ISSN 2815-0260
Proceedings of the Young Scientists' Conference on Multidisciplinary Research-2024
Young Scientists' Association, National Institute of Fundamental Studies, Sri Lanka
27th November, 2024

Paper ID: CMT-185

Synthesis and structure elucidation of boron-incorporated ZSM-5 zeolites using TEABr as a structure-directing agent

M.M.A.K. Mannapperuma[1], W.M.A.T. Bandara[1], L. Jayarathna[2*]

[1]*Department of Chemistry, Faculty of Science, University of Peradeniya, Peradeniya, Sri Lanka*
[2]*National Institute of Fundamental Studies, Kandy, Sri Lanka*

[*]*lakmal.ja@nifs.ac.lk*

Advancements in the porous structure and framework composition of ZSM-5 zeolites have gained substantial performance benefits for numerous industrial processes. This study investigates the influence of boron incorporation on the structural properties, crystallinity, and morphology of ZSM-5 zeolites, aiming to elucidate its impact on the overall performance of the material in industrial applications. The adjustability of framework composition can be achieved by the isomorphous substitution of heteroatoms into the zeolite structure. In this study, boro-alumino ZSM-5 zeolites were successfully synthesized by varying the Al: B ratio with a molar composition of 1 SiO_2: 0.0088 Al_2O_3: 0.255 Na_2O: 0.256 TEABr: 182 H_2O, at 453 K. Structure elucidation was carried out using advanced characterization techniques such as XRD, SEM, FTIR spectroscopy, and Raman spectroscopy. The XRD peak pattern and characteristic FT-IR inter-tetrahedral vibration of a five-membered ring at 540 cm^{-1} confirms the formation of ZSM-5 zeolites. SEM images emphasize the formation of ZSM-5 crystals with cuboidal morphology under the influence of TEABr. The presence of FTIR bands at 900 cm^{-1} and 1212 cm^{-1}, attributed to BO_3 and O-Si-O-B vibrations, respectively, in conjunction with a Raman shift at 1493 cm^{-1} corresponding to the Si-O-B bond, confirms the successful incorporation of boron into the aluminosilicate matrix. An increase in boron proportion is accompanied by a reduction in the intensity of the band at 1371 cm^{-1}, suggesting a distortion of the O-Al-O linkage. SEM and XRD analysis revealed that boron introduction does not alter the zeotype, however, it can impact the overall crystallinity of the synthesized material, in which excessive incorporation of boron disrupts the aluminosilicate framework, inhibiting the nucleation and growth of crystalline phases. These findings provide insights into the delicate balance between boron incorporation and preserving the structural integrity of ZSM-5 zeolites for potential applications.

Keywords: *Aluminosilicate, composition, inter-tetrahedral vibration, isomorphous substitution, morphology*