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Influence of the synthesis conditions on the formation of MSU-Z mesoporous material from Vietnamese kaolin and rice husk

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Abstract

In this study, MSU-Z mesoporous material was assembled from MFI zeolite seed using Vietnamese kaolin and rice husk silica low-cost precursor resoures. The effects of synthesis conditions are investigated in order to find the best conditions for the formation of hexagonal mesopore structure. The mesoporous material was synthesized applying a two-step hydrothermal synthesis procedure and characterized by small- angle-X-ray scattering (SAXS), transmission electron microscope (TEM), the nitrogen adsorption- desorption isotherms, energy dispersive X-ray (EDX), thermogravimetric analysis (TGA). The results showed that the material was obtained highly ordered hexagonal pore structure with pore size of 2.8 nm, large surface area of 945 m^2/g with pore volume 0.96 cm^3/g. The synthesis of MSU-Z material from natural resources can open new routes for sustainable and environment- friendly adsorption and catalyst fields.

Keywords: Mesoporous materials, kaolin, rice husk

1. Introduction

Mesoporous materials, which can be assembled from zeolite seeds, was first reported in 1992 (Grace Lee et al., Yue 2010). They have been extensively studied because of their outstanding characteritics such as centered pore size distribution, large surface area, hydrothermally stability, ability postsynthesis modification results in different application in fileds of catalyst, adsorption (Jie Wang et al., 2010), (Xiaoqian Chang et al., 2018), (Babak et al., 2018). However, the material is normally produced from expensive fine chemicals (Éric Prouzet et al., 2005). Therefore, the new direction of the synthesis of the materials from less toxic and less expensive substrates such as natural alumina and silica resources of kaolin and rice husk is not only economic, but also helps in protecting environmental issues.

Kaolin ore, contains the major phase of kaolinite ($Al_2Si_2O_5(OH)_4$ that is composed from alternating sheets of SiO_4 tetrahedra and Al octahedra to make the well- ordered layered crystalline structure with 6- coordinated Al and Si and composition of 39.5% Al_2O_3, 46.54% SiO_2, 13.96% water. Beside, trace amount of other oxides are Fe_2O_3, MgO, CaO, K_2O, Na_2O,... (Kasumba et al., 2022), (Giovanna, 2021). At high temprature, kaolin can be converted into an amorphous and highly reactive metakaolin (Yuan et al., 2021), (M. Irfan Khana et al., 2017). In this process, it is considered that the Al octahedra of O and OH of 6- coordinated Al and Si are transformed to a reactive geometry of 4-orcordinated Al and Si (J.M. Inocente et al., 2021). In the zeolite structures, Al and Si are

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