Magnetically Induced Catalysis for CO2 reduction

Bruno Chaudret
Université de Toulouse, Laboratoire de Physique et Chimie des Nano-Objets, UMR 5215 INSA-CNRS-UT
31077 Toulouse Cedex France
chaudret@insa-toulouse.fr

Abstract

Magnetically Induced Catalysis (MIC) represents a highly promising and emerging strategy that exploits magnetically active materials to trigger or enhance catalytic processes [1-2]. The application of external magnetic fields enables not only the rapid recovery of catalysts in solution but also spin-dependent interactions or selective control of reactions through local heating effects, typically achieved via magnetic induction heating. Unlike conventional approaches, the latter method enables localized and selective energy transfer. Such "self-heating" catalysts allow rapid activation, improved energy efficiency, and precise temporal control of reaction conditions. This methodology is particularly attractive for sustainable processes, including green chemistry, environmental remediation, and energy conversion, where minimizing energy consumption and maximizing catalytic performance are key goals.

Regarding CO_2, LPCNO has studied its reduction by hydrogen and developed selective catalytic processes for methanation, reverse water gas shift (RWGS) and, after the development with Technip of a set-up allowing MIC at 50 bars, synthesis of methanol. While initially based on magnetic nanoparticles deposited on an oxide support, we have developed new systems incorporating macroscopic magnetic susceptors for scale-up and durability purposes. Iron wool has hence appeared as a cheap and energy efficient material. With the help of the SATT TTT and of Téréga, a system based on iron wool and Ni nanoparticles deposited on alumina has then been developed at the pilot scale and used for the enrichment of biogas into methane injectable into existing gas networks. The research has given rise to a portfolio of 4 patents and to the creation in December 2025 of the start-up CATMAG devoted to heterogeneous catalysis and first methanation and RWGS.

MIC can be also used for fine chemistry, using the overheating of magnetic nanoparticles in a solution. This has been used for the local selective production of CO from pure formic acid and further use in carbonylation reactions.

The presentation will give the basics of magnetically induced heating and catalysis, the production of CO from formic acid and the path from the proof-of-concept to the creation of CATMAG.

References

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Keywords

CO_2; Magnetic Induction; Catalysis; Methane; CO; Methanol