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Effect of Cathode Waste Material Concentration in Conductive Paint Coating

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Abstract

The conductive paint coating can be used to control the electromagnetic interference in electronic application. Conductive paint coating was made by mixing the epoxy and hardener with cathode waste material (CWM) in order to manipulate their properties. In this study, the conductivity and the thickness of the paint has been studied. The thickness of conductive paint coating was depends on the agglomeration of CWM content. The increasing of wt% of CWM, the thickness of paint is increasing. Bruker D2Phaser X-Ray diffraction has been used in order to get the phase analysis of the paint before and after soaking into Potassium Hydroxide solution.

1. Introduction

The overview about paint has been given on the major of paint coating, type of paint coating, its properties and the application of paint coating. Paint coating has been used widely in the application of surface coating that gives properties such as colour, gloss and anti-corrosion.

Paint referred to any liquid or the composition that will converted to solid after applied on the surface of substrate. The paint coating acts as a barrier between metal and environment. This will avoid the substrate from direct contact to the moisture from ambient air. As a result, paint coating play a role as substrate protection. Basically the paint coating has been used in enormous due to non-conductive, low cost and good physical properties (Masri et al. 2010).

Besides, the paint coating was once referred to the most economical methods of protecting metal from deteriorate. The purpose of using the paint coating was to enhance the lifetime of metal and gives decorative to metal substrate (Nazeri et al. 2012). Paint coating consist of pigment, binder and additives. However, the paint coating consist of different composition such as in the pigments, binding media or binder and additives (Herit, 2016). This dissimilar in the composition depends on the applications requirement.

In addition, the technique in painting was important and intend to the different potential of application. The initial step was selection of topcoat primer and midcoats primer (Hu et al. 2012). However, the surface preparation of substrate is a most important factor that influences the success of paint coating system. In the other hand, the surface pre-treatment of the steel when using organic coating is very important towards the durability of the coating bond.

However, the conductive paint was produced from the combination of pigments into the systems. In order to produce conductive paint, the following method is possible to use which are, utilize conductive polymer as the continuous matrix, incorporate conductive pigments as sufficient pigment volume concentration, or combination of both method. In various application of electrical application, the electrical conductive paint is required in order to prevent spark and draw the static voltage charge that lead to dangerous discharge sparks. The amount of surface resistance needed is in range of 10^{-6} to 10^{-9} Ωcm^2 (Chew et al. 2000).

2. Materials and Methods

2.1. Preparation of Cathode Waste Material from Commercial Battery

The commercial battery has been cutting to taken out the CWM from the battery. The CWM then will undergo the process of remove all the electrolyte in the CWM. After the electrolyte was removed, the CWM was dried in the oven with temperature of 120°C. Then, dried CWM was undergoing the process of sieving in order to refine particle. The percentage of CWM was calculated using equation of CWM (%).

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CWM (%) = Mass of CWM/(Mass of epoxy resion + Mass of polyamide+Mass of CWM) x 100

2.2. Preparation of Conductive Paint Coating on Substrate

The epoxy resin and hardener from Fibre Glast was mixed with the ratio of 100:27 to form paint coating. Mild steel was used as substrate as the mild steel firstly undergo the surface preparation technique to remove oxide layer. The mild steel then covered with paint coating at different percentage of CWM. The paint was leave to dry for 24 hours at room temperature.

2.3. Net Thickness of Conductive Paint Coating

After dried for 24 hours, the samples of conductive paint coating were measured the thickness by using the Digital Portable Paint Coating Thickness Gauge Meter Width Measuring instrument F/N Probe. The three reading was taken to take the average of thickness of paint.

2.4. X-Ray Diffraction Analysis

The conductive paint coating was scanned under XRD, Bruker before and after exposed to potassium hydroxide (KOH) solution. The conductive paint was exposed to KOH solution by filled the PVC tube that sealed on the surface of paint. The sample then was left open to the air for 7 days. The phases and element was identified.

3. Results and Discussion

3.1. Net Thickness of Conductive Paint Coating

The average thickness of coating had been calculated by minus the net reading calibration factor with average net reading of coating. The net reading calibration factor was calculated before the finding of net reading by calibrate the Digital portable paint coating thickness gauge meter width measuring instrument F/N probe. The calibration factor found was 10.67 um.

Figure 1 and Table 3 shows the net thickness of conductive paint coating. The sample of ms02 is represent as mild steel, while sample ms04, ms05, ms06, ms07, ms08 and ms09 represent the mild steel covered with epoxy paint system, epoxy paint system with 5, 10, 15, 20, and 25 weight percentage of CWM, respectively. The graph shows the increasing in thickness as the weight percentage of CWM increase. The mild steel is acting as a control variable.

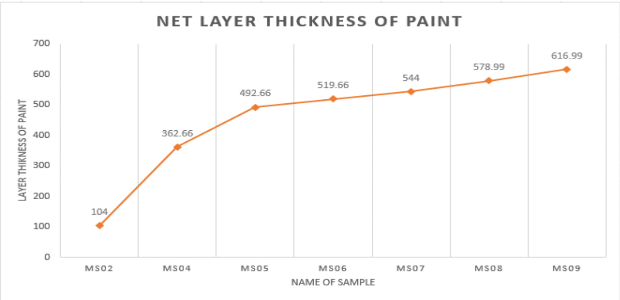

Figure1: Graph of thickness of conductive paint

Thickness of the paint may be vary because of the paint viscosity due to the existence of CWM in the paint. The epoxy paint system with 5% of CWM having lowest viscosity among the other paint system with various weight percentage of CWM. Meanwhile, the epoxy paint system with 25% of CWM having the highest viscosity as its thickness is the thick one among others.

Table 1: The thickness of conductive paint coating

Sample name	Thickness (um)	Average thickness (um)
Ms02	106.00 132.00 106.00	104.00
Ms04	371.00 378.00 371.00	362.66
Ms05	462.00 478.00 570.00	492.66
Ms06	492.00 540.00 559.00	519.66
Ms07	564.00 521.00 573.00	544.00
Ms08	578.00 614.00 575.00	578.99
Ms09	792.00 545.00 546.00	616.99

The thickness of conductive paint is depending on the agglomerate of the CWM in the paint system. The agglomeration of the CWM is depending on the size of CWM. In this research, the size of CWM is fixed at 20 µm by doing the sieving process. However, each of the sample has been leaved to cure for 24 hours. This is to prevent the agglomeration of epoxy paint system. Thus, it can be concluded that the increasing of the thickness depends on the content of CWM in epoxy paint system.

3.2. X-Ray Diffraction Analysis

X-ray diffraction technique (XRD) has scanned the sample from 0.002° to 89.997° at room temperature. 9 samples has been analysed. Sample of raw CWM, plain mild steel, mild steel and paint system after and before exposed to KOH solution with different weight percentage of CWM has been choose to be analysed. Sample of raw CWM has been analysed to show it structure and composition of element in paint. While, sample of plain mild steel and mild steel with paint system has been differentiate to show the activity after and before exposed to KOH solution.

Figure 2 shows the peak of mild steel before exposure 6 M of KOH solution in OCP analysis. The element such as C, Mn_2O_3, Al_2O_3 and Na that confirms the element of CWM. The C crystallography has been found in triclinic system with volume of 1115.63 and density of 1.332. The C is found in $C_{22}H_{43}Ag\,O_2$ which is an

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inorganic compound that may come from natural sources. The C element is discovered in (COD 1507774) pattern number. However, Al_2O_3 is found in (COD 9014359) pattern number by the name of Tricalcium aluminate that having the crystallography of cubic. Tricalcium aluminate contain 2 atom of Al, 3 atom of Ca, and 6 atom of O that has been classified as mineral, inorganic. The density and volume of Al_2O_3 is 3.036 and 443.15 respectively that slightly higher than C element. The element of Mn_2O_3 is found by the formula of Mn_2O_5 in pattern number of (COD 9015609) by the orthorthombic crystallography. Mn_2O_3 Is classed as inorganic element.

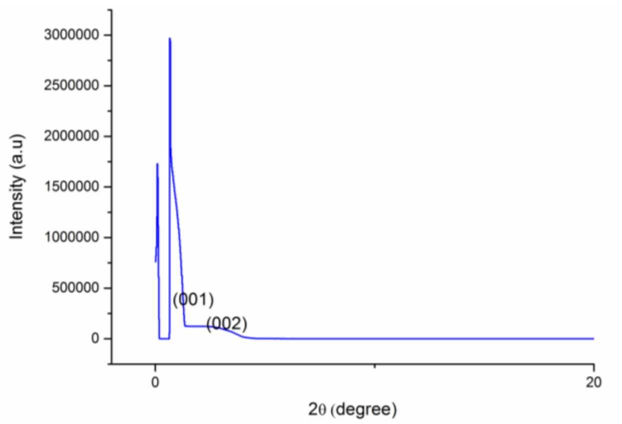

Figure 2: X-ray diffraction pattern of raw CWM

However, for the Figure 3 shows the pattern of XRD pattern of mild steel. From the graph shows the element of Fe has been found as it compounds name showed is Byzentieve. Byzentieve is form a hexagonal shape that has volume of 7357.94 and density of 4.149 that is high in composition of Fe element. The compound is a mineral, inorganic that discovered at (COD 9015509). At 2.590° the composition of Fe is at 100% which is perpendicular to plane (00-3). Thus, it is prove that the mild steel only have Fe element.

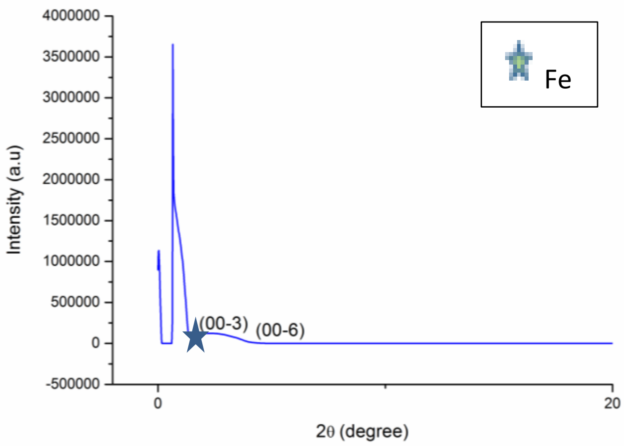

Figure 3: X-ray diffraction pattern of mild steel before exposure to KOH solution

From Figure 4, there is existence of $Fe(OH)_2$ that indicates the corrosion product from the attack of KOH solution. This product can be found at (COD9003076) by mineral name Geothite. However, this product come from the precipitation of $Fe^{2+} + 2OH^- \rightarrow Fe(OH)_2$. During the soaking of sample in the KOH solution, the oxide precipitated form on the surface of mild steel and on the surface of other paint system.

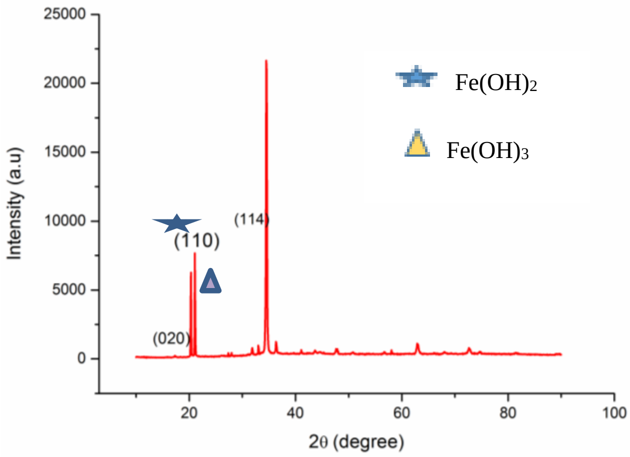

Figure 4: X-ray diffraction pattern of mild steel after exposed to 6 M KOH solution

From Figure 5 and 6, the peak of X-ray diffraction pattern of both samples before and after have been differentiate. The peak of the X-ray diffraction pattern before and after expose to KOH was changed completely. This is due to the existence of OH ion from the KOH solution that was changed in lattice parameter of the compound exist in the paint.

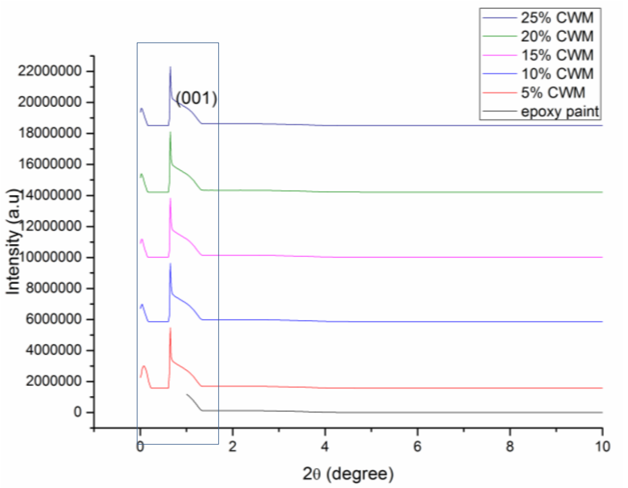

Figure 5: the comparison of X-ray pattern of sample before exposed to KOH solution

Before exposed to KOH solution, the X-ray diffraction pattern for all sample which are 5, 10, 15, 20, and 25wt% of CWM in epoxy paint system were same excluded the epoxy paint system sample. This was because, the epoxy paint system sample does not contain CWM element. The paint epoxy system sample only contain C and Fe element as C come from the epoxy itself. While, for the other samples that contain CWM element on the epoxy paint will having MnO_2, AlO_3 and C that indicates the element of CWM itself.

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However, after exposed to the KOH solution all the X-ray diffraction pattern was completely changed as shown in Figure 6. The changes in pattern of XRD analysis showed that the reaction of corrosion occur on the sample.

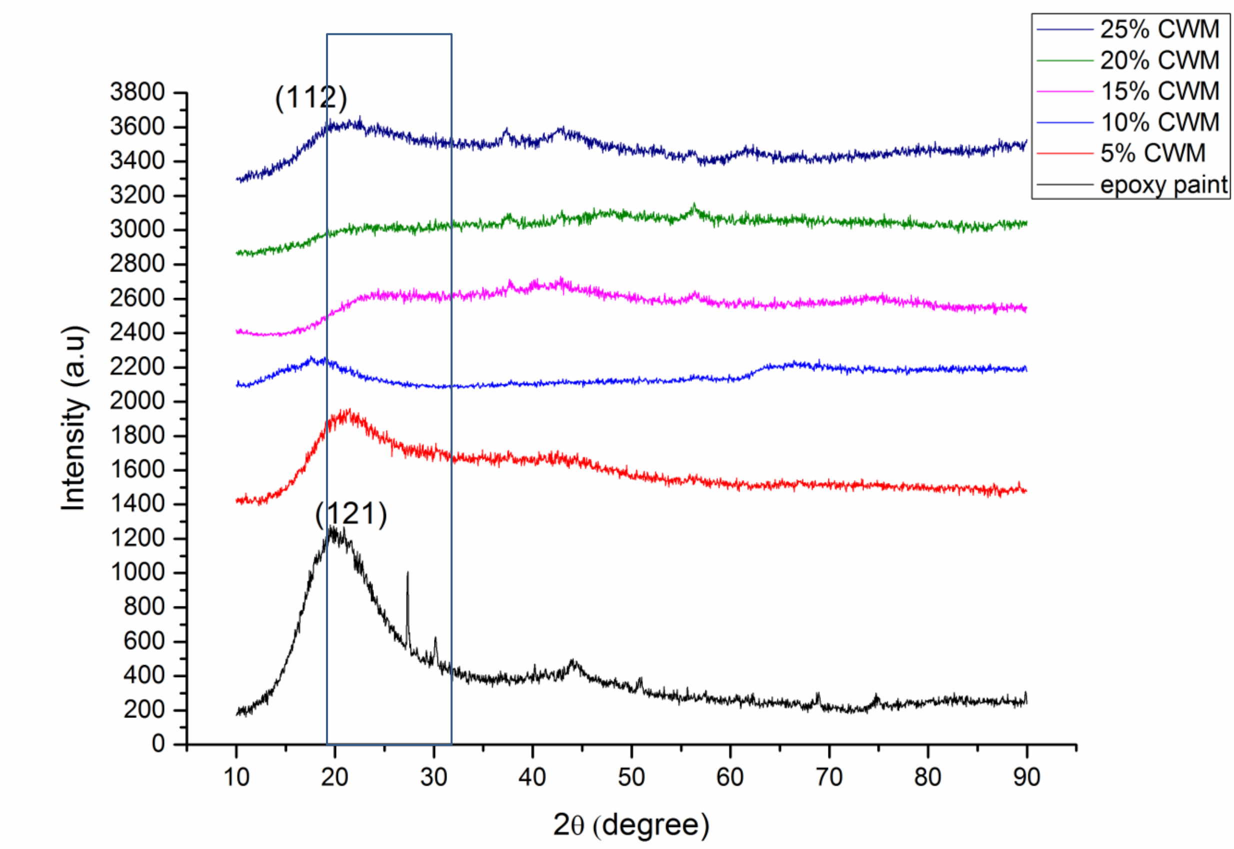

Figure 6: the comparison of X-ray pattern of sample after exposed to KOH solution after 7 days

4. Conclusion

In this study, the conclusion can be made that the adding of CWM can enhanced the properties of the paint as conductive paint coating. The optimum amount of CWM is 5wt% as the system of paint work excellently in the corrosive environment with 362.66 um thickness. The XRD analysis show that there were corrosion product and precipitation occur on surface of substrate after exposed to KOH solution.

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References

Masri, M. N., Yunus, Z. M., Warikh, A. R. M., & Mohamad, A. A. (2010). Electrical conductivity and corrosion protection properties of conductive paint coatings Electrical conductivity and corrosion protection properties of conductive paint coatings, (March 2016).

Mohd Nazeri, M. F., Mohd Suan, M. S., Najmi Masri, M., Alias, N., Abd Rashid, M. W., Alias, Y., & Azmin Mohamad, A. (2012). Corrosion and heat treatment of paint coating containing battery cathode waste material-epoxy resin in 3.5 wt% sodium chloride solution. International Journal of Electrochemical Science, 7(10), 9633–9642.

Herit, C. (2016). Tryptic cleavage of proteinaceous paint : a high-performance protein binder analytical technique Tryptic cleavage of proteinaceous paint : a high-performance protein binder, (April).

Hu, R., Zhang, S., Bu, J., Lin, C., & Song, G. (2012). Progress in Organic Coatings Recent progress in corrosion protection of magnesium alloys by organic coatings. Progress in Organic Coatings, 73(2–3), 129–141.

Chew, K. W., Yahaya, A. H., & Arof, A. K. (2000). Contributed papers Studies on the properties of silicone resin films on mild steel, 29(6), 364–368.

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