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研究论文

磺酸基团功能化的碳-硅介孔复合材料的制备及其在生物柴油绿色合成中的应用

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摘要 利用化学浸渍法将蔗糖负载到 SBA-15 介孔材料孔道内部, 高温炭化形成的多聚苯环经发烟硫酸气相磺化处理后, 得到磺酸基团功能化的新型碳-硅介孔复合材料. 发烟硫酸气相磺化处理是该材料合成的关键步骤. X 射线衍射、扫描电镜和氮气吸附结果表明, 碳-硅介孔复合材料经磺酸化处理保持了高度有序的介孔结构. 热重、傅里叶变换的红外光谱及吡啶吸附红外光谱结果证明, 磺酸功能基团成功的嫁接于碳-硅介孔复合材料孔道的内表面, 反应活性中心为 Brønsted 酸, 酸密度在 0.09~0.70 mmol/g 可以有效调变. 当碳负载量为 35% 时, 该复合材料在生物柴油的绿色合成中显示出最优的催化性能, 且可重复使用 3 次以上.

关键词: 固体酸 碳材料 磺酸功能基 生物柴油 介孔材料

Abstract: A carbon-mesoporous silica (CS) composite functionalized with sulfonic acid ($^{-}SO_3H$) groups was prepared by controlled carbonization of sucrose impregnated in SBA-15 mesoporous silica and its subsequent sulfonation. The moderate vapor phase sulfonation of the CS composite with fuming sulfuric acid (H_2SO_4?20%SO_3) was the key step in preparing the strong acid solid material (CS-SO_3H). Structural analysis and reaction data revealed that sulfonic acid groups were successfully incorporated into the mesoporous CS composite, and the Brønsted acid site density was tunable from 0.09 to 0.70 mmol/g by tuning the carbon loading. The sample with 35 wt% carbon exhibited a remarkable catalytic activity for biodiesel production by the esterification of palmitic acid and the transesterification of soybean oil with methanol.

Keywords: Solid acid, carbon, sulfonic acid group, biodiesel, mesoporous materials

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