SYNTHESIS AND BONDING ANALYSIS OF MAGNETITE (Fe_3O_4)/SILICA (SiO2) COMPOSITE BASED ON SUGARCANE BAGASSE

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Abstract. This article reports the results synthesis of composite Fe3O4/SiO2 and nanoparticles from natural resources (sugarcane bagasse). The synthesis of Fe3O4 and SiO2 nanoparticles used co-precipitation and sol-gel methods with SiO2 from sugarcane bagasse as a template. The XRD data analysis presented that Fe_3O_4 were successfully produced using co-precipitation methods. The XRD data analysis also presented that the crystalline phases showed Fe_3O_4. FTIR spectra presented some absorption peaks of new functional groups indicating the existence of Si-O-Si (silanol), Fe-O, and Fe-O-Si as new functional groups.

Keywords. Composite, Fe_3O_4/SiO_2, sugarcane bagasse

Introduction

Waste in Bandar Lampung consists of several types, namely liquid and liquid waste. Bagasse is one of the organic wastes. Liquid waste from human daily results and from the rest of the research. Sugarcane pulp can be a promising source of silica. However, producers of bagasse waste in Bandar Lampung City do not process it and become donors of organic waste. To reduce the content of bagasse in Bandar Lampung City, silica will be carried out template of Fe_3O_4. The synthesis method of SiO_2 to be used is solgel, this method was chosen because it was efficient, efficient, and easy in several parameters in the synthesis process.

In order to increase the application performance of the Fe_3O_4/SiO_2 particles effectively, it is essential to prepare the particles using the inexpensive method from natural resources as raw materials. Based on the previous reports, various methods have been employed such as hydrolysis, microemulsions, and co-precipitation. Meanwhile, the Fe_3O_4/SiO_2 nanocomposites have been fabricated by coprecipitation method. In this work, we exploited a simple co-precipitation method at room temperature which easier to control the particle size of the samples. The main purpose of this research was the synthesis of Fe_3O_4/SiO_2 composite based on natural materials using silica as a template, and analyzing the bonding analysis.

Method

Synthesis of Fe_3O_4 by co-presipitation Method

Synthesis of Fe_3O_4 nanoparticles was done using co-precipitation method. First, $FeCl_3.6H_2O$ (ferric chloride hexa-hydrate) and $FeSO_4.7H_2O$ (ferric sulphate hexa-hydrate) were dissolved, then slowly add 60 ml of 10% NH_4OH solution into the dissolved solution and stirred using a magnetic stirrer for 90 minutes at 60 °C with a stirring speed of 450 rpm. Then Fe_3O_4 solution was washed with distilled water until the smell of NH4OH lost and the solution precipitated with the help of an external field (permanent magnet). The precipitate was dried in a furnace at a temperature of 80 °C (2 hours). Finally dried samples obtained were then coated using SiO_2.

Synthesis of Silica Sol from sugarcane bagasse

The first step in the synthesis of Fe_3O_4/SiO_2 is to get filtrate (silica sol) from bagasse waste. To get filtrate (silica sol) from bagasse waste through an extraction process. However, before carrying out the process, bagasse waste of 4 large sacks is dried first. After that the bagasse is burned until get blackish-colored ash, then bagasse ash furnace with a temperature of 550 ^oC for 4 hours so that it forms whiter ash. Ash ready to be extracted into filtrate by dissolving it as much as 6 g with 120 mL NaOH 1 M solution in a glass beaker and stirring. During the mixing process, it is necessary to warm up at 200 ^oC until boiling, then hold for 60 minutes. The process of dissolution and heating is useful for obtaining optimal extraction results. After heating the silica sol is filtered using a filter. Filtrate (silica sol) is poured into beaker glass and drops with 1 M HCl to pH 6.5 so that a lumpy solution is obtained, then an aging process is carried out for 24 hours to obtain homogeneous ($Si(OH)_4$) silica sol.

Synthesis of Fe_3O_4/SiO_2 Composite

0.6 gram Fe_3O_4 nanoparticles are mixed into 30 ml of silica sol. The solution was sterilized for 5 hours at room temperature to be mixed and there was a bond between Fe_3O_4 nanoparticles and silica. The deposition stage is carried out with an external magnetic field (permanent magnet). The precipitate formed is washed 5 times. And it drying at room temperature.

Results and Discussion

The diffraction patterns are presented in Figure 1, the figure reveals the existence of a Fe_3O_4. These peaks are by their respective crystalline indices of (220), (311), (222), (400), (422), (511), and (440) showed an inverse cubic spinel.

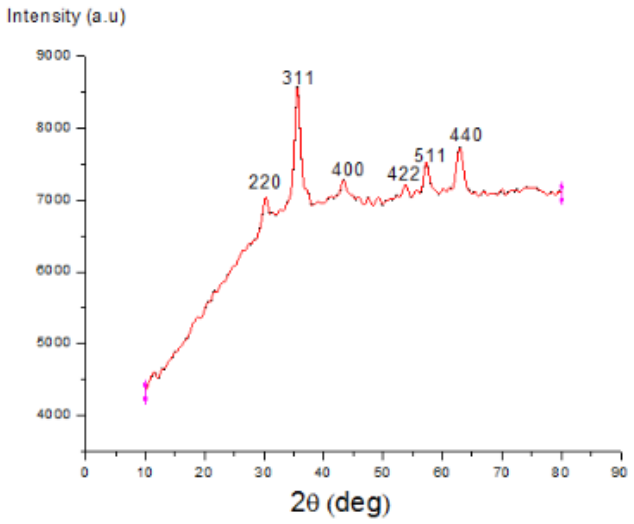

Fig 1. XRD pattern of Fe_3O_4

The absorption peaks of the synthesized Fe_3O_4/SiO_2 showed in figure 2. The analysis was done to identify the functional groups of the samples as shown in Figure 2 and as explained in Table 1. It appears a wavenumber of 586.36 cm^{-1} that confirmed a vibration on the Fe-O bond, which is a characteristic of the Fe_3O_4. Besides that, the peaks among the Fe_3O_4 and Fe_3O_4/SiO_2 composite could also be seen. On the wave number of 1058.6 and 2109.7 cm^{-1} represents the asymmetric vibration of the Si-O-Si and SiO2 bonds. The 3399.3 cm^{-1} wavenumbers show O-H (water molecule) bond stretching in SiO2. Such functional groups have similarities with the characteristics of the Fe_3O_4/ SiO_2 particles obtained from the previous research.

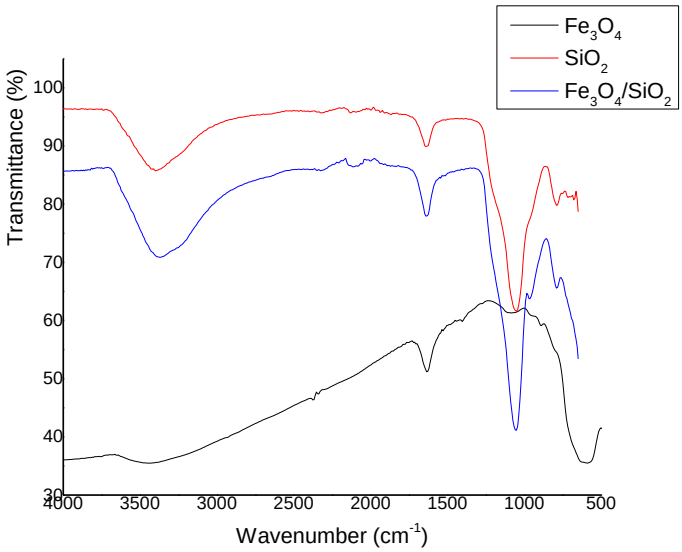

Fig 2. FTIR spectra of Fe_3O_4, SiO_2 and Fe_3O_4/SiO_2

Table 1. table of Functional group of Fe_3O_4, SiO_2 and Fe_3O_4/SiO_2

Functional Groups	Fe_3O_4	Silika	Composite	Type of Vibration
Fe-O	586,36	-	-	Streching
Si-O-Si	-	790,2	790,2	Streching Simetri
Si-O-Si	-	1058,6	1058,6	Streching Asimetri
Fe-O	-	-	1394	
M-OH	-	1640	1640	Bending
Si-O-Si	-	2132	2109,7	Streching Simetri
H-O-H	3448,72	3399,3	3369,5	Streching and Bending

Conclusion

The Fe_3O_4/SiO_2 composite have successfully prepared in crystalline, respectively. The XRD and FTIR data analysis showed that the Fe_3O_4 particles and covered by SiO2 particles. The functional groups of the samples exhibited the formation of the SiO_2 and Fe_3O_4 particles.

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Acknowledgment
The authors acknowledge Program *Hibah Penelitian Institut Teknologi Sumatera* 2018 for the support to this research work.