Synthesize and Characterization of ZnO-TiO_2 Nanocomposite

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***Abstract*— The present study was focused on the synthesize of ZnO-TiO_2 nanoparticles. To achieve this, the ZnO-TiO_2 nanoparticle was synthesize by using modified sol-gel method. The precursor of use were Titanium isopropoxide and Zinc acetate. Each precursor was prepare separately. Titanium isopropoxide was first mixed with ethanol forming solution A and zinc acetate was mixed with deionized water to form solution B. These solutions were then mixed together by titration while stirring for better solubility. The nanoparticle were characterized by using Fourier transform infrared spectroscopy (FTIR) to identify the functional group present in the sample, scanning electron microscope (SEM) to observe the sample's surface topography and particle size analyzer (PSA) to characterize the size of the particle produced.**

***Keywords*— ZnO-TiO_2 Nanoparticle, sol-gel method, characterization, FTIR, SEM and PSA**

I. INTRODUCTION

Nanoparticle are extremely fine sized material ranging between 1 to 100 nanometers that works as a group of unit when conveying its properties. Nanoparticles were studied due to its variety possibilities in application. The ultrafine size of nanoparticles could ease the interaction of atomic structured materials to bulk-sized materials. Their superior properties are highly due to their large surface area that allows better contact with the atmosphere or any other reactants. Though nanoparticles are originated from its bulker structure, when its length physical character exhibit an almost similar or lesser than the wavelength of light, the material may show various new properties (Dan Guo, 2013). Each nanoparticle of different material shows their own distinct properties thus opening up myriad of possibilities for industrial applications.

Nanoparticles had been widely studied by scientist and researchers nowadays. Its physical and chemical properties was extendedly discovered and exploited to fit the requirement of certain process. Zinc oxide nanoparticles, for example, shows good ultraviolet light blocking properties thus it is used in the process of making sunscreen lotion. Some material, shows greater ability to absorb solar radiation in nanoparticle form due to the surface area ratio. This ultimately leads to the application of a more efficient photovoltaic cell. Nanoparticles can also exhibit quantum confinement effect due to their nano-scale sized which is small enough to confine their electrons. They exhibit great transport and optical properties that is applicable in a better resolution of cellular imaging, biological sensors, light detector and many other. Hard nanoparticles are nanoparticles in clay form incorporated into polymer matrices, that results into stronger plastic.

Over the years, bacterial infection shows a range of mild to severe cases of disease. Some of it can also lead to death if left untreated. Doctors and biologist had turn to antimicrobial agent to prevent further case of bacterial infection. Many studies had been made to create the best working antimicrobial. Many types of antimicrobial agent and method had been exploited and used. Nanoparticle is one of the best antimicrobial agent discovered by biologist. Nanoparticles antibacterial produces electron holes than act as an oxidizing agent. Microorganism such as bacteria oxidized when in contact with metal particles thus destroying it.

The photo catalytic effect of these nanoparticles enhance the antibacterial activities. A single species metal nanoparticle can prove to be very lethal towards bacteria. Thus the idea is to dope multiple metal nanoparticles species to obtain maximum potential of an antibacterial agent.

Bacteria can also lead to chronic diseases such as blood stream infection. Escherichia coli is one of the species that contribute to this disease. A study was made in a tertiary teaching hospital, shows that from January 1992 to December 2005, 4287 cases of blood stream infection caused by *E. coli* was recorded. The bacteria enters the body through intra-abdominal, biliary and urinary tract (Marta Sanz-Garcı ´a, 2009). Other case of chronic bacterial infection was pneumonia. Chlamydia pneumonia is a bacteria species that can cause serious respiratory infection that can lead to pneumonia. A study had showed that serious pneumonia inflammation can cause lung cancer (Vassilis Samaras, 2010). Bartonella bacteria species was also shown to be able to cause tumor that act as a protective home to the bacteria making it harder to be treated.

A. Fourier transform infrared spectroscopy (FTIR)

FTIR is an equipment that work by absorption of infrared radiation that excites vibrational transitions of molecules. The vibrational frequency are determined by strength and polarity of the vibrating bonds, thus the position of an absorption can be determined by the vibrating masses and the type of bonds (Barth, 2007). Polar bonds can absorb infrared radiation, making it as the marker free technique to study functional groups.

B. Scanning electron microscope (SEM)

SEM works by detecting signals from interactions of electrons beams with the atoms that made up the sample physical structure. SEM is known to emit secondary electron emission that results in very high resolution images of sample surface that can magnify and image 10 to 800,000 folds (Maeda, 2014). This makes it very suitable to observe surface of less that 1 nm size particle structure like nanoparticle.

C. Particle size analyzer (PSA)

PSA works by using optical bench to capture scattering patern from a field particles and applying Mie theory to predict light scattering behavior, which can be scattered by spherical particles, light passing through and absorbed by particles (Mastersizer 2000 user manual, 2007).

II. METHODOLOGY

A. Synthesize of ZnO-TiO_2 Nanocomposite

The ZnO-TiO_2 nanoparicle was prepared by using modified sol-gel method. The precursor used were titanium isopropoxide (TTIP) and zinc acetate. Both precursor solutions were prepared separately. TiO_2 precursor sol was prepared by mixing 30 mL of titanium isopropoxide with 100 mL ethanol absolute forming solution A and was stirred for half an hour. In order to obtain ZnO precursor sol, 0.4g of zinc acetate and 90 mL deionized water were mixed with 10 mL acetic acid to form solution B and was stirred until zinc acetate completely dissolved. Then, solution B was added drop by drop into solution A under vigorous stirring for 2 h in order to increase the solubility and left to age for 24 h at room temperature until the gel was form

The product was dried in an oven at 100°C for about 12 hours in order to evaporate the solvent and to remove the organic residuals. 8.The crystal form of sample was then ground using mortar and pestle and calcinated for 3 hours with the heating rate of 5^{o}C/minutes at calcinations temperatures of 600^{o}C.

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III. RESULTS AND DISCUSSION

A. Characterization of nanocomposites

FT-IR spectra result had been presented with wave number range from 500-4000 cm^{-1}. 1738.67, 1542.14, 1365.93, and 1216.97 cm^{-1} as illustrated in figure 1 were the significant peak shown in the graph. The weak peak around 3450 cm^{-1} observed in the graph was assigned to OH stretching vibration from hydroxyl group. There is a small peak around 1450 cm-1 that was ascribed to the vibration mode of Ti-O (ShahramMoradi, 2012). The peak around 1350 cm^{-1} indicates C-H bending. A weak peak around 1540 cm^{-1} indicates C-O-H bending (Riyadh M. Alwan, 2015).

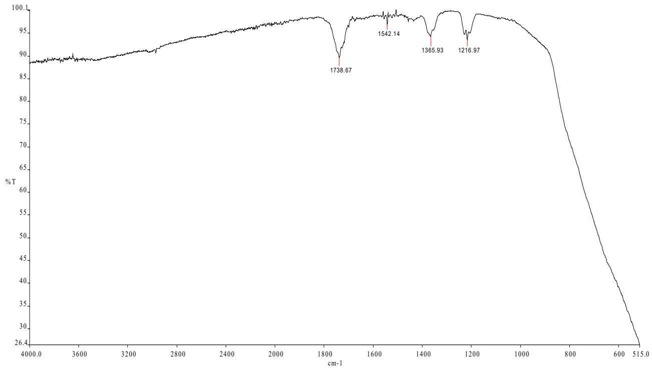

***Figure 1**: FT-IR Spectra analysis of ZnO-TiO_2 Nanocomposite*

As compared to the TiO2 powder, the bands are a lot weaker and the significant peaks it shows are at 3749.23, 1699.34 and 1541.74. It has a weak band of C-O-H bending and C=O bending.

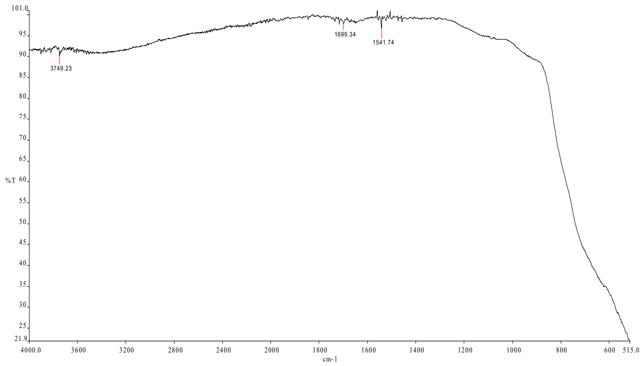

***Figure 2**: FT-IR Spectra analysis of TiO_2 powder*

Based on the FT-IR Spectra result, it shows that the TiO_2 and ZnO bands are weak and does not shows expected graph. There could be contaminations during the process of synthesizing the nanoparticle.

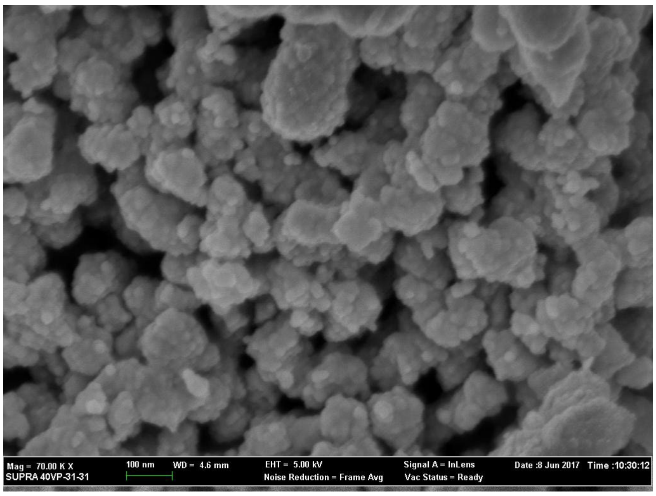

***Figure 3**: PSA analysis of ZnO-TiO_2 nanoparticle*

Scanning Electron Microscopy (SEM) analysis was used to study the topography of the sample. The image magnification was taken as X70,000. Image shows that the nanoparticle is spherical in shape with particle size around 18-25 nm. This result was as expected as it shown similar topography presented in other studies. Although the size of the nanoparticle was slightly smaller than the average nanoparticle observed which was 60-90 nm.

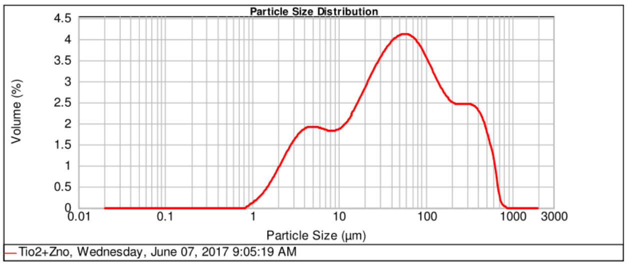

Figure 4: *PSA analysis of ZnO-TiO_2 nanoparticle*

The result of PSA shows that there is a distribution of sizes in the composite that is bigger than nanosize . The average size of the microparticles are in range of 53.5 to 60.4 µm (A. Stoyanova, 2013). This means that there exist a range of particle size present in the sample that may have explained the various bands on the FTIR spectra result.

IV. Conclusion

The FT-IR Spectra result show very little prove of ZnO or TiO2 band present in the sample. It also show many other unknown functional groups. However, the composite produced are nanosized and match the topography of nanocomposites according to SEM (R. Vijayalakshmi, 2012). Though the size of the particle sample is not consistant, some of the particle is microsized.

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