

Simple Metal Catalysis for Hydrogen and Ammonia Production

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Abstract

Hydrogen and ammonia are regarded as key energy carriers and chemical feedstocks for a sustainable future. However, their production still relies heavily on fossil resources and energy-intensive processes. The development of catalytic systems capable of producing these molecules from renewable resources under mild conditions therefore represents an important challenge in modern chemistry.

In this lecture, we will present our recent studies on simple metal catalysis for the production of hydrogen and ammonia. First, a ligand-free iron ion catalyst enables photocatalytic hydrogen evolution from methanol and other biomass-derived compounds under ultraviolet light irradiation.¹ Despite its remarkably simple composition, this homogeneous catalytic system exhibits efficient hydrogen production and can be applied to various renewable substrates. Second, a homogeneous rhenium catalyst promotes the photocatalytic conversion of nitrate to ammonia using methane as a reductant under ambient conditions.² This reaction provides a new strategy for transforming environmentally problematic nitrate into value-added ammonia while utilizing methane derived from renewable resources.

These studies demonstrate that surprisingly simple metal-based catalytic systems can mediate challenging small-molecule transformations. The results highlight new opportunities for sustainable hydrogen and ammonia production and suggest broader possibilities for the utilization of simple metal catalysts in future carbon- and nitrogen-neutral chemical processes.

References

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