Recent advances in electrocatalytic ammonia synthesis

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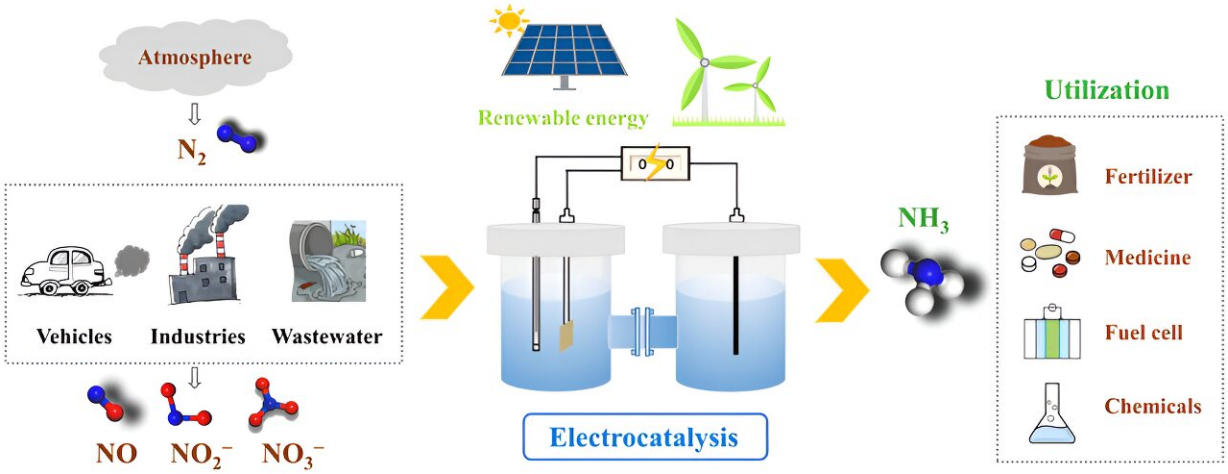

Artificial Electrocatalytic Ammonia Synthesis (Which Can Couple With Clean Renewable Electricity) Is Recently Becoming A Research Hotspot. Researchers Review Recent Advances In Electrocatalytic Ammonia Synthesis Involving Electrocatalytic Nitrogen Reduction Reaction, Nitric Oxide Reduction Reaction, And Nitrate/Nitrite Reduction Reaction. The Challenges And Future Perspectives Are Also Proposed In The Concluding Remarks. Credit: *Chinese Journal of Catalysis* (2023). DOI: 10.1016/S1872-2067(23)64464-X

NH_3 is the second largest chemical produced in the world and nearly 80% of produced NH_3 is employed in fertilizer synthesis. Meanwhile, NH_3 is an indispensable raw material for manufacturing nitric acid, which can be further employed in chemical production.

Moreover, NH_3 possesses high hydrogen capacity, making it a potential carbon-free fuel. As one of the greatest inventions, the Haber-Bosch process enables the large-scale production of value-added NH_3; however, it is against the principle of sustainable development theory due to the high operational costs and negative environmental impacts of the Haber-Bosch process.

Hence, it is imperative to explore green and sustainable approaches to produce NH_3 and simultaneously realize global environmental sustainability.

Artificial electrocatalytic NH_3 synthesis (which can couple with clean renewable electricity) is recently becoming a research hotspot, where the majority of researchers use N_2 gas as the N source. Although electrocatalytic N_2 reduction reaction (NRR) provides an eco-friendly and sustainable route for ambient NH_3 production, the conversion efficiency of N_2 reduction to NH_3 is unsatisfactory because of the high thermodynamic stability of the N_2 molecule.

Fortunately, the more active N sources (i.e., NO, NO_2^-, NO_3^-) have been deemed as attractive precursors to achieve effective NH_3 production, and meanwhile, the development of electrocatalytic NO reduction reaction (NORR) and NO_3^-/NO_2^- (NO_x^-) reduction reaction (NtrRR) is also expected to control and mitigate the related environmental pollution.

Although many promising studies have been done in the field of artificial electrosynthesis of NH_3, the design and development of active electrocatalysts with high selectivity and stability to achieve efficient NH_3 production remain certain challenges.

Recently, a research team led by Prof. Xuping Sun from University of Electronic Science and Technology of China introduced three electrochemical NH_3 synthesis routes (NRR, NORR, and NtrRR) then

summarized recent advances in electrocatalyst development for ambient NH_3 synthesis, mainly involving catalytic mechanisms, theoretical advances, and electrochemical performance.

The challenges and future perspectives are also proposed in the concluding remarks, aiming to provide experience and inspire more critical insights for the electrocatalytic NH_3 synthesis reactions. The results were published in the *Chinese Journal of Catalysis*.

More information: Ling Ouyang et al, Recent advances in electrocatalytic ammonia synthesis, *Chinese Journal of Catalysis* (2023). DOI: 10.1016/S1872-2067(23)64464-X

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