Waste to an Asset, Synthesis of Ammonia from Nitrate Reduction

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Ammonia is one of the most important industrial chemicals in the world, known not only as an essential raw material for fertilizer but also as an energy storage medium and carbon-free energy carrier. Currently, the industrial-scale NH_3 synthesis relies on the century-old Haber-Bosch process, which requires harsh operating conditions including high temperature (400-500 °C) and high pressure (150-300 atm) using heterogeneous iron-based compounds as catalysts. Such process accounts for 1-2% of the world's energy supply and causes *ca.* 1% of total global energy-related CO_2 emissions. As an attractive alternative to the Haber-Bosch process, the ambient electrocatalytic nitrogen reduction reaction (NRR), ideally powered by clean/renewable energies (e.g., solar or wind), has attracted great interest during the past few years.[1] However, efficient NRR has proven to be very challenging to achieve up to now. In our recent work,[2] we combined computational and experimental analysis to successfully propose and examine electrochemical production of ammonia from nitrate reduction using iron single-atom catalyst. This method bypasses the limitations of the NRR process and is highly competitive with the Haber-Bosch process.

[1] Foster, S. L. *et al.* Catalysts for nitrogen reduction to ammonia. *Nat. Catal.* **1**, 490–500 (2018).
[2] Wu, Z.-Y. *et al.* Electrochemical ammonia synthesis via nitrate reduction on Fe single atom catalyst. *Nat. Commun.* **12**, 2870 (2021).