

Protonation of Al-Grafted Mesoporous Silica Nanoparticles (MSN): Acidity and Catalytic Activity for Cumene Conversion

M.R. Sazegar^a, A.A. Jalil^b, S. Triwahyono^{a, c}, R.R. Mukti^d, M. Aziz^a, M.A.A. Aziz^b, H.D. Setiabudi^e, N.H.N. Kamarudin^b

^aDepartment of Chemistry, Faculty of Science, Universiti Teknologi Malaysia, 81310 UTM Johor Bahru, Johor, Malaysia

^bInstitute Hydrogen Economy, Department of Chemical Eng., Faculty of Chemical Eng., Universiti Teknologi Malaysia, 81310 UTM Johor Bahru, Johor, Malaysia

^cIbnu Sina Institute for Fundamental Science Studies, Universiti Teknologi Malaysia, 81310 UTM Johor Bahru, Johor, Malaysia

^dDivision of Inorganic and Physical Chemistry, Fac. of Mathematics and Natural Sciences, Institut Teknologi Bandung, Jl Ganesha No 10, Bandung 40132, Indonesia

^eFaculty of Chemical and Natural Resources Engineering, Universiti Malaysia Pahang, 26300 Gambang, Kuantan, Pahang, Malaysia

ABSTRACT

The hexagonal structure of the mesoporous silica nanoparticles (MSN) based solid acid catalyst was synthesized using 1,2-propanediol as a co-solvent by sol-gel method, followed by aluminum grafting and protonation. The activity of the catalysts was tested for cumene conversion in a pulse microcatalytic reactor at 323–573 K. XRD, TEM and N₂ physisorption results confirmed the hexagonal ordered structure with a pore diameter of 3.4–4.0 nm, a particle size of 70–120 nm and a surface area of 588–995 m²/g. Solid state NMR and IR results confirmed that the aluminum grafting and protonation form framework and extra-framework aluminums which led to generating strong Brønsted and Lewis acidic sites. High activity in the cumene conversion was only observed on HAIMSN producing propylene, benzene, toluene via a cracking on protonic acid sites and producing a main product of α -methylstyrene via a dehydrogenation on Lewis acidic sites at high reaction temperature. While only α -methylstyrene and higher hydrocarbon ($\geq C_{10}$) were produced at low reaction temperature showing the permanent Brønsted acid sites did not involve in the cumene conversion. It is suggested that the presence of hydrogen and strong Lewis acid sites increased the stability and activity of the HAIMSN catalyst in the cumene conversion. Although the small deactivation of HAIMSN was observed during the reaction due to the formation of small coke deposits on the surface, the reactivation recovered the activity of catalyst and the high activity was still observed after 60 h of reaction. The high stability and activity of HAIMSN in the cumene conversion can be considered as a method for the production of α -methylstyrene via a dehydrogenation process.

KEYWORDS: MSN; HAIMSN; Cumene; Dehydrogenation; α -Methylstyrene

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