About the art to prepare mixed SAPO-CHA/MFI catalyst materials for methanol-to-olefins reaction

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Abstract

Since the turn of the millennium, efforts to use alternative, regenerative hydrocarbon sources for the supply of basic chemicals have led to an increasing commercialization of the "methanol-to-olefins" (MTO) process. Current research efforts are mostly using established systems, with catalyst stability and olefin selectivity in particular needing to be optimized. Industrially, the SAPO materials with CHA structure (SAPO-34) and aluminosilicates with MFI structure (ZSM-5) have grown to high performing driving horses. Depending on the active site density, the higher selectivity of SAPO-34 is attributed, among other things, to generally milder acid centers due to framework phosphates. The long-term stability of ZSM-5 is attributed to reduced transport limitation despite harsher acid centers.
An MTO catalyst material must therefore combine the pore structure of ZSM-5 with the mild acid centers of SAPO-34, whereby the charge balance of framework phosphates, silicates and aluminates plays a major role in determining the structural stability.
The present study compares the synthetic aspects and catalytic performance trends in MTO reaction of different mixed-phase SAPO-CHA/MFI materials from (a) separate hydrothermal crystallization and grinding, (b) one-pot and stepwise hydrothermal synthesis and (c) combination by spray crystallization. The results reveal the interfaces between both structures and contact points are crucial from viewpoint of material crystallization, but also as metastable sites modifying selectivity and catalyst stability in MTO process.

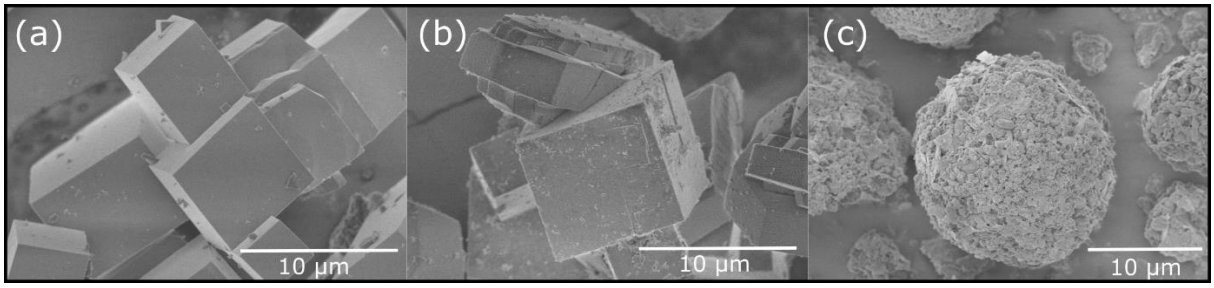

Figure: SEM images of synthesized materials with different crystallization methods as described above from (a) separate crystallization to (b) one-pot crystallization and stepwise synthesis until (c) spray crystallization.

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