

# In Situ Preparation, Characterization, and Catalytic Application of Various Amine Functionalized Microporous SAPO-37

Maqsood Ahmed<sup>1</sup>, Rekha Yadav<sup>1</sup>, and Ayyamperumal Sakthivel<sup>1,2,\*</sup>

<sup>1</sup>Department of Chemistry, Inorganic Materials and Catalysis Laboratory, University of Delhi (North Campus) Delhi 110007, India

<sup>2</sup>Central University of Kerala, Reverside Transit Campus Padnekkad, Nilesishwar, Kasaragod District 671314, Kerala, India

A series of monoamine, diamine, and aniline functionalized microporous silicoaluminophosphate molecular sieves (SAPO-37) was prepared by introduction of organo-silane ligand during hydrothermal synthesis. The template was selectively removed by the solvent extraction method in the presence of sodium nitrate salt. The effective removal of the template was evident from FT-IR, and <sup>13</sup>C MAS-NMR studies. The retention of high crystallinity was evident from the powder XRD pattern of the template-removed functionalized SAPO-37 materials. The functionalized materials showed a high surface area in the range of 200–300 m<sup>2</sup>g<sup>-1</sup> with a pore volume of 0.2–0.4 cm<sup>3</sup>g<sup>-1</sup>. The functionalized SAPO-37 was found to be a potential catalyst for epoxide ring opening with aniline.

**Keywords:** Amine-Functionalization, SAPO-37, Microporous Materials, Epoxide Ring Opening.

Copyright: American Scientific Publishers  
Delivered by Ingenta

## 1. INTRODUCTION

Zeolites and zeolite-like molecular sieves are emerging materials for various catalytic and adsorption processes in the petroleum and petrochemical industries.<sup>1–3</sup> In particular, faujasite (FAU)-type zeolite, viz., zeolite-Y having a 3D channel system with a 12-membered pore opening, is known as a potential catalyst in fluid catalytic cracking (FCC) and crude oil industry.<sup>4</sup> Microporous silicoaluminophosphate SAPO-37 is analogous to the faujasite-type zeolite-Y structure, but it has been explored relatively less compared to zeolite-Y owing to its poor structural stability in the presence of moisture.<sup>5–7</sup> In this regard, surface functionalization of these materials with different organosilanes might facilitate the generation of a hydrophobic environment and may also potential catalyst and adsorbents. The introduction of organosilane into mesoporous silica based molecular sieves has been widely investigated.<sup>8–15</sup> Generally the surface functionalization of molecular sieves can be achieved through two different approaches: either the post-synthesis grafting method (*ex-situ* synthesis) or the direct co-condensation method (*in situ* synthesis).<sup>16–18</sup> The post-synthesis grafting method has been extensively utilized for mesoporous

materials and further, the functionalized mesoporous materials have been explored for various applications such as metal ion capture,<sup>8</sup> CO<sub>2</sub> capture,<sup>19–21</sup> and base-catalyzed organic transformations.<sup>22–29</sup> However, there are only limited reports on the surface functionalization of microporous molecular sieve materials.<sup>17–22</sup> Incorporation of organosilane into the framework of faujasite-type silicoaluminophosphate (SAPO-37) via a direct co-condensation method can enhance its surface hydrophobicity, which may also help to improve its structural stability and catalytic activities. It is worth mentioning here that in comparison to post-synthesis functionalization, the direct co-condensation method or *in situ* synthesis involves the uniform distribution of organosilane moiety in the channels of framework surfaces.<sup>8,29</sup> These organosilane moieties can be covalently connected to the framework tetrahedral sites T (T = Si, P, or Al) through an Si–O–T bond. Herein we report the preparation of a series of organosilanes viz. (3-aminopropyl)triethoxysilane, *N*-[3-(triethoxysilyl)propyl]ethylenediamine, and *N*-[3-(trimethoxysilyl)propyl]aniline containing faujasite-type SAPO-37 molecular sieves by the co-condensation method. The templates present in the as-prepared materials were efficiently removed through the solvent extraction method using ethanolic sodium nitrate solution. Unlike

\*Author to whom correspondence should be addressed.