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THE EFFECT OF VARIATION IN (SiMn/PS) NANOCOMPOSITE COMPOSITION ON HYDROPHOBIC POPERTIES

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ABSTRACT

Many researches on hydrophobic synthesis have been carried out on coatings, but there are stillshortcomings,for example, the coating is easily scratched, easily corroded and damaged by contact with other materials, thereby reducing the quality of the coating. This can diminish the use of hydrophobic coatings in industry and others. Therefore, it is necessary to develop a hydrophobic coating that is strong, durable, and not-corrosion so that the quality of a surface can be improved.For this reason, research is carried out by mixinga substrate that hashard properties such as manganese and non-corrosive such as silica to conquer the problems that occurred previously by utilizing the spin coating method. The precursor was prepared by adding 0.5 grams of polystyrene,with varying SiMn compositions. The coating was carried out by utilizing the spin coating method using an oven for 1 hours ata calcination temperature was 60ºC. The results of the research from this composition variation shows that the SiMn/PS nanocomposite layer is hydrophobic depending on the contact angle test. The composition of 50%:50% is the largest contact angel with a large contact angle of 104.7°.

Keywords : *hydrophobic, Silica Oxide (SiO2), Manganese (Mn), polystyrene, contact angle, durability, nanocomposite.*

I. INTRODUCTION

Currently, research on hydrophobic surfaces has been carried out by many other researchers. However, the results obtained still have many shortcomings such as easy to scratch and easy to corrode. Consequently, the advancement of a strong and durable hydrophobic coating and resistance to corrosion in an efficient and easy method is direly required.

A surface can be supposed to be hydrophobic if it has specificproperties. The hydrophobic nature has anti-wet properties witha big contact angel of 90ºC [1]. To determine the hydrophobicity of a surface,it can be done by the angle formed between the glass surface coated by the SiMn nanocomposite and the water as well as by measuring the contact angle [2]. A hydrophobic surface has a contact angle between 90°-150°,whereas a contact angle >150° is called superhydrophobic [3].

Silica is a metal oxide compound that is broadly found in nature, silica alsohas anti-corrosion properties [4]. The arrangement of atoms in amorphous silica has a low degree of regularity and occurs randomly. Therefore, the silica sand purification process to remove impurities needs to be carried out [5]. Manganese is an element that has a grayish black color and is one of the plentiful abundant elements found in the earth's crust [6]. Manganese ore has the potential to be developed as an industrial material along with technological advances [7]. Nanocomposite is a matrix with dimensions of 1.0 x 10-9 m. For the production of coatings, polystyrene polymers are used. This polystyrene is impervious to acids, bases and other rusty materials [8]. There are several methods used for this purpose, for examplephase separation,electrochemical reactions, sol- gel,sin coating, dip coating, filler particles and coprecipitation.

Spin-couting method is used to make SiMn/PS nanocomposite layers, because this method is easy to do and can make a homogeneous layer. The coating matrix is polystyrene because it is resistant to acids, bases and other rust materials [7]

II. METHOD

This study examines the effect of variations in the composition of SiMn/PS nanocomposites on hydrophobic properties. This type of research is an experiment conducted at the Materials Physics Laboratory and Biophysics and Chemistry Laboratory, Faculty of Mathematics and Natural Sciences, Padang State University. the materialsused are silica, manganese, polystyrene (PS), tetrahydrofuran (THF) and aquadest. The equipment used is a beaker, measuring cup, magnetic stirrer, oven, furnace, spin coating, glass, camera, FTIR and XRD, SEM.

There are several steps taken:

Sample preparation stage, the synthesis of silica and manganese nanoparticles byweighing 8 grams of silica and manganeseand then groundfor 5 hours for silica and 16 hours for manganese using HEM-E3D. The next step is the manufacture of Silica Manganese/Polystyrene precursor by dissolving 0.5 grams of polystyrene in 15 ml of tetrahydrofuran using a magnetic stirrer at a temperature of 500C. Then mix it with SiMn with a varied composition where the composition used is 20%: 80%, 40%: 60%, 50%: 50%, 60%: 40%, 80%:20% with the amount of SiMn 0.4 grams, then stirred for 1 hour using a magnetic stirrer until homogeneous. The next step is sample preparation bypreparing glass preparations with a size of 0.5cm x 0.5cm and 1cm x 1cm then washing using an ultrasonic cleaner by soaking the glass in a solution of PEG and aquadest for 2 hours [9]. The next step is to make a thin layer using a spin coating by doing a Spin Coating by placing a glass substrate and then dripping it with a prepared SiMn/PS solution, then rotating it at a speed of 500 rpm for 60 seconds. Furthermore, the manganese silica nanocomposite layer formed was heated in an oven at 60ºC for 1 hour. Thentake photo for contact angle using camera in dark room. Then to measure the contact angle using ImageJ software. Here's how the ImageJ software looks and works [10].

Fig.1. ImageJ Software Display

For the contact angle measurement, in the file tool select the picture to be measured, the image will appear then select the angle tool, after that between the water droplet and the surface draw a straight line, then drag the line upwards to form an angle between the droplet and the sample surface [11].

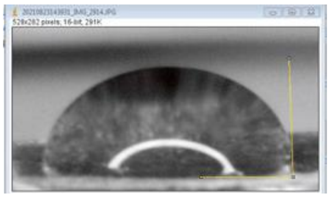

Fig.2. Measuring Contact Angle

The contact angle is identified by, select Analyze then choose Maesure, the contact angle result will be appeared. Then, calculate the average after making repeated measurements [12].

Next, analysis stage the contact angle acquired from the measurement of the composition of the SilicaManganese/Polystyrene (SiMn/PS) nanocomposite layer, the analysis can be calculated by the accompanying equation :

$$Contact\ angle = \frac{right\ contact\ angel + left\ contact\ angel}{2} \quad (1)$$

After that the data is deciphered as a diagram. The impact of temperature on the contact angle can be determined by plotting the data on the X and Y coordinates utilizing the Microsoft Excel program. The general technique used to plot data on an XY graph is that the independent variable is plotted on the X axis and the dependent variable is plotted on the Y axis [13].

III. RESULTS AND DISCUSSION

The result of this study is the identification of the contact angle taken from measurements on a thin layer of Silica Manganese/Polystyrene (SiMn/PS) nanocomposite with composition variations of 20%: 80%, 40%: 60%, 50%: 50%, 60%: 40 % and 80%:20%. measuring the contact angle can be done using the image-j application which can be seen in Figure 3 and the results can be seen in Table 1 for composition of nanokomposite SiMn 20%:80%

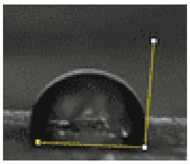

Fig.3. Contact Angle Measurement with 20%:80% SiMn composition variation

Table 1. Result of contact angle measurement with 20%:80% SiMn composition variation

Contact Angel		
Measurement Results		**The Calculation Results**
Θright	θLeft	Θ
92.245 °	92.072 °	92.158
92.726 °	91.513 °	92.119
92.984 °	91.441 °	92.212
92.821 °	91.122 °	91.971
92.153 °	91.214 °	91.686
Average		92.029

In the Table 1 it can be seen that the composition of the 20%:80% SiMn nanocomposite is already hydrophobic because the resulting angle is >90° with a large angle of 92.029°. Which can be seen in Figure 4 and the results can be seen in Table 2 For composition of SiMn 40%:60%

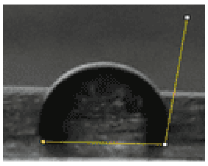

Fig.4. Contact Angle Measurement with 40%:60% SiMn composition variation

Table 2. Result of contact angle measurement with 40%:60% SiMn composition variation

Contact Angel		
Measurement Results		**The Calculation Results**
θRight	θLeft	Θ
97.063 °	97.326 °	97.194
97.634 °	97.474 °	97.554
97.884 °	97.627 °	97.755
97.462 °	97.608 °	97.746
97.379 °	97.235 °	97.307
Average		97.511

In the table 2 it can be seen that the composition of the 40%:60% SiMn nanocomposite is already hydrophobic because the resulting angle is >90° with a large angle of 97.511°. Which can be seen in Figure 5 and the results can be seen in Table 3 for composition of SiMn 50%:50%

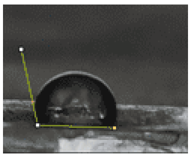

Fig.5. Contact Angle Measurement with 50%:50% SiMn composition variation

Table 3. Result of contact angle measurement with 50%:50% SiMn composition variation

Contact Angel		
Measurement Results		**The Calculation Results**
Θright	θLeft	Θ
104.986 °	105.457 °	105.221 °
104.484 °	104.339 °	104.411 °
105.287 °	105.097 °	105.197 °
104.706 °	104.925 °	104.817 °
104.321 °	103.389 °	103.855 °
Average		104.7 °

In the table 3 it can be seen that the composition of the 50%:50% SiMn nanocomposite is already hydrophobic because the resulting angle is >90° with a large angle of 104.7°. which can be seen in Figure 6 and the results can be seen in Table 4 for composition of SiMn 60%:40%

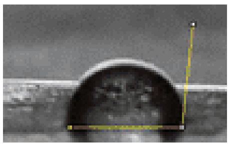

Fig.6. Contact Angle Measurement with 60%:40% SiMn composition variation

Table 4. Result of contact angle measurement with 60%:40% SiMn composition variation

Contact Angel		
Measurement Results		**The Calculation Results**
θ Right	θLeft	Θ
96.459 °	95.811 °	95.635
95.816 °	95.474 °	95.645
96.282 °	94.627 °	95.477
95.711 °	95.608 °	95.659
96.226 °	95.235 °	95.730
Average		95.629

In the table 4 it can be seen that the composition of the 60%:40% SiMn nanocomposite is already hydrophobic because the resulting angle is >90° with a large angle of 95.629°. Which can be seen in Figure 7 and the results can be seen in Table 5 for composition of SiMn 80%:20%

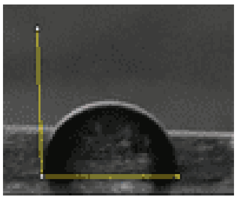

Fig.7. Contact Angle Measurement with 80%:20% SiMn composition variation

Table 5. Result of contact angle measurement with 80%:20% SiMn composition variation

Contact Angel		
Measurement Results		The Calculation Results
θ Right	θLeft	Θ
92.141 °	92.729 °	92.435
92.675 °	91.567 °	92.121
92.102 °	92.775 °	92.438
92.548°	91.546 °	92.047
92.027 °	91.346 °	91.686
Average		92.146

In the table 5 it can be seen that the composition of the 80%:20% SiMn nanocomposite is already hydrophobic because the resulting angle is >90° with a large angle of 92.146° which can be seen in Figure 8.

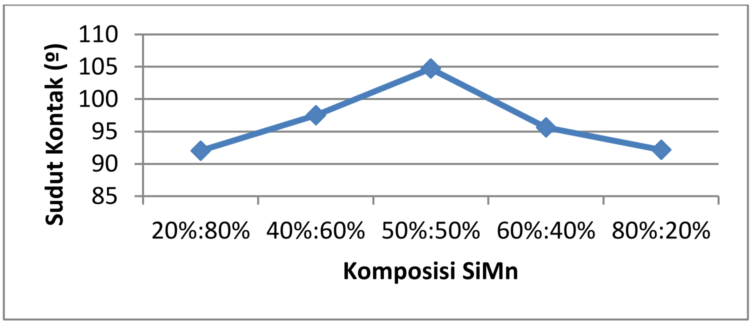

Fig.8. Relationship Between Composition Variation and Contact Angle Measurement

Based on the data in the Figure 8 obtained from the contact angle of the water droplets with the surface layer, 5 variations of composition were used, according to [4] polymers without the addition of nanoparticles had weak strength. Polymers mixed with nanoparticles will have a stronger and tighter structure. So, to make a hydrophobic coating using polystyrene, the composition of silica and manganese nanoparticles is added to it, here will be seen the effect of variations in the composition of nanoparticles on the contact angle of the hydrophobic layer, where the composition of SiMn nanoparticles used is 20%: 80%, 40%: 60, respectively. %, 50%:50%, 60%:40% and 80%:20%.

After going through the tests and measurements, it was found that the contact angles were not too different between the five variations of the silica composition, the contact angles had sizes of 92.029°, 97.511°, 104.7°, 95.629°, 92.146° so that it can be said that the composition of silica and manganese nanoparticles in the SiMn nanocomposite /polystyrene affects the magnitude of the contact angle, and the five variations have been successfully made hydrophobic. Where the highest contact angle is found in the 50%:50% SiMn composition, which is 104.7°. And the lowest is in the composition of SiMn 20%:80% with a contact angle of 92.029° which can be seen in Figure 9.

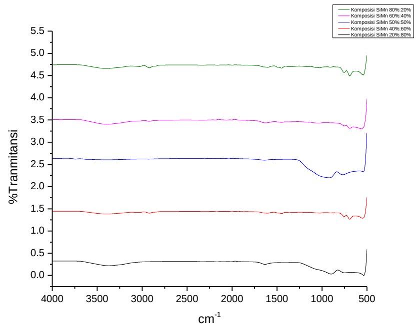

Fig. 9. FTIR measurement result data

FTIR serves in the Figure 9 to show the infrared spectrum that contains the presence of functional groups in the sample. In testing the surface of the coating with the composition of SiMn 20%:80%, 40%:60%, 50%:50%, 60%:40%, 80%:20%. These results show that the functional groups are present in the composition of SiMn 40%: 60% and SiMn 50%: 50. The absorption peak in the wave number region of 540.51 cm-1 comes from the Mn-O bond stretch (MO: 400-560 cm-1), 767.69 cm-1 comes from the Si-O stretch with a range of 782 - 805 cm -1. Which shows the absorption peak is observed at the wave number 1641.11cm-1 C=C group, in the form of a double carbon bond. Furthermore, the wavelength of 919.53cm-1 indicates the presence of bonds between carbon and hydrogen atoms with the C-H functional group.

From the data above, it shows that the group is in the composition of SiMn 50%:50% and SiMn 40%:60%.In the composition of SiMn 40%: 60% and SiMn 50%: 50% there are several very significant main absorption bands located at wave number 547.49 cm-1indicating the Mn-O bond stretch, the CH functional group at wave numbers 919.50 cm-1, 751.58 cm-1comes from the Si-O stretch with a range of 782 - 805 cm-1

IV. CONCLUSION

Based on the research that has been done, it can be concluded that the SiMn composition affects the contact angle and has shown a hydrophobic layer where the contact angle exceeds 90°. And the highest contact angle is found in the composition of SiMn 50%:50% with a contact angle of 104.7°.

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