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Iron based nanoparticles for the magnetically induced hydrogenation of carbon dioxide to methane

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To limit global warming and decrease the carbon footprint in the energy mix, electricity is increasingly produced from intermittent renewable resources. As a result, large scale and long term energy storage is required to face the unavoidable variations in electricity production. From this perspective, the chemical storage of energy through the Sabatier reaction (power to gas) is especially promising. Our group recently evidenced the interest of magnetic induction to thermally activate suitable heterogeneous catalysts. We present here the hydrogenation of CO_2 catalyzed by iron based nanoparticles through magnetically induced heating. The challenge of synthesizing nano-objects displaying both catalytic activity and appropriate magnetic properties was taken up by designing specific iron carbide nanoparticles. Based on an organometallic approach, the synthesis developed gives access to highly monodisperse and finely tunable iron carbide nanoparticles. The size, carbon content and crystallographic organization of the NPs were proven to be critical parameters to obtain high specific absorption rates (SAR). In optimal conditions, SAR as high as 3000 W/g were measured (100 kHz, 47.4 mT). To our knowledge, this value is by far the highest ever reported for such mild conditions. Subjected to an alternating magnetic field in a dedicated flow reactor, suitable iron carbide based nanoparticles were proven to be catalytically active for the hydrogenation of CO_2 to hydrocarbons. Interestingly, the catalytic activity of iron carbide nanoparticles can be tuned by functionalizing the NPs surface with different metals such as nickel and ruthenium.

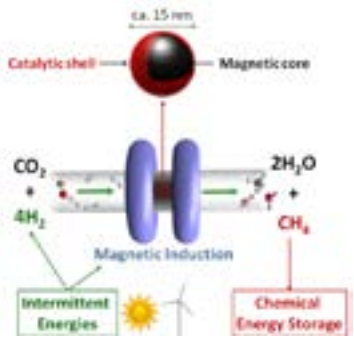

Figure 1: Illustration of the concept of chemical energy storage through magnetic induction.

Biography

Alexis Bordet performed his PhD at the LPCNO (University of Toulouse, France) under the supervision of Dr. Bruno Chaudret and Dr. Katerina Soulantika from November 2013 to December 2016. His project concerned the synthesis of magnetic nanoparticles for the magnetically induced catalytic hydrogenation of CO_2 to CH_4. He joined the group of Prof. Walter Leitner (ITMC, RWTH Aachen, Germany) as A Post-Doctorate Researcher in February 2017, and holds a position of sub-group Leader since August 2017. His research focuses on the synthesis and characterization of complex nano-catalysts for the chemical storage of energy and the conversion of biomass to biofuels.

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