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A STUDY OF TiO_2 COATING STRUCTURE ON SURFACES OF MERANTI WOOD (*SHOREA SP*) AS A PHOTOCATALYST IN PEAT WATER PURIFICATION

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Abstract
Coating of TiO_2 made on the surface of meranti wood acts as a photocatalyst which is a semiconductor that plays a role in the process of absorbing UV light to degrade humic acid in peat water. Making a thin layer of TiO_2 by Soaking meranti wood that has been cut with a size of 30mm x 30mm x 2mm into aqueous solution of TiCl4 and HCl with a ratio of 1: 1 at a temperature of 80 ° C for 1 hour. Before coating the wood with TiO_2 the meranti wood is first cleaned and soaked for 2 hours in 0.5 mmol / l surfactant sodium dodecyl sulfate (SDS Sigma Aldrich) at a temperature of 80°C to obtain hydrophobic properties. meranti wood with a thin layer of TiO_2 is used as a base on the peat water purification reactor. The analysis carried out was XRD to see TiO_2 crystals formed, SEM and EDS to see TiO_2 deposited on wood surfaces and wood pores. Analysis on peat water obtained a pH of 6.78 which means that the acid content in the water was mostly degraded, COD of 15 mg / l which had entered the class 2 water standard.

Keywords: TiO_2 thin layer, XRD, SEM and EDS, peat water, water purification

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INTRODUCTION

The necessary for clean water is a serious problem in various regions, especially tropical countries that have a dry climate(Zainul, 2016). Indonesia is a tropical country that has a lot of surface water potential, but surface water is not completely clean and can be used for daily needs. One of the abundant surface water is peat water(Ediputra & Aziz, 2019). Peat water in several regions in Indonesia has peat characteristics, namely brownish red color, high in organic matter, low pH, and high Fe content(Hermansyah & Munaf, 2016). With the potential for surface water which is very large, it is necessary to use the best water resources by processing it so that the water can be used to meet daily needs. There are several ways of processing that are carried out to purify peat water, the context is filtering, sedimentation, absorption of odor and color, and some are using acid decomposition(Rilda et al., 2016).

Decomposition of acid in peat water can be done by utilizing UV light from direct sunlight which is assisted by Titania semiconductors found on the surface of the container used in photochemical reactions to raise the pH of peat water(Rassam, Abdi, & Abdi, 2012), so that humic acid is degraded and peat water can be used for needs everyday without worrying about the negative effects of humic acid in the water. Some of the peat water content that is removed include color by filtering, pH, COD and BOD by photocatalytic reaction by utilizing UV energy from sunlight. Reactor containers generally use synthetic materials such as PVC, glass, metals, biomaterials such as rock and wood(Pori et al., 2016). Wood that can be used as a reactor base is wood that has a strong structure, and is hard, and has a high level of porosity, one of which is for example meranti wood(Sun et al., 2010).

Meranti wood is widely available in Indonesia which is spread outside the regions of Sumatra, Kalimantan, Papua and Riau islands. The characteristics of meranti wood are very good in terms of durability, tight porosity, small water content, so that it can be used as a base for reactors which later the wood surface will be coated with TiO2 which aims to be a catalyst in the absorption of energy from UV so that it helps in degrading the existing humic acid. in peat water(Odling, Ivaturi, Chatzisymeon, & Robertson, 2018). Utilization of meranti wood is motivated by a very abundant amount in nature, so that it can reduce usage of synthetic materials and the principle of maximizing the principle of natural resources can be maximized(Li & Zeng, 2011).

As is already the case with research, photocatalyst reactions are related to the absorption of energy from UV to be used for a chemical reaction. One of them is to reduce acid levels in peat water, TiO2 semiconductors are able to absorb UV rays with a wavelength of 380nm, positive holes and electrons will be formed on the surface of TiO2, then redox reactions will occur from compounds that are in direct contact with TiO_2(Levchuk, 2016). hydroxyl radicals (·OH) are formed from water, and the hydroxyl radical is a strong oxidizer with a pH of 1 and a potential oxidation difference of 2.8 volts relative to the hydrogen electrode(Hashimoto, Irie, & Fujishima, 2006). The amount of potential energy produced will be able to oxidize most of the organic compounds in water, the mechanism can be seen in the picture below(Sassoni, Amen, Roveri, & Scherer, 2018).

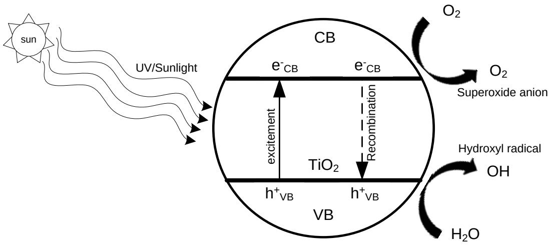


Figure 1. TiO2 Activity

This research uses UV sourced from nature, namely UV energy from sunlight. Sunlight has a 10% UV content, but two-thirds of the 10% reflected by ozone exits the Earth's atmosphere, only one-third of the 10% UV reaches the Earth. where the highest UV intensity is at 11:00 to 13:00 noon with sunny weather(Ediputra & Aziz, 2019).

In this research, We also describe several methods by which the activity of this material can be increased by the simple hydrolysis of TiCl4 which can produce deposition of small particles (Odling et al., 2018). This treatment has also been found to produce chlorine doping into the structure, improving substantial photocatalytic activity for the degradation of organic pollutants. This TiCl4(Odling et al., 2018).

RESEARCH METHODS

a. TiO_2 coating on wood surfaces.

Meranti wood (shorea asp) used as the base of the reactor is cut with dimensions of 30mm x 30mm x 2mm and then cleaned. Before the wood is coated with TiO_2, the wood is made hydropobically by immersing it in 0.5 mm./l sodium dodecyl sulfate (SDS sigma aldrich) solution for 2 hours at a temperature of 80°C and dried. The wood is then soaked into aqueous solution of $TiCl_4$ and HCl which has a ratio of 1: 1 for 1 hour and a temperature of 80°C, where the preparation of this solution is stirring slowly in cold conditions to avoid excessive heat. The wood is then dried in an oven to a constant mass(Pori et al., 2016).

b. coated wood is used as the base for a simple reactor bath, namely petri disc. The filtered peat water sample is then put into a petri disc and then dried in the direct sunlight at 11:00 to 13:00. where the signaling is carried out every day for 10 days with a one-time irradiation time of 2 hours(Lee & Liu, 2002). Retrieve pH and COD data every day of irradiation. there is a reaction of $TiCl_4$ and HCl in the formation of TiO_2, namely:

$$TiCl_4 + HCl + 5H_2O \rightarrow Ti(OH)_4 + 5HCl + H_2O$$

$$Ti(OH)_4 \xrightarrow[\Delta]{} TiO_2 + 2H_2O$$

RESULTS AND DISCUSSION

a. XRD analysis

The results obtained in this study are in the form of XRD data to see whether or not the TiO_2 structure is formed in wood samples. XRD characterization was carried out to determine the crystal structure of the TiO_2 catalyst by knowing the sample peaks and compared with the standard peaks(Farahmandjou, Khalili, Branch, & Branch, 2013). This needs to be done to determine the main catalyst used is not pure TiO_2, so whether this material can form TiO_2(Miditana, Tirukkovalluri, Alim, & Raju, 2019). The sample analyzed was meranti wood coated with TiO_2 catalyst, with a sample size of 30mm x 30mm x 2mm. Then the analysis using X-Ray Cu Anode, voltage 40 kV, current strength 30 mA and diffraction range (2ϴ) = 5° - 80°(Yi et al., 2016).

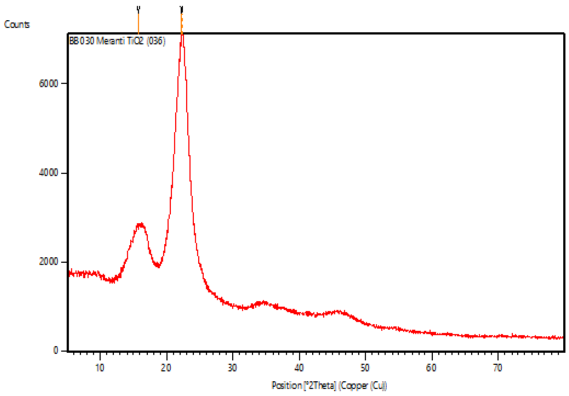
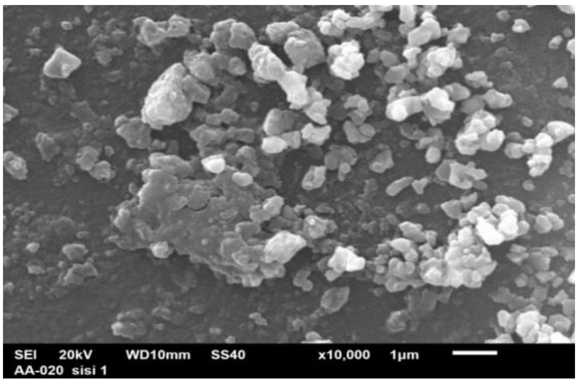


Figure 2. XRD analysis to see the TiO2 phase

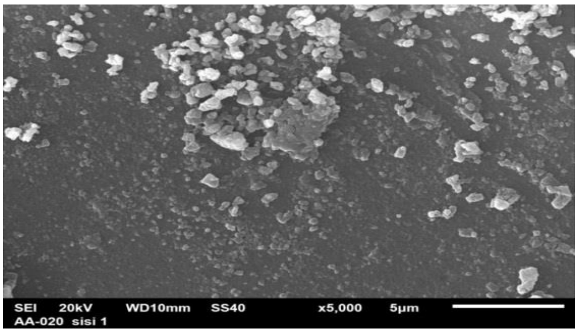
From the XRD chart above, it can be seen that at positions 15.71 and 15.75 have peak heights from the data are 759 and 379. This process there is a TiO2 Crystal formed with a rutile Crystal structure(Kamaei & Rashedi, 2018). While at 22,285 and 22,341 positions the peak data peak is 3689 and 1845, this proved the existence of TiO2 crystals formed with the Anatase structure(Fatimah, Sumarlan, & Alawiyah, 2015).

b. Analysis of SEM

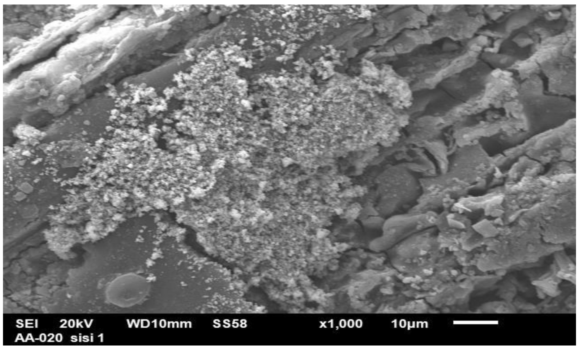
Electron Microscopes (SEM, JEOL 5500 LV, Joel) are used to examine hydrothermal deposits on surfaces and on cross-sections of wood. All samples are coated with a thin film of gold (Sputter Coater SCD 005, Baltec)(Kamaei & Rashedi, 2018). The specimens are scanned in a vacuum and a 20 kV voltage acceleration. To correlate the actual amount of TiO_2 formed on the wood surface as predicted(Rilda et al., 2016), SEM analysis was carried out on sample figure 3. (a) The SEM micrograph examination confirmed that there was an amount of TiO2 formed with 1µm magnification, figure 3. (b) and (c) magnification of 5 µm and 10 µm respectively. The particles can be easily observed. This is expected because it is not possible to obtain TiO_2 (rutile) particles from $TiCl_4$ solution at low temperatures(Farahmandjou, 2013).



(a)



(b)



(c)

Figure 3. SEM image of the surface of a wood sample that has been coated with TiO2

c. EDS Analysis (X-Ray Energy Dispersion Spectroscopy)
Quantitative analysis and titanium concentration profiles in the cross-section of the sample in figure 2 were performed by X-ray Energy Dispersive Spectroscopy (EDS, Oxford Instruments) using the INCA software. The actual acquisition time for EDS quantitative analysis is around 100 s, whereas for line analysis it is between 400 and 600 s. EDS quantitative analysis is carried out taking into account all elements of the analysis(Kumar, Srivastava, & Bansal, 2013). EDS line analysis of Titanium was carried out for sections of wooden beams cut from treated bulk wood (25mm×25mm×2mm) several millimeter from the original surface exposed to TiCl4 solution.

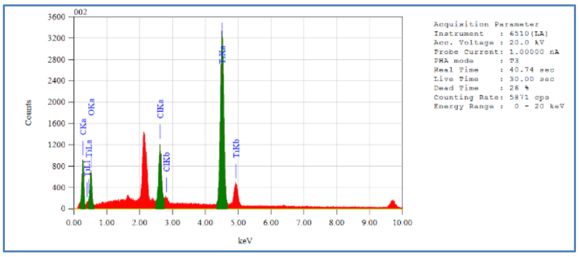


Figure. 4. The concentration profile for titanium was obtained by EDS

d. Analysis of pH and COD
The value of pH is taken daily at 2 hours of irradiation in the peat water sample(Dyan, Putra, Budiyono, Sumardiono, & Kusworo, 2015). pH increases from 4.75 and tends to rise until it reaches 6.78. this shows the degradation of acid contained in peat water, especially humic acid which has the most concentration. The first class water standard, which is water that is suitable for drinking, must have a pH of 6-8(Pourmousa, 2017), which means that peat water that has been irradiated with UV is suitable for drinking when viewed from its pH standard. COD value obtained from samples taken every day after irradiation are likely to decrease from initially 155 mg / l down to only 15 mg / l remaining(Mulyani, Prima, Budianto, & Kaavessina, 2018).

Table.1 pH, COD data of peat water

Time (h)	**pH**		**COD (mg/l)**	
	coating	**non coating**	**coating**	**non coating**
0	4.75	4.75	155	155
2	5.5	4.75	112.5	150
4	6.22	4.77	95.5	147.5
6	6.54	4.77	82	142.2
8	6.62	4.78	74.5	130.4
10	6.68	4.79	65.5	130

12	6.7	5	56	128.4
14	6.72	5.32	44.2	120
16	7.74	5.5	35.2	114
18	6.76	5.6	22.2	100.4
20	6.78	5.7	15	97.5

From table 1 shows that there is a significant increase of pH in reactors coated with TiO2 where the initial pH is 4.75 up to 6.78 when compared with uncoated reactors increase the pH to only 5.7. The COD value can also be seen in table.1 where the reactor without TiO2 coating shows a COD value of 97.5 gr/l is different from the reactor that is coated with TiO2 leaving only a COD value of 8.8 gr/l. The comparison of COD values with irradiation time can also be seen in the graphic image below;

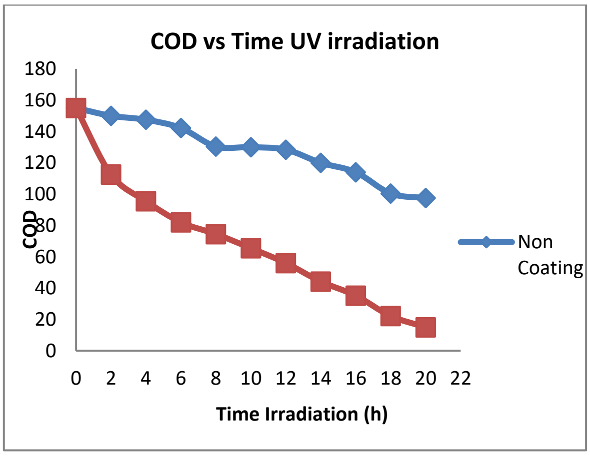


Figure 5. Comparison graph of COD value and UV exposure time

From Figure 5. also seen differences between the value of COD obtained by the irradiation time for 2 hours conducted every day for ten days with a total irradiation time for 20 hours(Dyan et al., 2015). The COD value obtained from the experiment shows the effectiveness of UV rays catalyzed by TiO_2 coated on the surface of meranti wood can reduce the COD value in peat water samples(Dogar, Nawaz, Majeed, & Saeed, 2013), so that the sample water after treatment can be categorized into class 2 water standards in Indonesia with a maximum price of 25 mg/l.

CONCLUSION

Meranti wood can be coated with TiO2 which is used as a photocatalyst reactor base, where TiO2 acts as a catalyst in the absorption of UV rays from direct sunlight on peoses purifying water process containing high levels of humic acid. With the absorption of UV energy obtained can increase the pH of peat water samples to 6.78 and the COD value drops to 15 mg/l.

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