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Conference Paper

FTIR Analysis of MgO/TiO_2 Nanocomposite on Adsorption of Remazol Turquoise Blue Dye

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ABSTRACT

A magnesium oxide and titanium (II) oxide nanocomposite, MgO/TiO_2 was synthesized to improve its surface area thus its adsorption capability may be risen. The synthesis was applying sol-gel method, combining MgO and TiO_2 nanoparticles with NaOH becomes a nanocomposite with higher surface area. Characterization using FTIR were carried out. The expectation of using MgO/TiO_2 compared with TiO_2 and MgO alone is it may react faster on an adsorption trial with remazol turquoise blue dye, and the TiO_2 may give its photocatalysis ability to the synthesized material. The FTIR analysis results show that the MgO and TiO_2 are successfully combined become MgO/TiO_2 nanocomposite. On adsorbing remazol blue, MgO/TiO_2's surface is chemically influenced by the dye's C=O and amides group.

Keywords: Nanocomposite, magnesium oxide, titanium dioxide, adsorption

Introduction

The extraordinary properties of nanomaterials, including large surface area, small size effect, quantum effect, photosensitivity, catalytic activity and electrochemical and magnetic properties, greatly benefit their application potentials in dye wastewater treatment (Cai *et al.,* 2017). The utilization of nanomaterials can be find in many studies, which some had applied it as a good adsorption agent. According to Lei *et al.* (2018) synthesized graphite oxide grafted titanate nanotubes to degrade dye pollutant in water. In other example, Selvaratnam and Koodali (2018) made a TiO_2-MgO composite for solar energy conversion, which conclude a good composition between oxides mixed rule its ability for water-splitting which potentially may be used for pollutant removal in gas and aqueous phases. However, the feasibility and price is important to make the development of nanomaterials become applicable. Some of well-known materials that can achieve this are titanium (Ti) and magnesium (Mg).

Titanium, especially as Titanium (II) oxide (TiO_2) is a material that widely used for water-splitting by photocatalysis mechanism. As a cheap material, TiO_2 has many beneficial characteristics such as its hydrophilicity, chemical stability, long durability, non-toxic, and its ability to degrade organic pollutants. There are many factors which may effects its removal performance including size, BET surface area, pore volume and structure, and its exposed surface facets. According to Park et al. (2013) had classified TiO_2 modification methods according to how the surface is modified. They are metal-loading, impurity doping, inorganic adsorbates, polymer coating, dye-sensitization, and charge transfer complexation. Each of method has distinct effect on pollutant removal

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performance. Metal-loading is the one of the most popular concern, as its ease of production. Metals that can be used for the loading can be Pt, Au, Pd, Ag, and Mg whether as a noble metal or as a metal oxide, such as MgO.

FTIR spectroscopy of adsorbed probe molecules is one of the most available and well developed methods for studying the composition and structure of the surface functional groups of supported metal catalysts. As the vibrational spectrum reflects both the properties of the molecule as a whole and the characteristic features of separate chemical bonds, FTIR spectroscopy offers the fullest possible information on the perturbation experienced by a molecule on contact with the solid surface, and often determines the structure of adsorption complexes and of surface compounds. Examination of supported metal catalysts deals with two types of surfaces strongly differing differing in their properties: surface of a support and surface of a metal-containing particle (Belskaya *et al.,* 2012).

In this study, an MgO/TiO_2 nanocomposite will be synthesized as a catalyst that expected it will able to do adsorption for wastewater pollutant, which will be represented by remazol turquoise blue dye. The catalyst will be produced using sol-gel method. The research will figure out the surface adsorption mechanism of the pollutant onto surface of the nanocomposite. Characterization of the catalyst will be determined using FTIR.

Material and Methods

The MgO nanoparticles in this research had been made with sol-gel method referencing to Moussavi and Mahmoudi (2009). To make the nanoparticles of MgO, 100 g of $MgCl_2.6H_2O$ was initially diluted in 500 mL of dd-water in a 1 liter of an erlenmeyer flask. In the mixture, 50 mL of 1 N NaOH solution was added. The fusion was then vigorously stirred for 4 hours to generate the magnesium hydroxide precipitates. The formed suspension was then sentrifuged at 2500 rpm for 5 minutes to get the $Mg (OH)_2$ gel. Obtained gel was then washed with dd-water, dried at 60 °C for 24 hours. Finally, the dried powder was calcinated in air at 450 °C for 2 hours, and the MgO nanoparticles is ready.

The procedure to prepare the MgO/TiO_2 nanocomposite is similar with the method to prepare the MgO nanoparticles. The difference is in the first step during mixing the $MgCl_2.6H_2O$ with dd-water, an amount of TiO_2 P25 is added, then the next steps are similar. The dye solution in this study is prepared using commercial remazol blue dye. To prepare the dye solution a 500 mg of the dye powder was weighted, and then mixed with dd-water in a 1000 mL of volumetric flask. Adsorption of the remazol experiment was held on a 50 mL closed reaction bottle. The FTIR analysis in this study were performed using JASCO FT/IR-6500.

Results and Discussion

The FTIR spectra of a material can be very helpful to analyze its composition by seeing any stretching or bending of the corresponding chemical bond. Figure 1 shows the FTIR spectra of P25 TiO_2, MgO, and MgO/TiO_2 nanocomposite. Referring to El-Sayed *et al.,* (2018), on the analysis of P25 TiO_2 in this study, the TiO_2 spectra at band 605 cm^{-1} is corresponding to the vibration mode of the Ti-O bonds. Also, two bands centered at 852 and 445 cm^{-1} confirm the Ti-O bonds stretching. For MgO, bands at 428 and 543 cm^{-1} are assigned to the stretching vibration of Mg-O bond. Band appearing at 858 cm^{-1} confirms the Mg- O bending vibration and interaction.

From the aforementioned explanation of TiO_2 and MgO above, it gives reference for analyzing the FTIR spectra of MgO/TiO_2 nanocomposite. As can be seen in the figure, the bands found in the spectra of both P25 TiO_2 and MgO are all can be found in the spectra of MgO/TiO_2 nanocomposite. It points out that compounding between MgO and TiO_2 is successful.

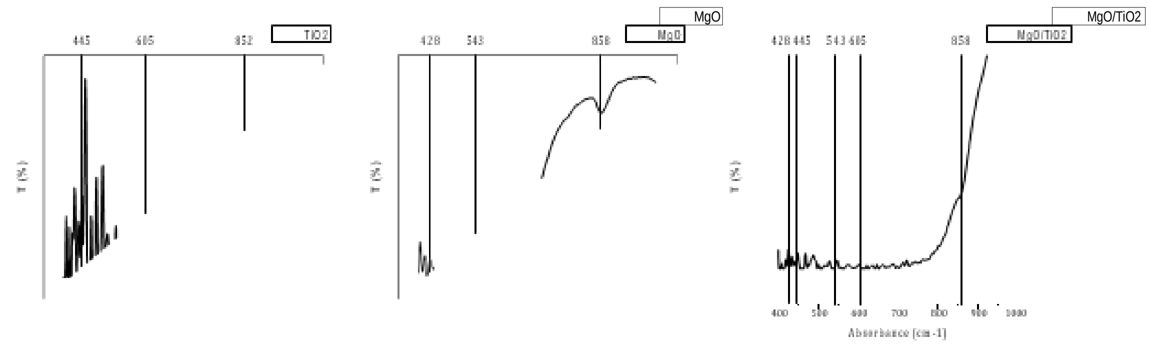

Figure 1. FTIR Spectra of TiO2, Mgo, and MgO/TiO2 nanocomposite

Using FTIR, it is also possible to analyze the adsorption phenomenon of the remazol blue dye onto each material, which certainly occurred during degradation process of the catalysts. Figure 2 is showing the FTIR spectra of TiO_2, MgO, and Mgo/TiO_2 catalysts before and after adsorp the remazol blue dye. Referring Ansari et al. (2018), it can be seen that the three catalysts are all showing a broad band at 3450 cm^{-1} which is associated with OH stretching vibrations of surface-adsorbed water molecules, while the band at 1620 cm^{-1} is associated with its bending vibration. It also can be seen from the three catalysts at 2400 cm^{-1} is having a very weak band which corresponding with CO_2 gas adsorption. It is well known that MgO can easily adsorp H_2O and CO_2 molecules from the atmosphere, and in this research, the phenomenon is also occurred to TiO_2 and MgO/TiO_2.

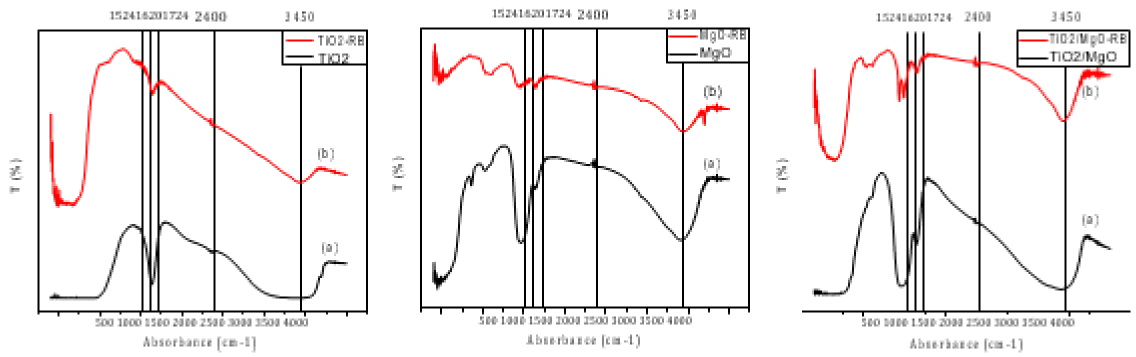

Figure 2. FTIR Spectra of TiO2, Mgo, and MgO/TiO2 nanocomposite before and after adsorbing remazol turquoise blue dye

Another bands to point out can be seen at 1524 cm^{-1} and 1724 cm^{-1}. These two bands are only can be found on the dye-saturated catalyst (after adsorption). The alteration at 1724 cm^{-1} peak is a stretching vibration of C=O, while the change at 1524 cm^{-1} indicates the presence of secondary amide. These two bonds probably are coming from the remazol blue dye to the surface of the catalysts (Pelosi *et al.,* 2014). From the explained findings and re-look at the FTIR spectras before and after adsorption, it seems likely the adsorption of remazol blue dye onto the three catalysts occurred chemically, as there are some minor to major changes in the spectras. However, it is not closing the possibility that the adsorption was occurred physically, or even by a combination of chemical and physical adsorption (Ren *et al.,* 2011).

Mixed oxides, like MgO, are often being used as a support for TiO_2 to improve its performance. Considerations of price, mechanical and thermal stability, and porosity of the support materials is the reason of applying mixed oxides to TiO_2. Due to its surface porosity, it further helps the adsorption of the organic pollutant in water onto the catalyst, then will maximize its degradation from water. The MgO preparation is also easy, which give high possibility to be produced in industrial scale, for example using sol-gel method (Selvaratnam & Koodali, 2018). Furthermore, MgO itself has a good potential as an adsorbent for pollutant in water, especially for dyes. According to Moussavi and Mahmoudi (2009) had observed its adsorption capacity up to 166.7 mg/g for remazol blue, and 123.5 mg/g for remazol red. However, as an inorganic adsorbent, further environmental issue like its reusability and its toxicity during post-adsorption is need to be explored (Harikishore *et al.,* 2017). Therefore, it urges an advance in the study of the adsorption capability of metal oxides such as MgO and its direct pollutant degradation with photocatalyst.

Conclusion

The FTIR analysis results show that the MgO and TiO_2 are successfully combined become MgO/TiO_2 nanocomposite. On adsorbing remazol blue, MgO/TiO_2's surface is chemically influenced by the dye's C=O and amides group.

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