

Ceria-Based Nanocomposites for Catalysis by Magnetic Heating

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Abstract:

Conversion of (renewable) electricity into fuels and chemicals, i.e., the electrification of chemical industry, is one of the keys for decarbonising the planet. Catalysis by magnetic (also referred to as induction) heating is an emerging technology, which enables the efficient use of electricity to supply the heat for thermo-catalytic processes. The technology is based on heating of magnetic nanoparticles imbedded in a catalyst support in an alternating magnetic field. The selective heating of catalyst surfaces can improve the selectivity and yields of catalytic reactions. In addition, the technology is very flexible (very fast heating and cooling rates) and brings high hopes for improving energy efficiency.

In this study, magnetic ceria-based catalysts were synthesized. First, magnetic iron-oxide nanoparticles were coated with nanocrystalline ceria using controlled precipitation of the Ce^{3+} ions in the presence of hexamethylenetetramin (HMTA) in the aqueous suspension. In the next step, Ru catalytic nanoparticles were deposited onto the magnetic ceria support. A special attention was given to reveal chemical mechanisms enabling the deposition of homogeneous ceria coatings with a high surface area. Morpho-structural properties of the synthesized materials were characterized using a combination of electron microscopy (SEM, TEM, and aberration-corrected STEM), measurements of specific surface area (BET) and XRD. The efficiency of magnetic heating was evaluated as a function of the amplitude of magnetic field and the structure and magnetic properties of catalyst (measured with VSM). Finally, the magnetic catalysts were tested for relevant chemical conversions where the magnetic heating was compared with the conventional heating.

Biography:

Prof. dr. Darko Makovec is full professor, head of Department for Materials Synthesis and scientific chancellor at Jožef Stefan Institute. He has defended his PhD from chemistry at the University of Ljubljana in year 1995. In 2001-2002 he worked as a Fulbright senior scholar at University of Illinois at Urbana-Champaign, USA. His scientific interests are focused on synthesis and characterization of the inorganic and hybrid nanomaterials, especially materials containing magnetic nanoparticles. He is also expert in advanced electron microscopy. Prof Makovec has published over 200 peer-review articles.