“Airborne” preparation of nanostructured, hybrid and chemo-enzymatic heterogeneous catalysts

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The technical features of aerosol processes make them highly interesting for the continuous, large scale, and tailored production of divided nanomaterials, and in particular of heterogeneous catalysts.[1] In addition to the “simple” aggregation of preformed particles via spray drying, advanced reactive aerosol processes – such as the “aerosol-assisted sol-gel” process (AASG) – allow synthesizing tailored-made catalysts with tunable surface properties, textures, compositions, etc.[2] The method is based on the sol-gel chemistry process, often coupled with the evaporation-induced self-assembly (EISA) concept. It allows producing micronic or submicronic, inorganic or hybrid organic-inorganic particles bearing tunable and calibrated porous structures at different scales.

Here, we present an overview of different types of nanostructured heterogeneous catalysts and we explain why this peculiar mode of preparation has allowed reaching enhanced performance in various applications including olefin metathesis,[3] ethyl lactate synthesis,[4] olefin epoxidation,[5] (trans)-esterification,[6] CO_2 methanation.[7] We also describe the one-step synthesis of surface functionalized hybrid catalysts, active for example in the upgrading of glycerol to solketal.[8] Finally, we turn to hybrid chemo-enzymatic heteroegenous catalysts (HCEHC), demonstrating the successful combination of a nano-zeolite and an enzyme to run chemo-enzymatic cascade reactions.[9]

Our objective is to demonstrate the tremendous possibilities offered by the coupling between bottom up synthesis routes and aerosol processing technologies which will arguably represent a major route of innovation in the mushrooming field of catalyst preparation research.

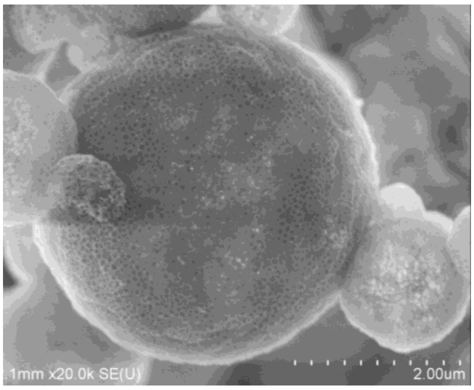

Fig.1 TEM micrograph of a hierarchically porous Ti-SiO_2 catalyst particle prepared by the aerosol-assisted sol-gel process and exploited in olefin epoxidation.[5]

Key words: sol-gel, spray drying, hierarchically porous, biocatalysis, hybrid catalysts

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