

## Hierarchical zeolites by *top-down* and *bottom-up* approaches for a variety of applications

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Hierarchical zeolites, which exhibit a distinctive structure characterized by interconnected micropores and mesopores, are versatile materials that can overcome the typical issues related to microporous materials, including poor mass transfer, hindered diffusion, and strict selectivity of resulting products (Fig. 1). Typically, hierarchical porous materials can be obtained through *bottom-up* or *top-down* approaches. The former introduces dual porosity during synthesis, while the latter employs a post-synthetic step on a pre-existing microporous matrix.<sup>[1,2]</sup>

In this contribution, both approaches were applied to synthesize hierarchical porous materials with different properties. In detail: two commercial zeolites, HZSM-5 and Y (both with  $\text{SiO}_2/\text{Al}_2\text{O}_3 = 80$ ) with a MFI and FAU structure respectively, and a natural clinoptilolite (HEU) were desilicated through a *top-down* approach using NaOH solutions at varying concentrations, to evaluate the treatment efficiency. In parallel, two different hierarchical SAPO-34 (CHA) were obtained through a *bottom-up* approach, using either non calcined MCM-41 or SBA-15, which serve as both Si source and mesoporegen. The synthesized hierarchical architectures were characterized by multi-technique approach using XRD,  $\text{N}_2$  physisorption at 77K, TGA and FTIR spectroscopy of adsorbed probe molecules, to assess the nature, strength and accessibility of the acid sites.

The generated hierarchical zeolites hold potential applications in various fields, such as heterogeneous catalysis and as adsorbents toward cationic species in solution (i.e. metal ions), either individually or in combination, depending on the quantity of captured metal and its coordination state.

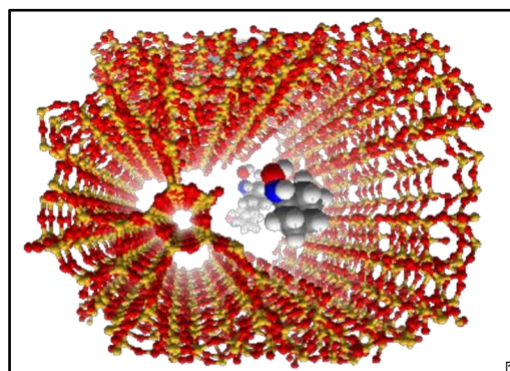


Figure 1: Graphical representation of a hierarchical zeolite.

[1] M. Hartmann, *Angew. Chem. Int. Ed.* **2004**, *43*, 5880–5882.

[2] S. Mitchell, B. Pinar, J. Kenvin, P. Crivelli, J. Kärger, J. Pérez-Ramírez, *Nat. Commun.* **2015**, *6*, 8633-8647.

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