Synthesis and Characterization of Nano Composite BiOI-Allophane Gamalama Volcanic Soil

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***Abstract*—Nano composite BiOI-Allophane was successfully synthesized by using hydrothermal reaction method. The allophane was isolated from Gamalama volcanic soil by using Henmi method which modified in accordance with the availability of laboratory equipments. Isolated allophane was added into mixtures of 5 mmol $Bi(NO_3)_2$ and 5 mmol KI. Acidity of mixtures was maintained at pH 7 by using NH_4OH 2M. The mixtures was then put into hydrothermal reactor and heated at 180°C for 24 hours. The composite was characterized by using FTIR, XRD, SEM, and TEM. FTIR spectra shows vibrations those are characteristic of BiOI and aluminosilica. XRD difractogram, SEM and TEM were confirmed that BiOI binded in allophane framework. The size and the form of BiOI-allophane composite is heterogeneous nano-ballabout 5 nm.**

Keywords: Hydrothermal, allophane, nano-ball, volcanic soil, composite.

I. INTRODUCTION

Semiconductor material could potentially be used as photocatalysts for the decomposition of contaminants such as methylene blue. Semiconductor materials such as TiO_2, ZnO, and $SrTiO_3$ has been widely used in the development of photo-catalyst and considered as the most effective photo-catalysts (Nishikiori, et al., 2011; Wang et al., 2014). However, its application is very limited due to the large bandgap value and capabilities that can only work under UV light (Min et al., 2014). Allophane nanoparticles hadbeen composited with a variety of semiconductor materials to be applied as a photocatalyst in the degradation of pollutants or as photofuel electrode (Nisihikiori, et al., 2014; Wang et al., 2014). Nishikiori et al., (2014) succeeded in making nano-composite allophane-titania as photofuel electrodes to generate an electric current. The composite only able to be applied under UV light is the weakness of nano-titania composites allophane. This is a problem that is very interesting to be overcome in order to produce a photo-catalyst which able to work under visible light, both for application of photo-degradation of pollutants or enrichment of renewable energy sources. To overcome this, BiOI can be used as a substitute for TiO_2. The abundance of Bismuth in Indonesia is an advantage to develop photocatalystsallophane-BiOI. Oxi-bismuth iodide (BiOI) is a P-type semiconductor material with a bandgap value is between 1.7 to 1.83 eV, and has the ability to absorb visible light (λ <700 nm) (Wang et al., 2011). In this study, will be synthesized nanocomposite allophane-BiOI for use as a photo-catalyst in the process of photo-degradation of methylene blue pollutants.

II. METHOD

Some allophane which has been extracted from the volcanic soil of Mount Gamalama first put in deionized water and stirred for two hours at 180 rpm. 5 mmol$Bi(NO_3)_3$. $5H_2O$ and 5 mmol KIpreviously dissolved separately by using 15 ml of ethylene glycol and 15 ml of deionized water were mix under vigorous stirringfor 30 minutes.The acidity of the mixture is conditioned to pH 7 by using NaOH. Allophane and 30 ml of the mixture was put intohydrothermal reactor at 180°C for 24 hours. The resulting precipitate was collected by centrifugation, washed with deionized water to remove unreacted ions. The resulting solid is then dried at a temperature of 80 ° C for 2 hours.

III. RESULT AND DISCUSSION

Nano composit BiOI-Allophane was synthesised by using hydrothermal method. The resulted composite was then characterized by using FTIR, XRD, SEM, and TEM.

A. FTIR Spectroscopy

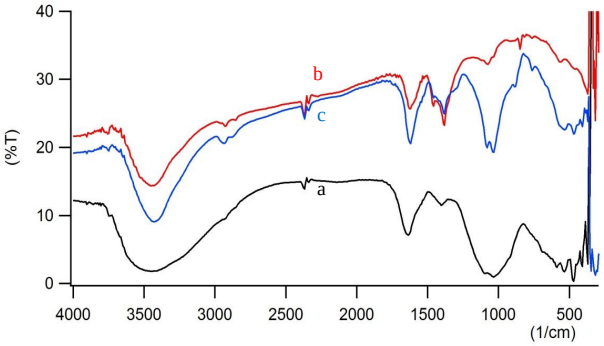

Fig.1. FTIR Spectra;(a) Allophane, (b) BiOI, (c) BiOI-Allophane

Figure 1 shows a comparison of the results of FTIR characterization of nano-composite BiOI-Allophane, BiOI, and allophane. Composite BiOI-Allophane FTIR characterization results showed several new peaks compared to the absorption peak of allophane. This indicates the form of

a new chemical species that is the bond between BiOI-allophane. In addition, some allophane absorption peaks still showed at 1033.85 and 586 cm^{-1}, respectively is absorption for the Si-O-Si and Si-O-Al in octahedral framework. Absorption peak at 1080.14 cm^{-1} may be caused by the presence of Bi-OH wich indicates the bind between BiOI and allophane. Peak at wave number 763,81 cm^{-1} is an indication of vibration IO_3^-.

B. XRD

XRD characterization results are shown in Figure 2. The composite diffraction patterns BiOI-allophane show increased crystallinity compared to the two main raw materials. This could be due to the regularity BiOI which has formed a composite with the amorphous structure of allophane. Peaks at 25.06°, 29.02°, 31.6°, and 45.94° corresponding to the crystal planes of (101), (102), (110), (200), were identified as the planes of tetragonal pahes of BiOI (JCPDS card No. 10-0445).

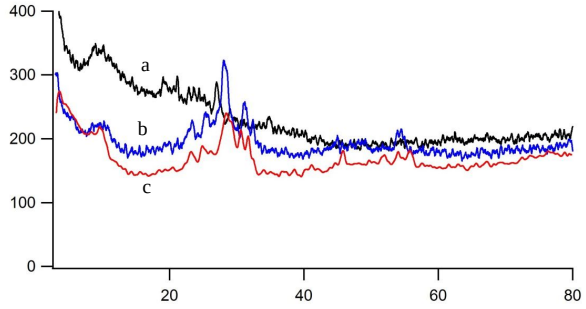

Fig.2 XRD patterns of (a)allophane, (b) BiOI-Allophane, (c) BiOI

C. TEM

TEM images of composite show in figure 3. The spread BiOI into allophane framework is uneven, this is probably due to the hydrothermal reaction process was not running optimally.

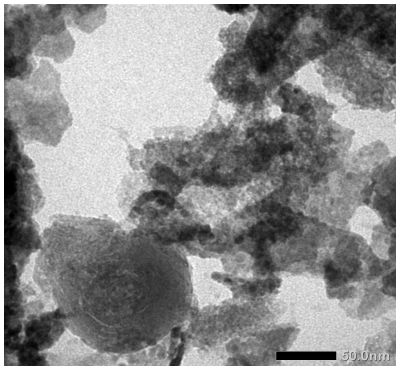

Fig.3. TEM of BiOI-Allophane

Temperature, pH, solvent and heating times are very influential on the formation of nano particles with hydrothermal method. Nano particles allophan-BiOI. TEM analysis indicates the size of nano particle allophane and BiOI about 5 nm.

D. SEM

The SEM images show that the aggregate nanoballallophane in part covered by BiOI, forming nanoBiOI. The diameter size of composite aggregates is not uniform in accordance with allophane aggregate diameter volcanic soil of Mount Gamalama. Aggregates ofBiOI-allophane composite ranges between 1µm - 3µm.

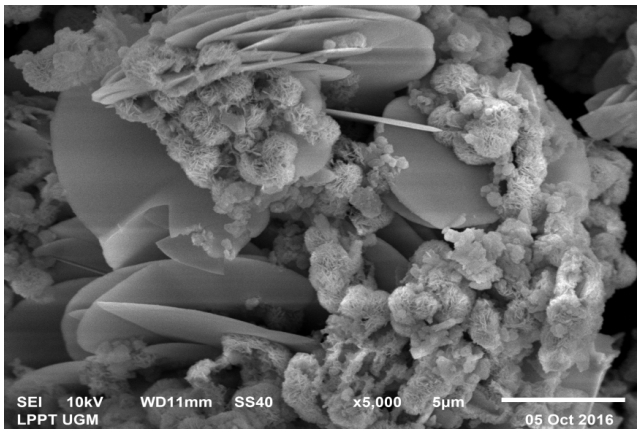

Fig.4. SEM BiOI-Allophane

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