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SYNTHESIS OF MESOPOROUS ALUMINA FROM RED MUD

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Abstract

Mesoporous Al_2O_3 has been successfully synthesized by using calcined red mud as raw material and cetyltrimethylammonium bromide (CTAB) as template at room temperature. The effect of CTAB ratio on the structural and textural properties of mesoporous Al_2O_3 was investigated. In this study, Al_2O_3 from red mud was separated by centrifugation, dissolving and precipitation methods. Firstly, HCl 6N solution was added to separate SiO_2. Subsequently, other impurities was separated by addition of NaOH 5N solution. Physical properties of obtained samples were characterized by X-ray diffraction (XRD), N_2 adsorption-desorption, transmission electron microscopy (TEM), scanning electron microscopy (SEM) with energy-dispersive X-ray analysis (EDAX). The results indicated that red mud has a great potential as mesoporous alumina. XRF result of red mud from Bintan Kepulauan Riau shown that it most contains of Al_2O_3 29 wt%, Fe_2O_3 44.86 wt%, and SiO_2 20.3 wt%. XRD results confirmed that mesoporous Al_2O_3 was obtained after calcined samples at 550 °C. BET results indicated that all samples had mesoporous structures with BET surface area of 241 m^2/g and pore size of 3.820 nm. In addition, the reaction mechanism involved in the process was proposed and discussed.

Key words: Mesoporous alumina, red mud, CTAB

INTRODUCTION

Red mud is a residue or waste material derived from the processing of bauxite to alumina production. Globally, there are about 70 million tons of red mud are worldwide produced annually. Averagely, 0.3–2.5 tons of red mud maybe generated after producing 1 ton of alumina depending on the grade of ore used [1]. For solid waste, red mud will be found in the form of wet or dry mud which is collected in a pond. The magnitude of waste generated by industry clearly demonstrates the need for future developments that find a beneficial use for this material.

Red mud is comprised of iron oxides, titanium oxides, silicon oxides and undissolved alumina, along with a wide range of other oxides depending on the country of origin [2]. Trace levels of metal oxides, such as arsenic, cadmium, chromium, copper, gallium, lead, mercury, nickel and in some cases thorium and uranium, are of particular concern [3]. Apart from heavy metal contamination, the alkalinity of red mud also constrains viable applications due to the cost of neutralization. Alkalinity in the residue exists in both solid and solution as: (1) entrained liquor (sodium hydroxide, sodium aluminate and sodium carbonate), (2) calcium compounds, such as hydrocalumite, tri-calcium aluminate and lime, and (3) sodalite ($(NaAlSiO_4)6(Na_2X)$), where X can be SO_4^{2-} , CO_3^{2-} , $Al(OH)^{4-}$ or Cl^-) [4].

The recovery of a significant quantity of valuable components from the red mud is difficult, as they are locked up in complex mineral phases which are very fine grained and quite