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THE MORPHOLOGY OF ANTI-CORROSIVE COATINGS ON METAL SURFACES USING EXRACTS OF CALOTROPIS PROCERA AND EUPHOBIA KAMERUNICA PAX

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ABSTRACT

This study was carried out in order to assess the morphology of coatings on mild steel metal surfaces using *Euphorbia kamarunica* Pax and *Calotropis procera* plant extracts as corrosion-inhibitors. The determination of the morphology of the coated film on the metal surfaces was carried using the scanning electron microscope. The images obtained showed extracts of *E. kamarunica* are in the form of strands on the metal surface with mean particle size of 25 nm while those of *C. procera* were oval in shape with mean particle size of 180 nm. Generally, the particle sizes seen from both extracts ranged from 12500 to 25nm. Shapes of morphology plant coatings on metal, mean provides the distribution of particle sizes-allowing particle dimension for characterizing materials studying aggregates and assessing particle distribution, angles sizes of the orientation of features in a SEM image enables the analysis of crystallographic orientation surface roughness and the alignment of particles and length which helps to understand the scale and dimensions of the objects observed under microscope of the coated plant extracts have all been provided from the Scanning Electron Microscope analysis of the natural plants. These results are indicative of the degree of effectiveness of using these plant extracts as corrosion inhibitors.

Key Words: Corrosion, Extract, Morphology, Plants, Scanning electron microscope.

1.0 Introduction

Corrosion is defined as the degradation or deterioration of a material or metal as a result of chemical or electrochemical reactions with its environment. In this process metals are converted into stable compounds like metal oxides, metal sulfide or metal hydroxides (Beleni *et al*., 2024). It is as a result of electrochemical reactions between materials and substances present in our environment.

The problem of corrosion has resulted to lots of challenges in our society today: there are cases of collapsed buildings and bridges which has led to the loss of lives and properties. There are also cases of oil pipe breakages, chemical plant leakages and bathroom/house floods, all, resulting from broken pipe, causing accidents, injuries and even death (Mohammad, 2020).

Cases abound of corroded electrical materials which have caused fire outbreak that damaged so many lives and properties. Additionally, some corroded medical implants have resulted in blood poisoning. Corrosion has also damaged several works of arts in the environment (Rene *et al*., 2024). Corrosion negatively impact on iron and steel desirable properties, making them loose strength and consequently unfit for use. Lots of accidents occur due to the effects of corrosion on our doors, pipes and vehicles. Dissolved lead in pipes pollutes water making it unfit for drinking and domestic uses. The consequences are lead poisoning and deaths (Beleni, *et al*., 2024).

Coating and painting of metal surfaces are some of the measures undertaken to avert the effect of rusting of metal surfaces. However, the high cost of coating and painting, leaves more to be desired. This research focuses on evaluating the morphology of the coated film on the metal using Scanning Electron Microscopy (SEM) using *Euphorbia kamarunica* Pax and *Calotropis procera* as corrosion inhibitors.

2.0 Materials and Methods

2.1 Study Area

The study area is Shabu in Lafia town the capital of Nasarawa State. It lies within latitude and longitude of $8^0$34"N, $8^0$33"E respectively (Silas, 2020).

2.2 Sample Collection

The two plants *Calotropis procera* (Plate 1) commonly called Apple of Sodom, Tumfafiya in Hausa and Ewe Bomubomu in Yoruba (Olufunke, 2021) and *Euphorbia kamerunica* Pax (Plate 2) also known as cactus plant (Fai and Fagade, 2005) were collected at 9:00am on the 5th and 6th January, 2023 respectively in the environment of Natasha estate in Shabu, Lafia North Development Area of Nasarawa State, Nigeria. The leaves and stem were carefully cut from the tree using a knife and taken to the laboratory for the next stage of processing.

Plate1: *E. kamerunica*

Plate 2: *C. procera*

2.3 Materials and Reagents

Materials and reagents used in this study include Q-235 Mild Steel plates, distilled water, mortar and pestle, buchner apparatus, knife, Analytical weighing balance, 500 mL beakers, Measuring cylinder, Electric blender and Funnel (Robert and Siddappa, 2024).

2.4 Sample Preparation

The plant samples were thoroughly washed with distilled water to remove dust and unwanted particles. The leaves and stems were dried at room temperature for seven days and ground into a fine powder using electric blender for *C. procera* and a mortar and pestle for *E.kamerunica* plant (because of its thickness, leafless stems covered in spines or sharp spikes) and later ground into a fine powder using electric blender and stored in a dry cupboard (Ag service laboratory, 2023). The mild steel metal surface was coated with the sample of plant extract solution labeled C (*Euphobia kamerunica*), P (*Calotropis procera*) and A (no coating), for analysis using JSM 7600F-JPG scanning machine model number Joel-JSM 7600F.

3.0 Results and Discussion

Morphology of the cooated film on the metal using Scanning Electron Microscopy The morphology of sample A (pure metal plate without coating) as analysed by the scanning electron microscope (SEM analysis) in magnifications of 600 shown in Figure 1 while the particle size Figure 2. The images showed particles of varied sizes, lengths, angle areas and shapes on the respective metal plates are SEM readings on the metal plate using J.soft ware. Figure 1 showed smooth images on the metal surfaces and Figure 2 showed that the average particle size of the metal coupon to be 12500 nm. These data provide information about the physical relationships of the sizes; crystallinity and juxtaposition of the phases present (Hyojin *et al*., 2020).

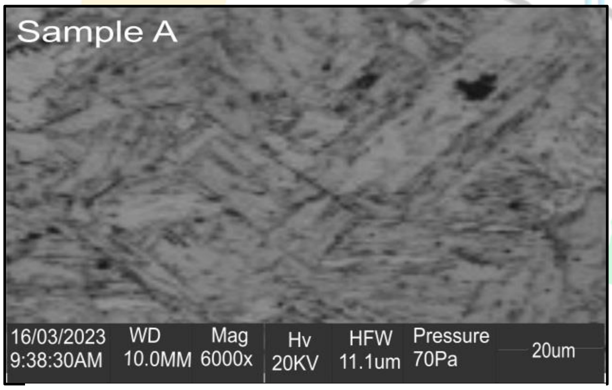

Figure 1: Sample A (Plane metal plate at 6000)

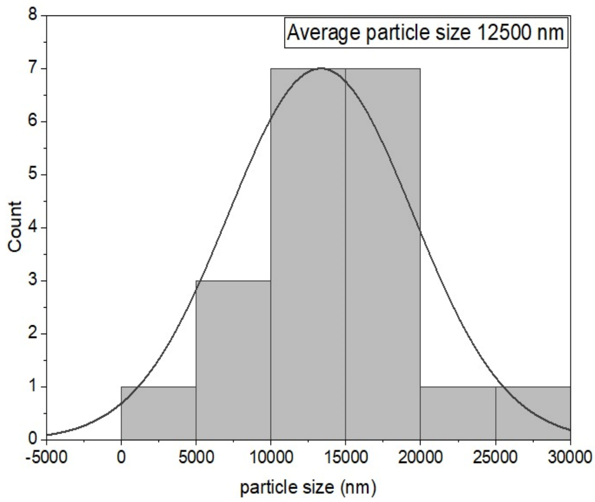

Figure 2: Sample A SEM Reading

A particle size of 12500nm implies that the corrosion rate will be higher because it has no inhibitor coated on it. Generally, the smaller the particle size the better its inhibitory efficiency (Alice *et al*., 2022). In another studies, nanomaterial have a higher corrosion inhibition properties due to an increase in surface to volume ratio (Soumya and Swatee, 2024). When the particle size decreases, the surface area is covered with nanoparticles on the metal which increases the inhibition efficiency (Shoeb *et al*., 2019). Figures 3 shows the morphology of sample C (*E. kamerunica*) extracts coated on the metal plates. Figure 4 further shows the various particle sizes of the coated film. Particle shapes were noted to be in form of long strands with high area coverage of the steel metal plate. An average particle size of 25 nm was observed. This depicts a case of low corrosion rate and consequently a high inhibition efficiency of the plant extract.

This may not be unconnected to the presence of several phytochemicals and their corresponding functional groups present in the inhibitor used. The observations of the SEM analysis corroborated with reports of the findings by (Bernard *et al*., 2020) which opined that high inhibition efficiency is attained when particle sizes are smaller because a smaller particle size of plant extract can result in an increase extraction of antioxidant compounds from plant materials due to higher surface area, extract yield and phytochemical composition are also abundant in smaller chemical sizes. The corrosion rate of metals increases when the particle sizes are higher because they have lower surface area to volume ratio compared to smaller particle size (Yankari *et al*., 2021).

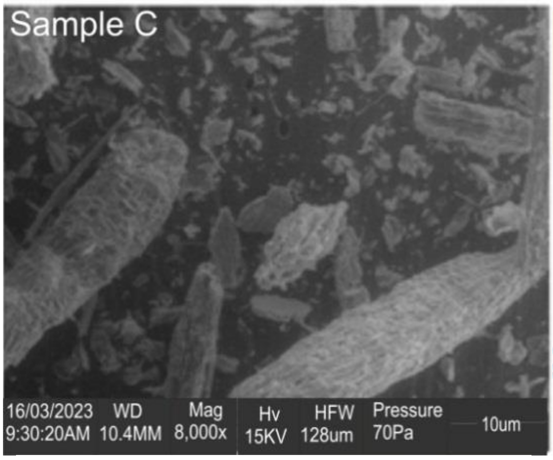

Figure 3: Sample C *E. kamerunica* plant extract coated on metal at 8000x plant extract

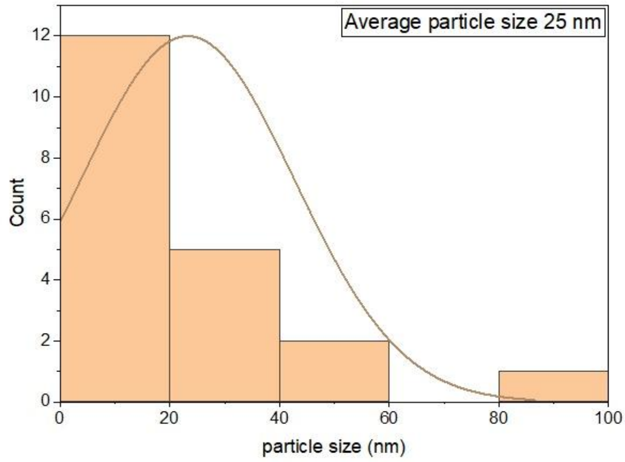

Figure 4: Sample C *E. kamerunica* plant extract SEM Reading

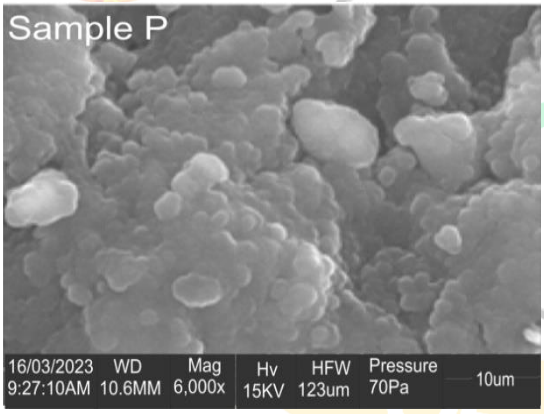

Figure 5: Sample P (*C. procera*) coated on the metal plate at 6000x

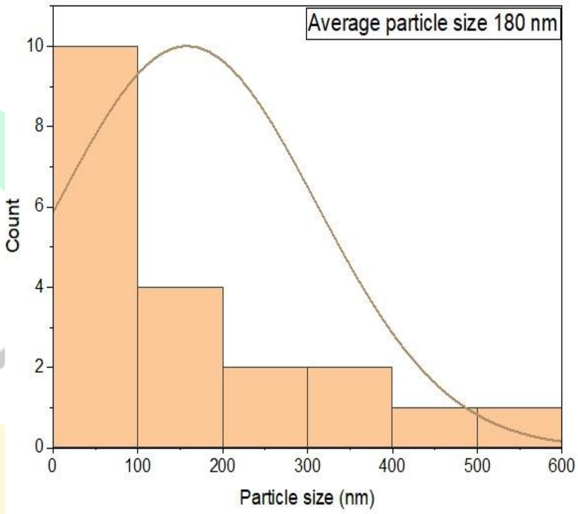

Figure 6: Sample P (*C. procera*) SEM reading

Images showing the particle shape, sizes, area covered of the SEM reading are presented in Figures 5 above. Particle shape for sample P (*C. procera*) extract showed an oval shaped particle and an average size of 180 nm. This shows a lower corrosion rate and inhibition efficiency when compared with *E. kamerunica* extracts. The counts on the graph have no unit for they are different counts taken on the coated metal surface.

4.0 Conclusion

The leaves of *C. procera* and *E. kamerunica* plants were successfully extracted. The Scaning Electron Microscopy analysis showed the morphology of the extracts coated on the metal plates. The SEM images showed sample P (*C.procera* extract) to have particles that appear as strands with a mean size of 25 nm. Morphology of sample C (*E.kamerunica* extract) showed its particles to be oval in shape and the mean particle size was 180 nm while sample A,(uncoated metal plate) the steel metal plate, had its surface observed to be smooth and average particle size of 12500 nm. It was generally noted that the smaller the particle size, the better the efficiency of the plant extract as an inhibitor and a higher particle size, increases the corrosion rate because the extracts have a lower surface area to volume ratio.

Conflict of Interest

There is no conflict of interest among the authors.

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