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Editorial

Structured Supports and Catalysts: Design, Preparation, and Applications

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In the field of industrial chemistry, catalysts play a fundamental role in determining the ability of chemical production processes to reach and improve productivity targets. In addition to the chemical composition, several factors can represent critical parameters in determining the performance of catalysts, including the geometric shape and thermal conductivity of the constituent materials [1]. The use of structured supports, on which active phases are deposited to obtain structured catalysts, enables the management of transport phenomena, optimizing the thermal profiles and the mass transfer [2]. The design of structured catalysts is directly related to the process in which they are to be used; when choosing the structure, the operating temperatures and pressure, the flow regime, and the thermal conductivity of the material must be considered [3]. Similarly, the choice of the catalytic coating to be applied onto the structure depends on chemical reactions of the process, just as the deposition technique depends on the characteristics of the surface of the structure.

The most commonly used structures in catalysis are open cell foams and honeycomb monoliths. The foams are characterized by a three-dimensional array of empty polygons, and can be classified according to porosity and relative density [4]; both metallic and ceramic are available, and can be obtained by replication [5] or bubble generation methods [6]. The honeycomb monoliths are characterized by channels, which can have different geometries and can be of two types: flow-through, in which every channel is open on both sides; or wall-flow, in which the channels are alternatively closed, and the stream is forced to flow through the porous walls. The most commonly used preparation technique is extrusion; however, the rolling and piling of crimped foils has also been proposed [7]. The recent developments in additive manufacturing techniques have greatly expanded the opportunities. Due to 3D printing, monolithic honeycomb and foam structures can be easily obtained; in addition, mixed structures can be easily created, the geometry of which can be established according to the process needs [8].

Among the deposition techniques of the active phases, washcoating is widely used [9]; however, in the case of high-density porous structures, the risk of occlusion suggests the use of alternative techniques [10]. In the latter case, in addition to the classic impregnation, modified-chemical conversion coating [10], electrodeposition [11], chemical vapor deposition [12], and atomic layer deposition [13] can be used.

Structured catalysts find applications in several processes; the thermal profiles of exothermic and endothermic catalytic reaction beds can be easily optimized with conductive structures, achieving benefits both on conversions and on the process energy demand [14,15]. The integration between structure and heating can be easily realized in structured heating elements, to eliminate the resistance to heat transfer [16]. In the context of process electrification, SiC material appears to be the best choice for designing structures that can operate at currents and voltages and be used safely [17]; moreover, the microwave susceptibility of SiC makes it an ideal candidate for the design of microwave-assisted catalyzed processes [18]. The replacement of the traditional external heat source with induced heating inside the catalyst is an extremely attractive topic; the intensification of

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the processes is therefore achieved through the strong reduction in reactor volume, and the use of electricity as a "green" energy carrier.

The use of additive techniques and the integration of heating with structures can revolutionize catalyzed production processes and have a tremendous positive environmental impact. Additionally, future research should point in this direction. However, some paradigms must be changed, the catalyst design must be "on demand", calibrated to the process needs, optimized structured geometries and new conductive materials must be implemented, new active phase deposition techniques must be developed, and in some cases, the production plants will have to be redesigned. Significant investments are needed, both in the economy and research; this Special Issue aims to provide an overview of the state of the art and propose future developments in the realization of structured supports and catalytic coatings for the structured catalysts production, for environmental applications and in production processes.

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