Regenerating metal supported nanoparticles for CO_2 conversion applications

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One of the nowadays biggest challenges is how to make use of CO_2 for the synthesis of higher value chemicals. With this respect CO_2 methanation and CO_2-mediated dehydrogenation of alkanes play an important role. Supported metal nanoparticles are fundamental to activate these reactions. However, during high-temperature and prolonged operation these materials suffer from deactivation by sintering and surface coke poisoning.
In the present paper, the synthesis of smart, regenerative supported metal nanoparticles obtained by cationic segregation from perovskite oxide supports is showed. High-temperature treatments under reducing atmosphere lead to reduction of metal dopants and the formation of strongly anchored nanoparticles. Upon oxidation, the exsolved metal nanoparticles dissolve back into the perovskite lattice as dopant. The nanoparticles are then self-regenerated during a second reduction step.
We will show that by nanostructuring the parental perovskite oxide we significantly improve the exsolution kinetics and thereby achieve better control of size and distribution of Ni and bimetallic Fe-Ni nanoparticles. The combination of embedded Ni nanoparticles within mesoporous perovskite supports lead to improved CO_2 conversion to methane with respect to non-porous and commercial catalysts. Also, bimetallic Fe-Ni nanoparticles of decreasing size showed improved propene selectivity in the CO_2-mediated propane dehydrogenation reaction.