Designing Next-Generation Zeolite Catalysts: Recent Advancements and Challenges

Jeffrey D. Rimer

Abraham E. Dukler Endowed Chair and Professor of Chemical Engineering
University of Houston, Department of Chemical and Biomolecular Engineering,
4726 Calhoun Road, Houston, TX 77004

The diverse network of confined pores in zeolites have been widely used for shape-selective catalysis in the (petro)chemical industry. A common objective of zeolite catalyst design is to overcome the inherent mass transport limitations of nanopores; however, the complex pathways of zeolite crystallization make it difficult to control their physicochemical properties.[1-2] With increasing demands on catalyst performance for a broad range of commercial applications, the ability to tailor zeolite crystal size, morphology, and composition in ways that collectively reduce diffusion limitations is a design objective where realization is often hindered by synthesis challenges. This talk will highlight recent advancements in the design of zeolite catalysts with superior performance compared to those obtained by conventional synthesis routes. Topics will include new methods to generate 2-dimensional (single layer) zeolites with high external surface area[3], catalysts with controlled acid siting (e.g. zoned and coreshell zeolites), hierarchical materials (e.g. self-pillared pentasils)[4], and a new class of catalysts referred to as finned zeolites.[5] Discussion and examples will emphasize novel synthesis methods, structure-performance relationships, and current materials gaps in catalyst design and preparation.

References

1. Choudhary, M. K.; Jain, R.; Rimer, J. D., In situ imaging of two-dimensional surface growth reveals the prevalence and role of defects in zeolite crystallization. *Proc. Natl. Acad. Sci. U. S. A.* **2020,** *117* (46), 28632-28639.
2. Lupulescu, A. I.; Rimer, J. D., In Situ Imaging of Silicalite-1 Surface Growth Reveals the Mechanism of Crystallization. *Science* **2014,** *344* (6185), 729-732.
3. Zhou, Y. W.; Mu, Y. Y.; Hsieh, M. F.; Kabius, B.; Pacheco, C.; Bator, C.; Rioux, R. M.; Rimer, J. D., Enhanced Surface Activity of MWW Zeolite Nanosheets Prepared via a One-Step Synthesis. *J. Am. Chem. Soc.* **2020,** *142* (18), 8211-8222.
4. Jain, R.; Chawla, A.; Linares, N.; Martinez, J. G.; Rimer, J. D., Spontaneous Pillaring of Pentasil Zeolites. *Adv. Mater.* **2021,** *33* (22), 2100897.
5. Dai, H.; Shen, Y. F.; Yang, T. M.; Lee, C. S.; Fu, D. L.; Agarwal, A.; Le, T. T.; Tsapatsis, M.; Palmer, J. C.; Weckhuysen, B. M.; Dauenhauer, P. J.; Zou, X. D.; Rimer, J. D., Finned zeolite catalysts. *Nat. Mater.* **2020,** *19* (10), 1074-+.