Development of adsorbent materials (catalyst support) for CO_2 capture and conversion.

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Over the last two centuries, world energy demand has increased dramatically as a result of population growth and industrialization [1]. Today, nearly 80% of these needs are met through carbon-containing fossil fuels that increase CO_2 emissions.

Human-made CO_2 emissions should be limited to reach the ambitious targets set by the Paris Agreement and the EU's 2030 Climate and Energy Framework. Carbon capture and storage (CCS), for example by adsorption onto basic solid materials or injection of CO_2 in undersee caves, have been and are going to be used to palliate CO_2 emissions from large-scale industrial processes. While CCS technologies have the potential to reduce CO2 emissions from conventional generating stations by 80 90%, their cost-effectiveness is limited by the necessity of transporting compressed CO_2 gas and storing it in geological formations. An alternative strategy to CO_2 storage is the “carbon capture and utilization” (CCU) process, in which CO_2 is utilized as a raw material and catalytically converted into hydrocarbons, such as methane and methanol [2]. Recently, an integrated CO_2 capture and utilization (ICCU) process, by which CO_2 is first captured and then catalytically hydrogenated into a chemicals or fuel in a single fixed bed reactor under isothermal conditions, has aroused considerable interest [3,4]. In both processes, the development of new solid materials (or catalyst supports) capable of adsorbing and releasing CO_2 at relatively high temperature is crucial. Several technical challenges related to the low adsorption capacity and the poor durability after multiple sorption/desorption cycles, remain to overcome.

In this project, CO_2 adsorbents as clay materials, modified hydrotalcites, mixed oxides, and MgO/BaO- containing composites, will be prepared and fully characterized. Studies on the CO_2 adsorption, in terms of capacity and strength of interaction, on the different materials will be also performed to select the samples capable to store CO_2 and then release it for feeding the hydrogenation reaction at the target temperature. Deep investigations by XPS and thermal analysis will be performed to identify the type and strength of the adsorption sites, and the CO_2 adsorption/desorption capacity at high temperature (>250 °C).

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