Iron-based nanoparticles as self-heating catalysts under magnetic induction: a solution for CO_2 utilization?

We have explored different approaches to convert CO_2 into valuable products via thermocatalytic processes, using heterogeneous catalysts based on earth-abundant metals. One of such reactions is the reverse water gas shift (RWGS) reaction, that converts captured CO_2 streams into syngas. RWGS is an endothermic reaction and requires temperatures above 400 °C to achieve substantial conversions. Fe nanoparticles are ferromagnetic and can be inductively heated to the reaction temperature by a relatively small, alternating magnetic field with intensities in the order of 10^{-2} T. The approach of using Fe nanoparticles both for catalysis and inductive heating is expected to bring advantages such as the elimination of heat transfer limitations, fast response and the possibility of directly using electricity from renewable sources [1,2]. This work studies the magnetic and catalytic properties of Fe and Fe-Co supported nanoparticles and their stability as catalysts and inductive heaters under RWGS reaction conditions. We show that ferromagnetic Fe, Co and Fe oxide nanoparticles supported on mesoporous oxides can heat up to 700 °C via hysteresis losses when placed under an alternating magnetic field, and efficiently catalyse the RWGS reaction [3]. At the temperatures targeted for energy-intensive chemical reactions such as RWGS, the surface of magnetic nanoparticles is subject to dynamic changes and can also chemically react with the environment, changing in composition and structure and, thus, affecting its magnetic properties. Combined X-ray absorption spectroscopy and diffraction shows the interconversion and evolution of different Fe(Co) metal, mixed oxide and carbide phases under RWGS conditions and set the basis for understanding how materials properties can be adjusted for an optimal and stable performance in an induction reactor.

1. M. R. Almind, et al., Improving performance of induction-heated steam methane reforming, *Catalysis Today* **2020**, *342*, 13–20

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