Induction-heated magnetic nanoparticles for catalytic hydrogen production

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Induction-heating of nanoparticles placed inside chemical reactors, as illustrated in Fig. 1, is an alternative "green" approach for heating high-temperature endothermic catalytic reactions such as steam methane reforming (SMR) [1-4].

As of today, most of the world's hydrogen is produced from natural gas through SMR, but the reaction has conventionally been heated by firing, causing ~1% of the world's CO2 emission [1].

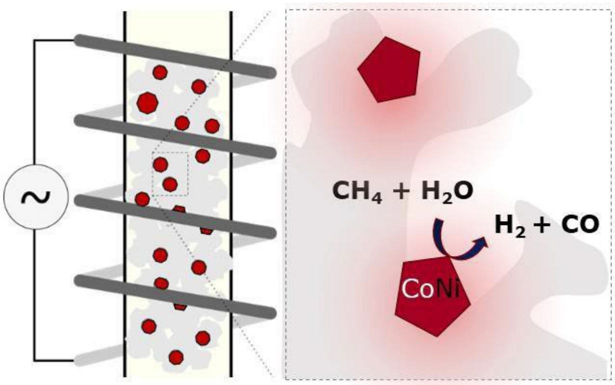

Figure 1: Induction-heated catalytic nanoparticles driving the SMR process for hydrogen production.

This talk addresses the potential of induction heating by magnetic nanoparticles.
Magnetic nanoparticles can heat locally "from the inside" of the reactor, supplying heat where it is needed, while avoiding large temperature gradients across the catalyst bed [1-4]. Moreover, the heating can be powered by electricity from renewable sources and may due to faster reactor startup times exploit periods of surplus electricity [1-4].

Our recent work shows how CoNi nanoparticles on an alumina support can act both as catalyst and as magnetic susceptor to drive SMR at high methane to hydrogen conversion rate at high temperatures (~800 °C) [1-4]. The Co:Ni composition can be tuned for optimal performance at given operating temperatures and induction field amplitudes [1]. Moreover, composition can be chosen such that the Curie temperature prevents overheating [1]. A new sample holder enables vibrating sample magnetometry (VSM) studies of the powder materials at high temperature in well-controlled gas atmospheres.

The talk discusses the applicability of induction heating to drive catalytic reactions [1-4] and compares induction heating with conventional heating [1-4] and resistive heating [6,7] in the case of SMR and more generally.

References

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