Design of Heterogeneous Catalyst through Aerosol Processing

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 advanced heterogeneous catalysts.[1] In addition to the “simple” aggregation of preformed particles via spray drying, 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 tuneable and calibrated porous structures at different scales.[3]

Here, we present an overview of different types of aerosol-processed heterogeneous catalysts and we explain why this peculiar mode of preparation has allowed reaching enhanced performance, with a strong focus on green chemistry applications: lactate synthesis from glycerol,[4] CO2 hydrogenation,[5] (trans)-esterification of bio-based alcohols.[6] We will also demonstrate the concept of bi-functional hybrid catalyst, combining a nano-zeolite and an enzyme to run a chemo-enzymatic cascade reaction.[7] Our objective is to demonstrate the tremendous possibilities offered by the coupling between bottom up synthesis routes and these aerosol processing technologies which will arguably represent a major route of innovation in the mushrooming field of catalyst preparation research.

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

BIOGRAPHY

Damien P. Debecker is a Professor at the Faculty of Bio-Science Engineering of the University of Louvain (UCLouvain, Belgium), where he teaches physical chemistry, process engineering, and principles of biorefining. He received his PhD in heterogeneous catalysis at UCLouvain in 2010, under a fellowship from the FNRS (supervised by Prof. Eric M. Gaigneaux). As a post-doctoral researcher he worked in the fields of materials chemistry in France (with Prof. Clément Sanchez, Sorbonne Université, Collège de France) and biocatalysis in the UK (with Prof. Nicholas J. Turner, University of Manchester). In 2012, he settled at UCLouvain as an Associate Professor, where he started his own research group, part of the Institute of Condensed Matter and Nanosciences. He was appointed Professor in 2019. His research focuses on the development of innovative preparation routes to efficient heterogeneous catalysts and biocatalysts, targeting applications in green and sustainable chemical processes. He is currently the holder of the Francqui Research Professor chair and he has recently received the “Young Researcher Award” 2020 from the Catalysis Division of the French Chemical Society.

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