

Highly Active Aluminosilicates with a Hierarchical Porous Structure for Acetalization of 3,4-dimethoxybenzaldehyde

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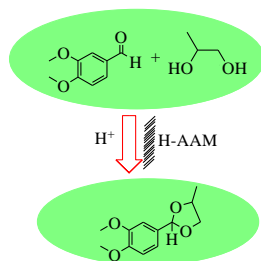
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Graphical abstract



Abstract

We report the synthesis of highly active mesoporous aluminosilicate for the acetalization of 3,4-dimethoxybenzaldehyde with propylene glycol. The existing synthesis methods for aluminosilicate and ZSM-5 were modified to produce aluminosilicate material with hierarchical porous structure. A combination of two structure directing agents, tetrapropylammonium hydroxide (TPAOH) and cetyltrimethylammonium bromide (CTAB), produced a highly active aluminosilicate framework that provides a wide access for bulky reactants and strong acid sites to catalyse the reaction. The pore structure and the strength of the acid sites were crucial for high conversion of 3,4-dimethoxybenzaldehyde.

Keywords: Hierarchical porous aluminosilicate; acetalization; 3,4-dimethoxybenzaldehyde

Abstrak

Kami melaporkan hasil sintesis aluminosilikat mesopori dengan aktiviti tinggi untuk asetalisasi 3,4-dimetoksi benzaldehida dengan propilena glikol. Kaedah sintesis aluminosilikat dan ZSM-5 yang telah sedia ada dimodifikasi sehingga menghasilkan material aluminosilikat dengan struktur liang hierarki. Kombinasi kedua-dua sebatian pengarah struktur, iaitu tetrapropilamonium hidroksida (TPAOH) dan setiltrimetilamonium bromida (CTAB), telah menghasilkan kerangka aluminosilikat dengan aktiviti tinggi kerana memberikan kemudahan akses bagi reaktan bermolekul besar dan tapak asid yang kuat sebagai mangkin tindak balas. Struktur liang dan tapak asid yang kuat merupakan faktor yang penting untuk menghasilkan konversi yang tinggi dari 3,4-dimetoksi benzaldehida.

Kata kunci: Aluminosilikat berliang hierarki; asetalisasi; 3,4-dimetoksibenzaldehida

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1.0 INTRODUCTION

Acetalization reaction between aldehyde and alcohol is an important process in industry and has been widely used to produce active additives in fragrances. The unique chemical structure in acetal compound plays an important role as protecting agent in organic synthesis [1]. The industrial needs of acetal compound, especially to be used as additive in fragrances, has prompted this study to find alternative ways for designing a simpler synthesis approach and environmentally friendly catalysts [2].

Currently, acetal compound is produced largely from glycol/diol [1-4]; propylene glycol [1,5]; glycerol/triol [1,3,6,10,11]; methanol [7-9,12]; 2-ethyl hexanol [13]; and

pentaerythritol [14] by using protic acid catalysts such as hydrochloric acid, sulfuric acid, and *p*-toluenesulfonic acid (PTSA) [15]. Although the activity of the catalysts is significantly higher, it still suffers from the common problems caused by homogeneous catalysts such as a tedious process for product purification and a large amount of acidic waste that can cause severe environmental pollutions including corrosion to chemical plants [1]. Zeolites [1,16] and molecular sieves [6,7] have been identified as a potential heterogeneous acid catalysts for such reaction. Aluminosilicate material was explored as active catalyst to drive the reaction where researches have been focused only on porous aluminosilicate catalysts [16]. However, the lack of interest in amorphous materials has prompted this study to explore the real potential of this material. We modified