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Amine functionalized AFI type microporous SAPO-5 materials: preparation, unique method on template extraction, characterization and its catalytic application on epoxide ring opening

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Abstract
Microporous AFI type silicoaluminophosphate (SAPO-5) having aminosilane functionality in the framework was prepared by in-situ (direct co-condensation) approach under hydrothermal conditions. The template (structure directing agent) presents within the channels of synthesized aminosilane modified SAPO-5 framework was selectively removed by a unique method using acidic ethanol extraction. Before and after the template extraction, presence of AFI type phase of SAPO-5 was confirmed through powder XRD pattern. The complete removal of template from the channels of framework was confirmed through FT-IR, ^{13}C MAS NMR and N_2 sorption studies. The covalent bonding of aminosilane functionality within the organic–inorganic hybrid SAPO-5 framework was evident through ^{29}Si MAS NMR and ^{13}C MAS NMR studies. The final material was utilized for selective synthesis of 1-phenoxy-2-propanol (99%) via propylene oxide ring opening with phenol under solvent free conditions in liquid phase medium.

Keywords In situ synthesis · Template extraction · SAPO-5 material and phenoxylation of propylene oxide

1 Introduction

Introduction of organosilane functionalities into inorganic framework molecules gains much attention due to its eminent applications in catalysis, grafting of various homogeneous complexes, CO_2 and metal ion capture [1–9]. Microporous zeolites type sieve materials viz. zeolite-Y, AlPOs, SAPOs with different topology are well known as potential catalysts in various fine and petrochemical processes [10, 11]. Functionalization of such material with organic functionalities facilitates to create hydrophobicity and leads to organic–inorganic hybrid materials [12, 13]. AlPO-5 type materials with AFI topology possess unidimensional channels system with 12 membered ring opening having excellent framework flexibility and shown promising catalysis for fine chemicals [14–16]. AFI type silicoaluminophosphates (SAPO-5) with large pore opening (0.73 nm) are analogous to AlPO-5 show good framework flexibility for different isomorphic substitutions [14]. The mild acidity and unidimensional pore opening of SAPO-5 favors potential catalyst for fine chemical production. It will be interesting to introduce the organosilane with specific active sites ($–NH_2$, $–NH_2(CH_2)_2NH_2$, etc.) into the inorganic framework channels of microporous AFI type SAPO-5 material via in situ approach. The presence of organo functionalities enhances the hydrophobic environment and broadens the scope of catalytic behavior in diverse fields depending upon the choice of the organo functionality introduced into the framework. However the major challenges in functionalized microporous framework materials is the selective removal of template without effecting organic functional groups and framework structure. Thus the present study focused on in situ preparation of aminosilane functionalized SAPO-5 material with different

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