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Preparation of Magnetic Nanoparticle TiO_2 $NiFe_2O_4$ by Coprecipitation Method and Photocatalytic Properties

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ABSTRACT

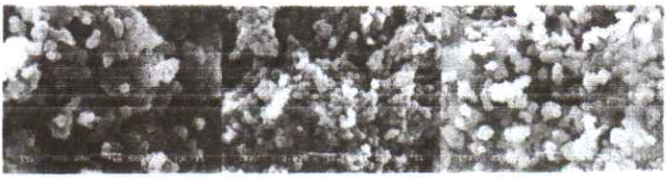
Preparation of magnetic nanoparticle TiO_2-$NiFe_2O_4$ has been conducted by coprecipitation method using metal nitric and titanium isopropoxside (TIP) as precursors. The powder X-ray difractometer (XRD) and scanning electron microscopy (SEM) were use to characterized the structur and morphology of particle. The magnetic properties were measured by vibrating sample magnetometer (VSM). In the XRD patterns show the peak of TiO_2-$NiFe_2O_4$ was calcinated at 550 ^{0}C has high intensity of TiO_2 anatase. From SEM image indicate that the particle was prepared using propanol solvent has the most homogeneous surface. The magnetic properties analysis show that the particle has a magnetic properties. Photocatalitic activity of samples in response to visible light irradiation was determined by degradation of rhodamin B show that the particle was calsinated at 550 ^{0}C has a good actifity.

Key words: TiO_2-$NiFe_2O_4$ particle, coprecipitation method, magnetic and photocatalitic properties

1. INTRODUCTION

TiO2 powders have been commonly used as white pigments from ancient times. They are inexpensive, chemically stable and harmless, and have no absorption in the visible region. Therefore, they have a white color. However, the chemical stability of TiO2 holds only in the dark. Instead, it is active under UV light irradiation, inducing some chemical reactions. Such activity under sunlight was known from the flaking of paints and the degradation of fabrics incorporating. TiO2Titania-coated magnetic particles have been proposed to solve the difficulty of photocatalyst separation from the treated water by applying an external magnetic field. TiO_2, anatase has the best photocatalytic activity. This is because the structure of anatase has a band gap of 3.2 eV which is active on UV light irradiation. It is a disadvantage for this photocatalytic when used in sunlight because TiO_2 can only use 3-5% of sunlight. The dopping process of TiO_2 with $NiFe_2O_3$ metal to decrease the band gap of TiO_2 can be conducted by coprecipitation method. The advantages of this particle has magnetic properties so that can be recycled when it was used as photocatalyst in degradation of the organic compound in waste water.

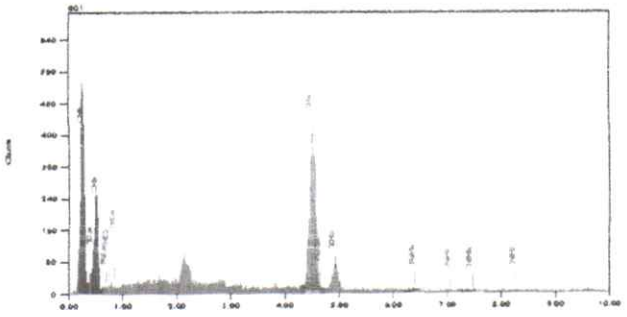
2. RESULT



a b c

Figure 1. SEM image of nanoparticle TiO_2-$NiFe_2O_4$ in a) etanol, b) propanol, c) isopropanol solvent

The SEM photographs of the TiO_2-$NiFe_2O_4$ powders solved with at etanol, propanol and isopropanol are given in Fig. 1. The TEM photographs show that propanol solvent give a good distribution particle with little aggregated particulate. The size of the partickle with the propanol solvent are relatively have a same size if compared with the etanol and isopropanol solvent. The EDX analisis (fig. 2) give information about the composition of this nanoparticle. This nanoparticle has 38,66%, O 33,52% , C 26,93%, Fe 0,7%, Ni 0,2%.



Element		(keV)	mass%	Error%	At%	Compound	mass%	Cation	K
C K		0.277	28.93	0.05	43.44			22.1862	
O K		0.525	33.52	0.38	40.61			19.7463	
Ti K		4.508	38.66	0.34	15.64			56.8294	
Fe K	*	6.398	0.70	0.79	0.24			0.9811	
Ni K	*	7.471	0.20	1.35	0.07			0.2770	
Total			100.00		100.00				

Figure 2. EDX analisis of TiO_2-$NiFe_2O_4$

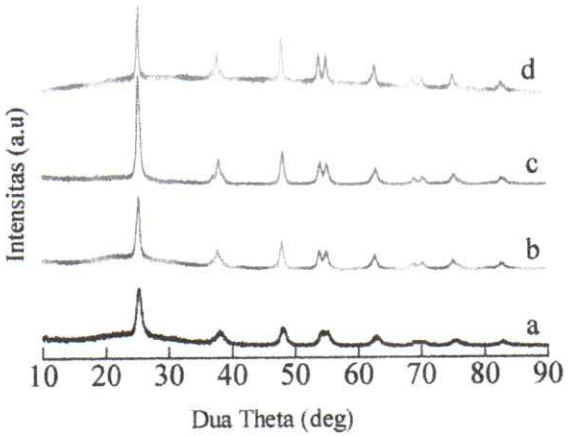


Figure 3. XRD patern $TiO_2/NiFe_2O_4$ (1 : 0,01)with variation Calcination temperatur a) 450°C b) 500°C c) 550°C d) 600°C

The XRD patterns of the $TiO_2/NiFe_2O_4$ powders calcined at different temperatures are shown in Fig. 3.The highest peaks of anatase at 2θ = 25.3° are corelated with the JCPDS No. 21-1272. The diffraction peaks are continuously getting sharper with increasing calcination temperature, which reveals that the grain size become larger with increasing calcination temperature. The mean size of $TiO_2/NiFe_2O_4$ calcined at 450, 500, 550, and 600□C for 2 h, respectively, can be calculated by the Scherrer formula, and the phases and the mean size are listed in Table 1. Table 1 shows that the mean size of $TiO_2/NiFe_2O_4$ become larger and larger when the calcination temperature increased from 450 to 600 □C. The XRD patterns of the $TiO_2/NiFe_2O_4$ with the ratio concentration 1 : 0,1. shown in Fig. 4. It can be seen that the XRD pattern show the highest peaks of TiO_2 anatase 2θ = 25.3° and the peaks of $NiFe_2O_4$ at 2θ = 35,68 are corelated with JCPDS No. 21-1081.

Tabel 1 : the Crystallite size of $TiO_2/NiFe_2O_4$ (1 : 0,01) with variation Calcination temperatur

Calcination temperatur	Crystallite size
450	8,067
500	8,067
550	9,786
600	13,714

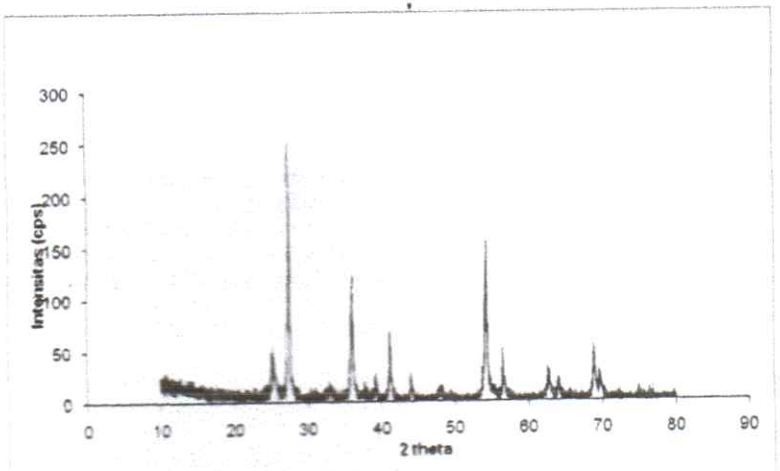


Figure 4. XRD patern of TiO_2-$NiFe_2O_4$ (1 : 0,1)

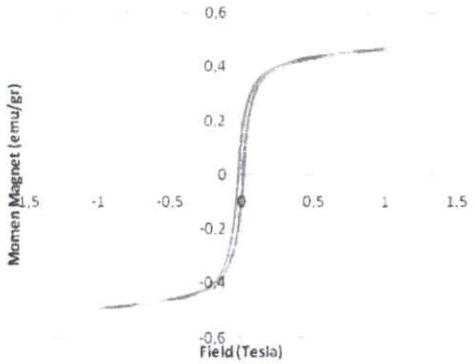


Figure 5. magnetic properties of TiO_2-$NiFe_2O_3$ (1:0,1)

Figure 5 shows the room temperature hysteresis loop of the coprecipitated TiO_2-$NiFe_2O_3$ and as can be seen the saturation magnetization of the nanopowders is 0,462 emu/g and -0,497 emu/g. With the value of coercive -0,0206 T and the value of remanent 0,0194 emu/g. From this hysteresis loop the propertis of this nanoparticle is paramagnetic because the value of saturation magnetization ≤ 92 emu/g. The value of remanent and coercive approach 0.

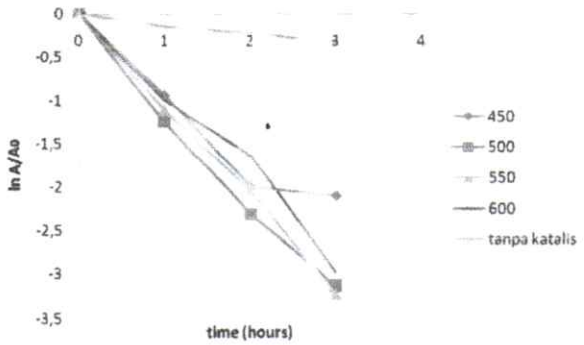


Figure 6. Graph ln (A/A_0) for degradation rodamin B by TiO_2-$NiFe_3O_4$ with variation calcination temperature

The degradation result of rhodamin B iradiation in sunrise is show in fig. 6. For the purposes of comparison, the photocatalytic degradation of rhodamin B was carried out using the catalis TiO_2-$NiFe_3O_4$ with the variation of caltination temperature.These results are also shown in Fig. 6. These experimental results show that the TiO_2-$NiFe_3O_4$ with the caltination temperature 550^{0}C has greatly higher photocatalytic after iradiation in sun rise at 3 hours if compared with the TiO_2-$NiFe_3O_4$ in other caltination temperature.

3. CONCLUSION

In order to develop efficient photocatalysts working withh sun light, TiO_2-$NiFe_2O_4$ nanoparticles were synthesis by coprecipititation method. The SEM image shown propanol solvent using in synthesis produces more homogeneous nanoparticles than ethanol and isopropanol. From EDX grafik we knows the composition of this nanoparticle. The characterization using XRD show the highest intensity of anatase read at 2θ: 25.3° of particle was calcinated at 550^{0}C. In XRD peaks with variation consentration show the peak of the metal $NiFe_2O_4$ at 2θ : 35,68. Characterization using VSM show the small value of coercive and remanent so this material has magnetic properties. The catalytic activity of this particles were determined by degradation of rhodhamin B indicate that TiO_2-$NiFe_2O_4$ nanoparticles that was calcinated at 550^{0}C gave the largest percent degradation after irradiation by the sun for 3 hours.

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