree in macromolecular science from Fudan University in 1998, and his PhD degree in polymer science and engineering from University of Massachusetts, Amherst in 2002. He did his postdoctoral research at the University of Illinois at Urbana-Champaign. He joined the Department of Materials Science and Engineering at the Iowa State University as an assistant professor in 2004 and was promoted to associate professor in 2010. He moved to the Georgia Institute of Technology in 2011 and became a professor in 2014. He relocated to National University of Singapore in 2022. His research interests include photocatalysis, electrocatalysis, batteries, solar cells, block copolymers, conjugated polymers, functional nanocrystals, hierarchically structured and assembled materials, and surface and interfacial properties.



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themed collection highlights the development of novel nanocatalysts for efficient CO₂ electroreduction (<https://doi.org/10.1039/D4NR01416B>, <https://doi.org/10.1039/D4NR01484G>, <https://doi.org/10.1039/D4NR01173B>, <https://doi.org/10.1039/D4NR00909F>, <https://doi.org/10.1039/D4NR00340C> and <https://doi.org/10.1039/D4NR01082E>). The development of efficient oxygen reduction electrocatalysts contributes to advancing energy sustainability (<https://doi.org/10.1039/D3NR06647A> and <https://doi.org/10.1039/D4NR02425G>). The electrochemical reduction of nitrate to ammonia is a promising catalytic pathway for both ammonia production and nitrate reuse from industrial wastewater (<https://doi.org/10.1039/D4NR01625D>).

In the field of photocatalysis and photoelectrochemical applications, Waclawik *et al.* (<https://doi.org/10.1039/D4NR00885E>) review light modulation techniques to improve product selectivity in photocatalytic reactions. Yang *et al.* (<https://doi.org/10.1039/D4NR01040J>) discuss advancements in utilizing quantum dots for hydrogen production. Additionally, Seh *et al.* (<https://doi.org/10.1039/D4NR02342K>) highlight recent developments in photocatalysts, emphasizing strategies to enhance their performance in environmental remediation and energy conversion. Aizenberg and van der Hoeven *et al.* (<https://doi.org/10.1039/D4NR01200C>) discovered that the placement of nanoparticles in gold-loaded titanium dioxide (Au/TiO₂) inverse opals influences both photocatalytic activity and stability. Efficient hydrogen production and ammonia generation can be achieved by adjusting the structure (<https://doi.org/10.1039/D4NR01194E>) and electronic state (<https://doi.org/10.1039/D4NR01787K> and <https://doi.org/10.1039/D4NR00868E>) of the photocatalyst. In addition, constructing photocatalysts with porous frameworks is an effective strategy for enhancing photocatalytic efficiency (<https://doi.org/10.1039/D4NR00779D>, <https://doi.org/10.1039/D4NR00608A> and <https://doi.org/10.1039/D4NR00391H>). The development of efficient catalysts is

also essential for photoelectrochemical applications (<https://doi.org/10.1039/D4NR00949E>).

In addition to electrocatalysis and photocatalysis, this themed collection also encompasses research on thermal catalysis. Frenkel *et al.* (<https://doi.org/10.1039/D4NR01396D>) identify the origins of reaction-driven aggregation and fragmentation of atomically dispersed Pt catalysts on ceria supports during the high-temperature water gas shift reaction. Machida *et al.* (<https://doi.org/10.1039/D4NR01156B>) found that the nanoscale smoothness of the Pt capping layer increases the TOF more than tenfold compared to a rough Pt surface in the ammonia oxidation reaction. Pomposo *et al.* (<https://doi.org/10.1039/D4NR01261E>) developed heterobimetallic single-chain nanoparticles as soft nanocatalysts, facilitating one-pot alkyne semihydrogenation and olefin double oxidation reactions in *N*-butylpyrrolidone at room temperature, without the need for toxic solvents like *N,N*-dimethylformamide. The study by Behrens *et al.* (<https://doi.org/10.1039/D4NR02025A>) demonstrated that Ni,Fe catalysts supported on zirconia and ceria exhibited higher activity than those on magnesia in CO₂ hydrogenation, attributed to changes in metal-support interactions resulting from differences in reducibility and oxygen vacancy formation. Nanomaterials derived from metal-organic frameworks are also regarded as an effective strategy for developing efficient catalysts (<https://doi.org/10.1039/D4NR01185F>). Additionally, constructing composite nanocatalysts can effectively enhance catalytic activity, selectivity, and stability (<https://doi.org/10.1039/D4NR01184H>, <https://doi.org/10.1039/D4NR01211A>, <https://doi.org/10.1039/D4NR01222D>, <https://doi.org/10.1039/D4NR01116C>, <https://doi.org/10.1039/D4NR01409J>, <https://doi.org/10.1039/D4NR00948G>, <https://doi.org/10.1039/D4NR01243G>, <https://doi.org/10.1039/D4NR00358F> and <https://doi.org/10.1039/D3NR06518A>).

Finally, this themed collection highlights emerging applications of nanocatalysis in biocatalysis, biosensing, and

batteries. Negishi *et al.* (<https://doi.org/10.1039/D4NR02506G>) report the design and construction of a novel (3,6)-connected two-dimensional silver cluster-assembled material, used for the first time as a support matrix for enzyme immobilization. Tong *et al.* (<https://doi.org/10.1039/D4NR01208A>) reveal the unique pH-dependent behaviors of iron oxide nanozymes and ascorbic acid, paving the way for macrophage-based cell therapy. Wang *et al.* (<https://doi.org/10.1039/D4NR00521J>) developed a nanoengineering approach for highly sensitive vanillin detection using neodymium niobate nanospheres on functionalized carbon nanofibers. In addition, developing efficient catalysts for both the cathode and anode can significantly enhance overall battery performance (<https://doi.org/10.1039/D4NR00518J>, <https://doi.org/10.1039/D4NR02385D> and <https://doi.org/10.1039/D4NR02418D>).

This themed collection represents the diverse, interdisciplinary nature of nanocatalysis research, from theoretical insights to practical applications in energy, sustainability, and health. We hope the collection provides readers with a comprehensive overview of recent progress and future directions in nanocatalysis. We extend our thanks to all contributing authors, reviewers, and the editorial and production staff for their support in bringing this themed collection to fruition.

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