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Irradiation Time Optimization on Photocatalytic Activity of Nanoparticles MgO from Dolomite Bangkalan

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Abstract

Dolomite is a type of sedimentary rock material that is often found in the Bangkalan Madura area. This dolomite has a higher MgO compound content than in the other areas, namely 40 %, but its utilization has only been as fertilizer and building materials. For this reason, this research aims to determine the characteristics of MgO nanoparticles and their application in photocatalytic with visible light irradiation. The synthesis of MgO nanoparticles used the hydrochloric acid leaching method, and the results were characterized by X-ray diffraction, Fourier transform infrared, Scanning electron microscopy, Transmission electron microscopy, Raman spectroscopy, Photoluminescence, and Ultraviolet-visible spectroscopy. The results showed that the synthesized MgO nanoparticles had a periclase phase and were shaped like a spherical cube with an average nanoparticle size of 27 nm and an energy gap of 3.9 eV. The optical properties of the MgO nanoparticles showed quite strong luminescence at a Raman shift of 1,087.36 cm^{-1}, which was associated with the type of vibrational waves in the atomic lattice, and there were surface defects on the surface of the MgO nanoparticles, namely in the emission spectra of 720.06 and 740.39 nm originating from oxygen vacancies (F-center) and Mg vacancies (V-center). The photocatalytic activity of MgO nanoparticles in visible light showed the optimum time to degrade 30 ppm methylene blue dye in 360 min and yielded a degradation percentage of 99 %. Therefore, MgO nanoparticles could be used for processing industrial dye waste using visible light.

Keywords: MgO nanoparticles, Dolomite, Photocatalytic activity

Introduction

Indonesia is a country that has enormous potential for mineral resources, one of which is dolomite. Dolomite can be found along the north coast of Java Island to the east, starting from Rembang Regency to Gresik Regency and then continuing on Madura Island from Bangkalan Regency to Pamekasan Regency [1]. Dolomite is a sedimentary rock material often found in nature but needs to be utilized more [2]. Several studies have been conducted to determine the MgO elemental content of dolomite in Indonesia. Madura dolomite MgO content is 40 % [3], Gresik 19 % [1], Tuban 3.3 % [4], and Aceh 25 % [5]. Based on those research results, the content of MgO compounds in dolomite in the Madura area is higher than in other areas. But so far, dolomite in that area has only been used as a building material and has not been fully utilized.

MgO nanoparticles are semiconductor materials that are of great interest to researchers because of their good optical properties, luminescence potential for photonic applications, and highly efficient physicochemical properties for use in various wastewater treatment applications, especially photocatalytic degradation [6,7]. When photons are absorbed by the MgO nanoparticle material, the surface properties change. This process can be associated with photoconductivity, photoluminescence, and photocatalytic phenomena [8]. In the photocatalytic process, metal oxide semiconductor materials are used effectively to mineralize organic impurities into H_2O, CO_2, and organic ions [7]. With a small amount of energy, such as heat energy, during the photocatalytic reaction, electrons are transferred from the valence band to the conduction band, and an electric current arises, resulting in oxidation and reduction reactions that can degrade the dye [9]. MgO nanoparticles are photocatalyst materials that can degrade methylene blue dyes under light irradiation. Dye methylene blue is a coloring agent often used in the textile industry over other

dyes because it is easily soluble in water and has an economical price compared to other dyes. However, this dye can become waste in water because it has a benzene group, so it is difficult to decompose naturally, and specific techniques are needed to reduce dye waste. One such technique is by utilizing MgO nanoparticle photocatalysts [10].

Methylene blue dye can cause eye and skin irritation and, when entering the human body, can cause vomiting, diarrhea, and dizziness. Thus, it is necessary to degrade the dye using the photocatalytic activity of MgO, which can decompose complex compounds in methylene blue. The photocatalytic activity of MgO is very effective, considering that the removal of dyes in water by coagulation, flocculation, and adsorption techniques only moves the dyes from the liquid phase into the solid phase and does not decompose the compounds in the dyes so that the color particles can agglomerate and cause new pollution. Research conducted by Rahmawati and Rohmawati [11] showed the photocatalyst process using MgO on methylene blue dye, which was carried out under sunlight, UV light, and dark room with a time of 180, 240, and 300 min showing a degradation rate of 82, 42, and 34 %, respectively. Yadav *et al.* [12] pointed out the same regarding the effectiveness of MgO in photocatalytic activity to degrade methylene blue dye under sunlight and UV light, with degradation percentages of 97 and 92 %, respectively. In addition to UV light irradiation, MgO photocatalytic activity can also use visible light irradiation to degrade methylene blue dye; this is because visible light has oxidizing solid power, so MgO nanoparticles can be used as non-toxic, environmentally friendly adsorbents for removing organic pollutants in water [7,13,14]. Alaizeri *et al.* [15], in their research regarding the photocatalytic activity of MgO nanoparticles, had a degradation efficiency of methylene blue under UV irradiation with a percentage of 52 to 75 % for 180 min. The MgO thin film showed a high photodegradation rate of about 83 % after 180 min under the influence of sunlight [16]. MgO nanoparticles with a gap energy of 4.1758 eV are very effective in photocatalytic degradation, with a maximum of 81 % against methylene blue dye for 250 min [17]. Based on the data above, MgO nanoparticles have good photocatalytic activity under UV light and sunlight. The photocatalytic activity of MgO nanoparticles can also be done under the influence of visible light, as was done by Ahmadet *et al.* [14], in which the absorbance spectrum of methylene blue dye using MgO nanoparticles at 120 min with visible light irradiation resulted in a percent degradation of 90 %. This research used a methylene blue concentration of 30 ppm with a MgO nanoparticle mass of 10 mg. Using the green synthesis method, the MgO nanoparticles were obtained from Texas sage leaf extract.

Based on the explanation above, further studies were carried out regarding the microstructural properties, optical properties, and even the photocatalytic ability of MgO nanoparticles from dolomite Bangkalan, primarily related to optimization of irradiation time using visible light irradiation, namely 60 to 360 min, which is the novelty in this research. The results of this research are expected to show that MgO nanoparticles from dolomite have good photocatalytic abilities in degrading methylene blue dye, which can later be used and developed more broadly in the industrial sector, especially in organic waste treatment.

Materials and methods

Material

Research materials included dolomite from Bangkalan (Madura, East Java, Indonesia), distilled water, 5 M HCl (Merck), 5 M NH_3 (Merck), and methylene blue (Merck). The equipment in this study included a digital balance, spatula, 200 mesh sieve, crucible, furnace, beaker glass, measuring cup, filtering flask, magnetic stirrer, aluminum foil, filter paper, Buchner funnel, petri dish, mortar and pestle, pH paper and glass vials.

Methods

Synthesis of MgO from dolomite Bangkalan

Referring to research from Rahmawati and Rohmawati [11], they synthesized MgO using the leaching method, first by sifting dolomite powder using a 200-mesh sieve. Furthermore, 50 g of dolomite was dissolved in 210 mL of 5 M HCl and then stirred using a stirrer at 300 rpm at 75 °C until a solution formed a slurry. After that, the solution was filtered to obtain filtrated $CaCl_2$ and $MgCl_2$. The filtered filtrate is added with NH_3 (5 M) to pH 12, and a precipitate is formed as $Mg(OH)_2$. The precipitate was washed with distilled water, dried at 90 °C for 6 h, then calcined at 800 °C for 8 h, and cooled at room temperature. The complete MgO nanoparticle synthesis procedure can be seen in **Figure 1**.

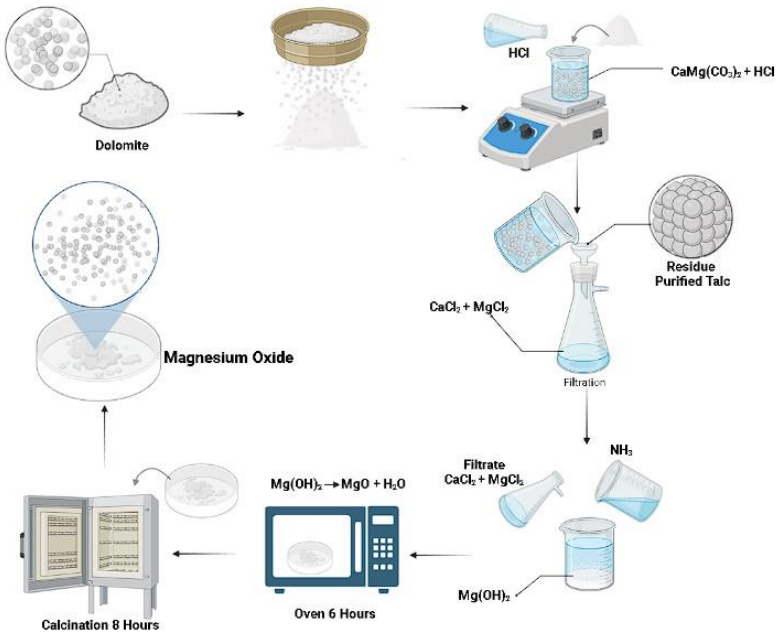


Figure 1 Synthesis MgO from dolomite Bangkalan.

Characterization

The synthesized MgO nanoparticle samples were identified for their characteristics using X-ray Diffraction (XRD) characterization, Fourier Transform Infrared (FTIR), Transmission Electron Microscopy (TEM), Raman spectroscopy, Photoluminescence (PL) spectroscopy, and Ultra Violet-visible (UV-vis) spectroscopy. XRD characterization used the Rigaku MiniFlex 600-C brand, which has a Cu anode radiation source, 40 kV, 30 mA, a CuKα wavelength of 1.54060 Å and a testing angle of 20 - 90 ° with a step size of 0.02 °/min. Data from the XRD test results were analyzed using the match! Software, namely by matching the test results data with the PDF (Powder Diffraction File) card in the software so that the main phase of the sample could be identified. Analysis of the sample crystallite size can be determined from the FWHM value using the Scherrer equation according to Eq. (1):

$$D = \frac{K\lambda}{\beta \cos \theta} \quad (1)$$

Where D is the crystal size (nm), K is the Scherrer constant, β is the FWHM value of the peak, λ is the XRD wavelength, and θ is the Bragg angle [18]. The functional groups of the sample could be identified using the FTIR characterization of the Shimadzu brand type IRPrestige 21, which works at wave numbers of 4,000 to 500 cm^{-1}. TEM characterization of the JEM-1400 brand was carried out to determine the morphology and structure of the samples. The particle size distribution of the sample could be determined using ImageJ software. Brand Raman spectroscopy Raman iHR320 Horiba with a laser source with a wavelength of 532 nm is used to determine the vibration mode of the sample, which is at a Raman shift of 0 - 2,000 cm^{-1}. Photoluminescence characterization used the Horiba MicOS Photoluminescence Microspectrometer with a 5 MW diode laser and a 420 nm wavelength source. The results of this characterization could be seen as structural defects in the sample, such as oxygen vacancies. UV-vis characterization of the Analytical Jena brand-type Specord 200 plus was carried out to determine the absorbance value of the methylene blue (MB) solution, which had been given the addition of a synthesized sample catalyst under the influence of visible light irradiation. The results of the absorbance can be measured by the percentage degradation of the MB dye according to the equation below:

$$\%Degradation = \frac{A_0 - A_t}{A_0} \times 100\% \quad (2)$$

Where A_o is the initial absorbance MB (a.u) and A_t is the final absorbance MB (a.u) after irradiation at a certain time [19]. The band gap energy of the synthesized sample was known from analysis using the Tauc plot, where data was obtained from the results of UV-vis characterization.

Photocatalytic activity MgO from dolomite Bangkalan

The photocatalytic activity of the degraded methylene blue (MB) dye could be carried out by preparing 30 ppm of methylene blue dye and then adding 10 mg of the synthesized MgO nanoparticle catalyst. The mixture was stirred using a stirrer at 300 rpm for 1 h in the dark. After that, irradiation was carried out with visible light using a xenon lamp (10 W, 57 MW/cm^2) at 60, 120, 180, 240, 300, and 360-min intervals. The irradiation results were centrifuged at 3,000 rpm for 5 min; then, the solution was placed in a cuvette for UV-Vis characterization. In detail, the process of preparing photocatalytic materials can be seen in **Figure 2**.

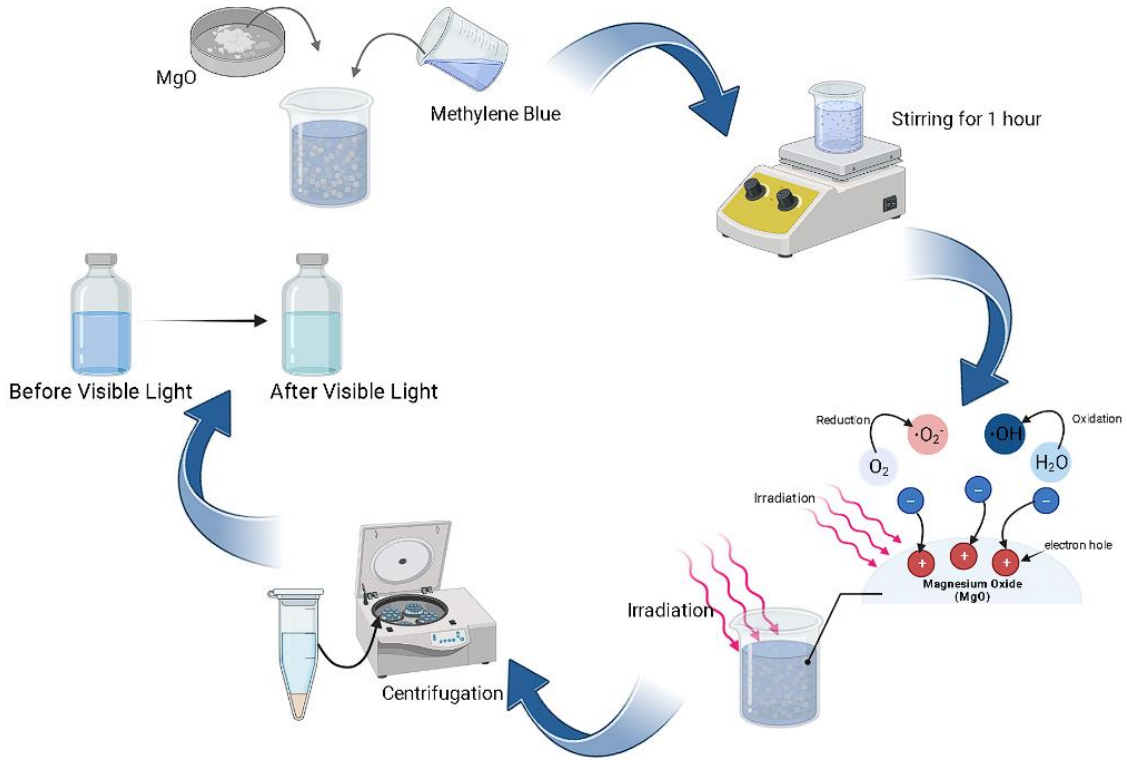


Figure 2 Photocatalytic process of MgO nanoparticles synthesized in methylene blue solution.

Results and discussion

Analysis XRD

The results of the diffractogram in this study are shown in **Figure 3**, which is derived from samples synthesized from Bangkalan dolomite by calcination at 800 °C. Analysis using software match! Showing the position of 2θ at each peak indicates that the compound formed from the synthesis results is a MgO crystallite structure with a periclase phase. The optimum peak is at a diffraction angle of 2θ of 42.849 °, indicating the presence of MgO crystallite intensity with crystal plane orientation as the miller index of the plane (200). At this angle, according to research conducted by Fouda *et al.* [20], the maximum intensity of MgO in the periclase phase was at 2θ = 42.8, with a Miller index (200). Other peaks indicate the formation of MgO nanoparticles at angles (2θ) 36.950, 62.279, 74.629, and 78.660 ° with miller index (111), (220), (311), and (222). The diffraction peaks indicate a periclase phase with a polycrystalline cubic structure by the JCPDS data standard number 78 - 0430 [11]. Through analysis using Eq. (1), a MgO nanocrystallite size of 21.70 nm is obtained.

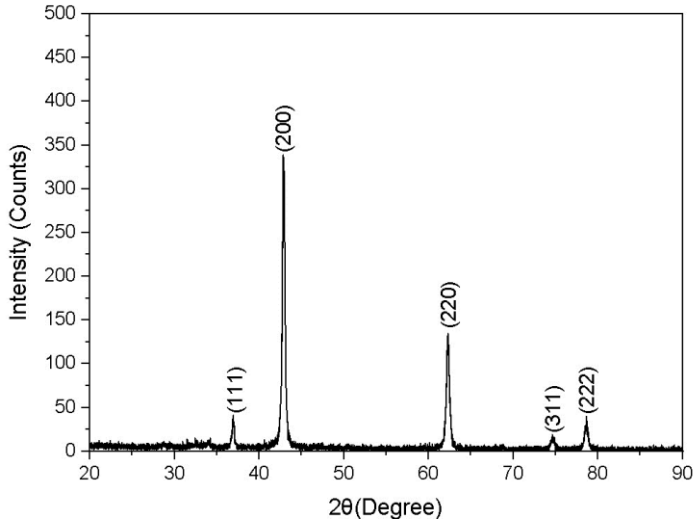


Figure 3 Sample diffraction patterns.

FTIR analysis

The functional groups of the synthesized MgO nanoparticle sample can be identified by carrying out FTIR characterization, where the test is in the wave number range of 4,000 - 500 $cm^{-1,}$ the results of which are shown in **Figure 4**. The spectrum results indicated the absorption peaks of the synthesized sample at wave numbers 3,687.39, 3,438.80, 2,829.57, 2,497.82, 1,652.99, 1,494.83, 974.04, and 669.30 cm^{-1}. The absorption peak at 669.30 cm^{-1} has Mg-O stretching vibrations, which can be attributed to MgO compounds [21].

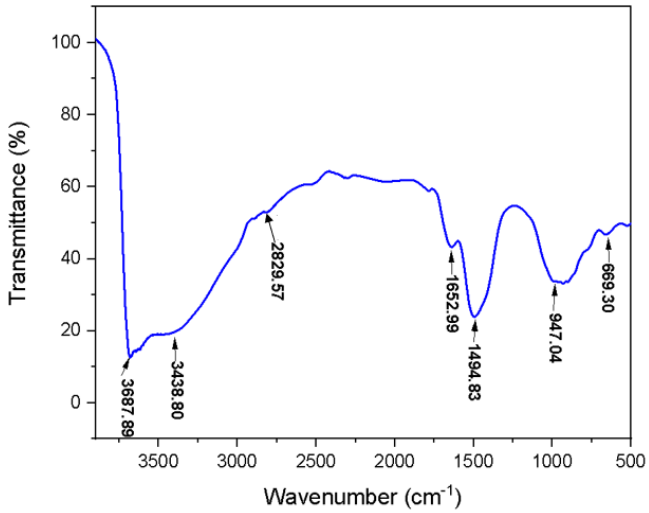


Figure 4 The FTIR spectrum of the sample.

The FTIR spectrum also detected bonding and interaction of Mg-O at wave numbers 947.04 and 1,494.83 cm^{-1}, indicating the presence of MgO compounds [22]. At wave number 1,652.99 cm^{-1}, C = O stretching occurs, indicating the presence of a carbonyl group [21,23]. Weak absorption occurred at 3,438.80 and 2,829.57 cm^{-1}, which could be associated with OH stretching and bonding. Strong absorption occurred at wave number 3,687.89 cm^{-1}, indicating the presence of -OH- stretching and the absorption of H_2O on the surface of MgO [24]. In **Figure 4**, there is a strong absorption of the OH group because the FTIR test is sensitive to the OH group. Molecules H_2O and CO_2 are highly adsorbed on the surface of MgO (chemisorbed) from the atmosphere [25-26]. Chemisorption occurs due to adsorbate, which diffuses on the surface of the adsorbent, or chemical bonds occur between ionic and covalent bonds. Chemisorption of CO_2 on MgO can occur with the intermediary H_2O [27], so a carbonyl group is detected in the FTIR absorption

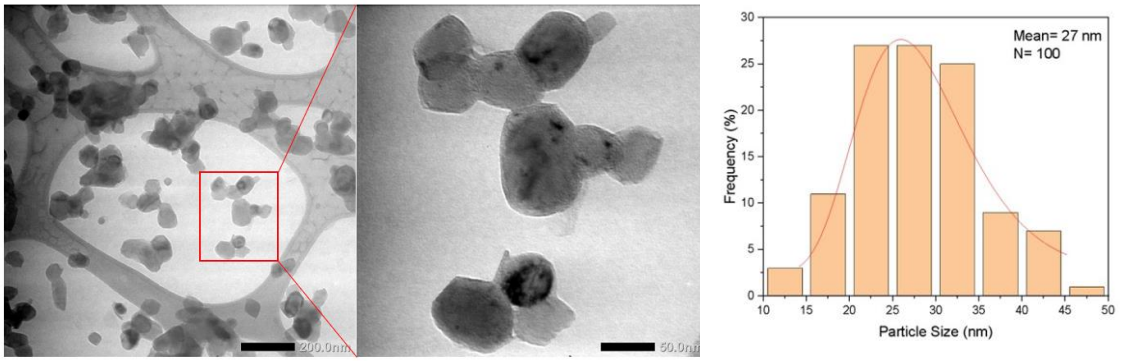
spectrum. FTIR spectrum data results can be observed in **Table 1**, indicating the sample functional groups for each absorption peak.

Table 1 Bonds of material functional groups.

Wave number (cm^{-1})		Bond type
Experiment	**Reference**	
669.30	661 [21]	Mg-O stretching
947.04	900 [22]	Mg-O bonding
1,494.83	1,460 [28]	Interaction Mg-O
1,652.99	1,634 [21]	C = O stretchng
2,829.57	2,853 [29]	O-H stretching
3,438.80	3,439 [30]	-OH bonding and stretching
3,687.89	3,697 [24]	-OH- stretching

TEM analysis

TEM test results are shown in **Figure 5(a)**, which show that the synthesized MgO nanoparticles have a rounded cubic shape. MgO nanoparticles have an aggregated form consisting of a combination of particles. When viewed in more detail, there is an accumulation or grouping of small particles (agglomeration), which causes their size to increase [28]. In the TEM results, black particles indicate accumulation between particles, while white particles indicate single particles. The average size distribution of the synthesized samples can be calculated using the ImageJ application by taking 100 appropriate particles (**Figure 5(b)**) and obtaining a sample size of 27 nm. With a particle size of less than 100 nm, the synthesized sample can be said to have nanoparticle size.



(a) (b)

Figure 5 (a) TEM image and (b) particle size distribution of sample.

Spectroscopic raman analysis

The characterization of the optical properties of MgO nanoparticles from dolomite was studied using Raman spectroscopy analysis, the results of which are in **Figure 6**. The synthesized Bangkalan dolomite MgO nanoparticles had spectral peaks at 108.44, 155.87, 212.53, 281.83, 446.37, 712.93, 750.56, 1,087.36, 1,437.22, and 1,749.14 cm^{-1}. Visweswaran *et al.* [31] stated that active Raman polarization was present in A_{1g}, E_g, and T_{2g}, obtained from crystallography data. In the Raman polarization, there was a polarizability mode including symmetric stretch (A_{1g}), bending mode/asymmetric deformation (E_g), asymmetric stretch, and symmetric deformation (T_{1g} and T_{2g}) [32,33]. Symmetrical stretch (A_{1g}) occurred at the peak of 1,087.36 cm^{-1}, which could be associated with TO (Optical Transverse) and LO (Optical Longitudinal) phonons [31,34]. The peak of the Raman was about 446.37 cm^{-1}, with TA phonon with asymmetric deformation mode (E_g) [31,35,36]. The cases of T_{1g} and T_{2g} indicated a Raman shift above 1,000 cm^{-1} because they had low energy [37].

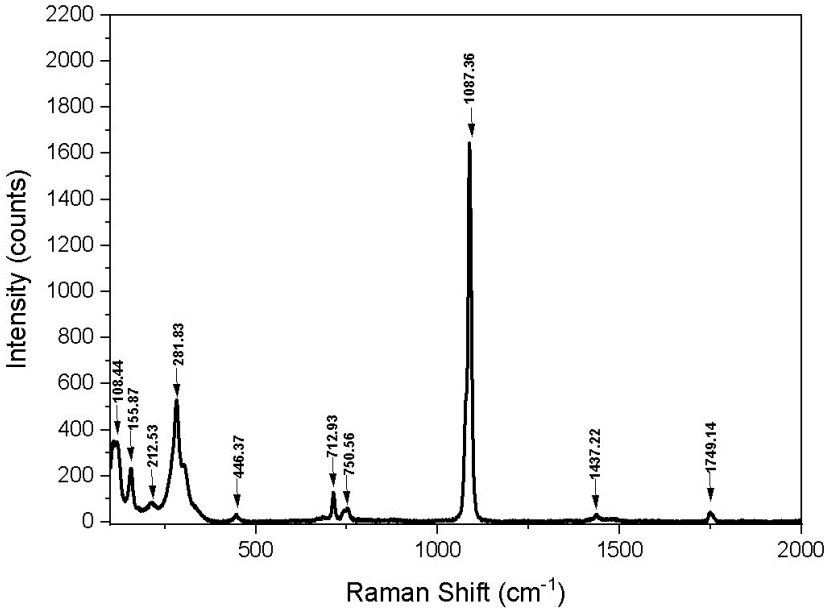


Figure 7 Raman spectrum of MgO sample.

The peak of the Raman spectrum at 108.44 cm^{-1} indicated the presence of MgO [38]. The vibration of the O-Mg-O bending mode was detected at the Raman number of 155.87 cm^{-1} [33] and at 212.53 cm^{-1}, which was the vibration of the MgO compound [39]. The Mg-O stretching vibration occurred at the Raman peak of 281.83 cm^{-1}, related to the TA phonon [36,40]. Two low-intensity peaks were observed at 712.93 and 750.56 cm^{-1}, which could be attributed to MgO [41]. The results of identifying Raman vibrations in the MgO nanoparticle samples can be seen in **Table 2**.

Table 2 Vibration modes of Raman spectroscopy.

Raman shift (cm^{-1})		Vibration mode type
Experiment	**Reference**	
108.44	120 [38]	O-Mg-O bending
155.87	176 [33]	O-Mg-O bending
212.53	200 [39]	MgO vibration
281.83	281 [36]	TA Phonon
446.37	446 [36]	TA Phonon
712.93	710 [41]	O-Mg-O bending
750.56	805 [41]	O-Mg-O bending
1,087.36	1,084 [34]	TO-LO Phonon
1,437.22	1,495 [34]	D-Band
1,749.14	1,923 [34]	G-Band

In **Figure 7**, there is a spectrum peak below 1,500 cm^{-1}, which is related to the D band, while in the range of 1,500 to 2,000 cm^{-1}, there is a G band. The D band is the breathing mode on the crystal surface, such as oxygen vacancies. Meanwhile, the G band is a tangential mode that can be associated with bonded carbon. The indicated peak G band in **Figure 7** occurs because the MgO compound can have O elements that can bind to other elements, such as C atoms. D bands and G bands provide information about the surface defect's crystal size [34]. Surface defects on the metal oxide surface have an essential role in optics, namely electronic properties. Therefore, studying the presence of defects on the surface of MgO is very

important. Surface defects on the MgO surface can cause a glow. Hence, it is necessary to test the photoluminescence spectrum of MgO nanoparticles.

Analysis Photoluminescence

The results of the PL characterization are a graph of the relationship between wavelength and intensity. This characterization was carried out at a wavelength of 420 nm at room temperature. Based on the curve in **Figure 8**, the spectral peaks of MgO were at wavelengths of 679.97, 687.23, 698.88, 712.32, 720.06, and 740.39 nm. The dominant emission spectrum was detected at a wavelength of 680 - 743 nm and a broad emission spectrum of 400 - 600 nm [42]. Jahanger *et al.* [43] explained that the PL intensity occurred due to the motion of particles and molecules in the MgO lattice; besides, the spectral peaks could be attributed to the emission from MgO due to defects or centers of imperfection. The PL emission spectrum at 720.06 and 740.39 nm detected oxygen or anion vacancies (type F-center) and defect mg or cation vacancies (type V-center). These results followed Jahanger's research *et al.* [43], where MgO emission was at a wavelength of 721 and 743 nm. A defect in the crystal structure had a significant emission source [44]. The PL spectrum of MgO nanoparticles at a wavelength of 720.06 nm corresponded to the excited atomic states, which could be associated with F & F^+ center-type defects [45]. The peak of the PL emission also followed the results of Khalid researcher *et al.* [46], which showed MgO emission luminescence in the range of 650 - 900 nm, with peaks observed at 687.23 and 712.32 nm, where these peaks indicated defects in the lattice. Soma and Uchino [47] reported a defect in the crystal structure of MgO nanoparticles, such as particle size distribution, morphology, porosity, and band gap, which could be related to recombination at the center-type F, namely (F & F^+) [44]. Several emission peaks in the PL spectrum indicated defects in the crystal, which also had the potential to improve the performance of MgO nanoparticles as photocatalytic [48], namely having the ability to adsorb reactants under the influence of efficient photonic activation [49].

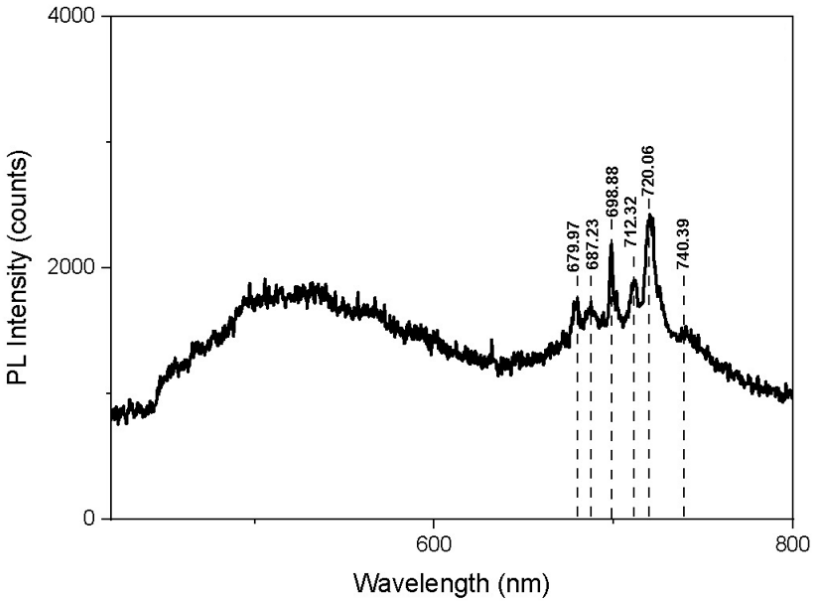


Figure 8 Photoluminescence spectrum of MgO sample.

Photocatalytic activity analysis

The UV-vis characterization results indicating the MgO nanoparticles' absorbance on MB dyes can be seen in **Figure 9**. Along with the irradiation time, the MB dye absorbance intensity decreases from no irradiation to visible light irradiation for 360 min. After 360 min, the absorbance intensity of the MB solution is very low, and even the solution becomes clear and transparent. It shows that the degradation of pollutants with visible light radiation for 360 is optimum and efficient, which is 99.13 % according to **Figure 10**.

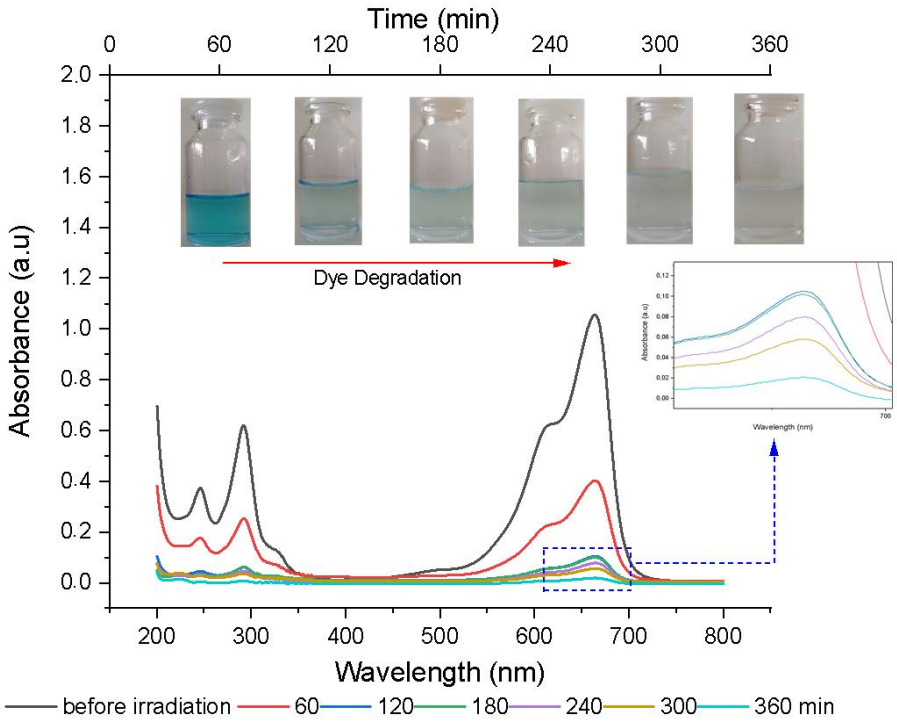


Figure 9 UV-vis absorbance spectrum of methylene blue dye on the photocatalytic activity of nanoparticle MgO under visible light irradiation.

MgO nanoparticles as a catalyst showed good photocatalytic performance in degrading MB dyes under visible light irradiation, which experienced a linear increase in the absorption of MB solutions. Balakrishnan *et al.* [50] stated that the smaller crystallite size and large outer surface of MgO nanoparticles, which were catalysts in this case, greatly influenced their ability to adsorb MB dyes. In addition, the presence of crystal defects and oxygen vacancies could also increase photocatalytic activity. Oxygen vacancies in the sample resulted in a positive free charge (hole), attracting oxygen more quickly and forming H_2O_2 to produce hydroxyl radicals.

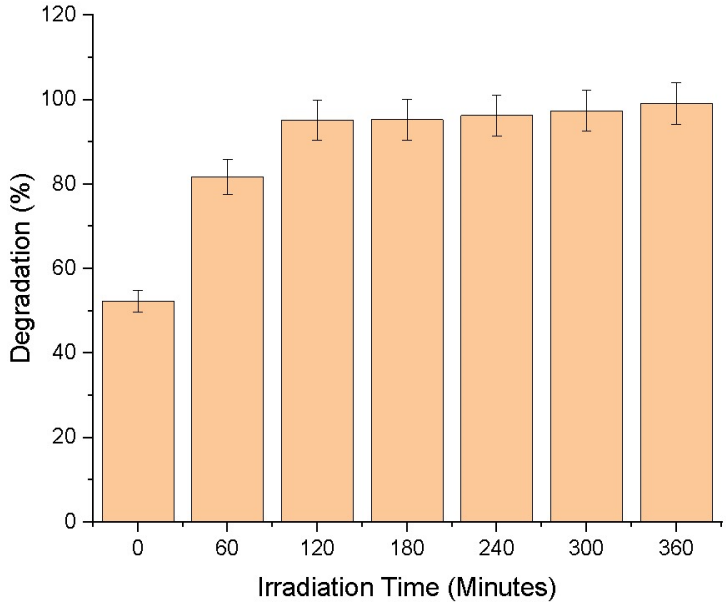


Figure 10 Percent degradation in MgO nanoparticles' photocatalytic activity under visible light irradiation.

In **Figure 10**, it can be seen that the percentage of degradation of the photocatalytic activity of MgO nanoparticles in methylene blue increases with the length of exposure to visible light, namely from before irradiation, which has a degradation percentage of 52.3 % to after irradiation for 60, 120, 180, 240, 300, and 360 min with a degradation percentage of 81.74. 95.20, 95.28, 96.31, 97.36 and 99.13 %. In this research, the adsorption of MB began to experience an increase in the percentage of degradation up to 95 % after 60 min. This degradation percentage is higher than Ahmad *et al.* research [14]; using visible light for 120 min resulted in a degradation percentage of only 90 % with the same MB content of 30 ppm. Likewise, research conducted by Gingasu *et al.* [51] and Salehifar *et al.* [52] showed the results of the photocatalytic activity of MgO nanoparticles by irradiating visible light for 180 min, obtaining results of 70 and 90 % (**Table 3**). Thus, in this study, the photocatalytic activity of MgO nanoparticles had an optimum time to degrade 30 ppm methylene blue, namely 360 min, with a degradation percentage of 99 %. Based on the results of this research, MgO nanoparticles can be applied for processing organic dye waste, especially in the industrial sector.

Table 3 Comparison of methylene blue dye photocatalytic degradation using MgO nanoparticle of sample.

Nanomaterials	Synthesis Method	Time (min)	Degradation (%)	References
MgO Nanoparticles	Green synthesis	150	64 %	[53]
MgO Nanorod	Thermal decomposition	180	90 %	[52]
MgO Nanoparticles	Green synthesis	120	90 %	[14]
MgO Nanoballs	Hydrothermal	120	27 %	[7]
Nanoparticles	Green synthesis	180	70 %	[51]
MgO Nanoparticles	Leaching method	180 360	95 % 99 %	This work

The photocatalytic effectiveness of photocatalysts depends on the band gap energy [54]. In this study, the MgO nanoparticles synthesized had a band gap energy of 3.9 eV (**Figure 10**). It shows that a small band gap width facilitates the transfer of electrons from the valence band to the conduction band so that the rate of oxidation of methylene blue dye is swift. UV light has a wavelength of around 10 - 400 nm, so UV light has a large amount of energy and is considered capable of accelerating chemical reactions in photocatalytic activity. Compared with visible light rays, which have a large wavelength, namely > 400 nm, using visible light irradiation is considered less effective for photocatalytic activity because it has low energy. However, the results of this research, by **Figures 9** and **10**, show that the photocatalytic activity of MgO nanoparticles in visible light has an optimum degradation percentage of 99 % within 360 min. The high degradation efficiency indicates superior photocatalytic activity. This optimum degradation percentage is even more significant when compared with the results of several researchers, which are presented in **Table 3**.

Likewise, for photocatalytic using UV light, within 120 min with a gap energy of 4.15 eV with MgO nanoparticles from shrimp shells, a degradation percentage of 89 % was obtained [55]. Compared with the results of this study using visible light, at the same time, namely 120 min, the percent degradation of methylene blue was 95.20 %. Thus, the longer the exposure during the photocatalysis process under visible light irradiates, the higher the photon energy produced, so the number of hydroxyl radicals produced is also more significant. Hydroxyl radicals are potent oxidizing agents that can degrade MB dye and increase photocatalytic activity [14]. Apart from that, the gap energy of nanoparticles also affects their ability to photodegrade. The smaller the energy, the faster the rate of oxidation process in degrading methylene blue.

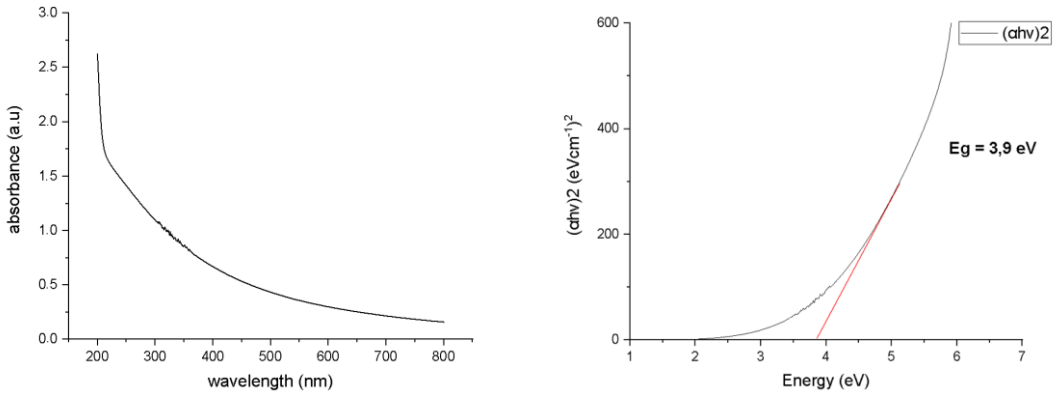


Figure 10 (a) UV-vis spectrum and(b) Tauc plot of the synthesized sample.

Conclusions

MgO nanoparticles from Bangkalan dolomite have been successfully synthesized using the leaching method with a strong acid solvent and have a periclase phase with nanocrystallite size 21.70 nm, nanoparticle size of 27 nm and a gap energy of 3.9 eV. The surface morphology of the MgO particles shows that the particles are spherical in shape. The optical properties of MgO show quite strong luminescence at a Raman shift of 1,087.36 cm^{-1}, which is associated with a type of vibration wave in the atomic lattice. Luminescence in MgO nanoparticles can also be associated with the presence of surface defects in the form of oxygen vacancies or anion vacancies (type F-centers) and Mg defects or cation vacancies (type V-centers), which were detected at wavelengths of 720.06 and 740.39 nm. The presence of nanocrystallite size, crystal defects, and oxygen vacancies in MgO nanoparticles can increase photocatalytic activity. MgO nanoparticles as a catalyst show good photocatalytic performance in degrading MB dye under visible light irradiation, even though it requires a relatively long exposure time. It is known that the optimum time to degrade 30 ppm MB dye is 360 minutes, with a degradation rate of 99 %. The longer the visible light is exposed to photocatalysis, the greater the photon energy produced. It affected the increasing number of hydroxyl radicals produced, which act as robust oxidants that can be used to degrade MB dyes. The smaller the energy, the faster the rate of oxidation process in degrading methylene blue. Thus, MgO nanoparticles can be applied in the textile industry, especially for processing organic dye waste.

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