International Journal of Engineering & Technology
CENTRE OF PROFESSIONAL RESEARCH PUBLICATIONS
ISSN 2049-3444
International Journal of Engineering and Technology Volume 7 No.3, March, 2017

Improvement Corrosion Resistance on AL-Alloys by Polymer Coating (Epoxy Resin)

Baraa H. Al khaqani
Metallurgy Department/ University Of Babylon / College Of Materials Engineering/Iraq

ABSTRACT

In order to prevent corrosion of selected aluminum alloys were coated with epoxy resin polymer investigated by using the Tafel electrochemical method in simulated salt water environments. The microscopic structure of al- alloy surface coatings tested before and after using an optical microscope (OM) analysis, to view a layer that chromate coating alloy selected Ally and in different proportions, where we use the ratio (5% and 25%) chromate. Done measure the surface roughness of the samples coated chromate and we found that the sample coated by a 25% vines more roughness up to (0.594) micrometers and this makes them more suitable to be a connection between the alloy base and a layer of polymer coatings. Done coat epoxy different times layer (five minutes and ten minutes) using the method of the simple immersion was the thickness of the paint layer a time of ten minutes is equal to (23.6) micrometers represents the best layer coating .He then held Tafel samples tested and found that epoxy coated sample represents less than the rate of corrosion is equal to (0.385 mm/y).

Keywords: *Coating Polymer, Epoxy Resin, Corrosion, Aluminum Alloys.*

1. INTRODUCTION

Aluminum alloy widely used in various industrial, electrical, chemical and other fields so as to strength and Toughness , its weight in addition to heat and higher electric delivery in addition to the few cost, in any case, the alloy of aluminum applications are concentrated in the resistance and its chemical high, where the oxides protect themselves and increase their resistance to corrosion, , It is possible that the erosion contributes to create of defects in oxide film formed as a result of interaction with atmospheric air , Likely that these defects when exposed to the atmosphere are exposed to the attacks of chloride ions, causing cracks erosion of a very dangerous [2]. Generally, finish can be split into three section: rebirth coating, inorganic & organic deposited coatings. Spiritual rebirth coatings are produced by chemical or electrochemical suppression between the surface of specimen and the aquatic sol to shape an oxide film in order to together increase inside & outwards. Such transformation coatings appear an functional route to raise the abrasion inviolability of AL , Mg & Ti alloys or, as a pre-treatment, to improvement the adherence of a eventual conversion painting [2-3]. aluminum is an pushing metal and its resistance to corrosion depends on the formation of the protective oxide film[3]. The plated electrode was measured by polarizing the electrode, them locate in order to aggression at aluminum base alloy occurred underneath the epoxy, and this articulate a (CL^-) deploy across epoxy to interact at the underlying substrate [4]. Generally, corrosion resistance covering have been classified into three case , including ($CrO3$)coating as a primers, and polymer layer. Chromate is considered the most effective way to prevent corrosion of al- alloys, especially in space applications. He also said that chromium ions are hexagon plays a large role in the repair of the deformation resulting in coating [5-6]. So it is a turning chromate coating is the reason for the improved corrosion resistance of aluminum alloy . However, In any case, possible to have the traditional paint cause significant damage to health when exposed to the vicinity of abraded such as metals (chromium with zinc) in addition to the high manufacturing cost [1]. This work aims to improve the corrosion resistance of aluminum alloy coated epoxy and compare it to resist corrosion of the base alloy.

2. EXPERIMENTAL

2.1. Aluminum alloy used for the test:

The sample is required to be coated of aluminum alloy (2024-T4), the composition of alloy in list 1.

List(1) chemical Composition (%)

Element	Fe	Si	Cu	Mg	Mn	Cr	Ti	Zn	AL
Standard Value	0.5	0.5	3.8_4.9	1.2_1.8	0.3_0.9	0.1	0.15	0.25	balance
Heat No.2015-570	0.274	0.0804	4.1	1.59	0.482	0.0069	0.0185	0.0375	93.41

Table 2. Exact description of the layers of coating sample

Coating	description	thickness(min)	thickness(max)	Comment
None	Aluminum alloy	N/A	N/A	2024-T4
Alloy coated with chromate	Primer	4.30 mg/mm^2	21.52 mg/mm^2	Conversion coating
Alloy coated with epoxy	Simple immersion	5.77 mg/mm^2	18.16 mg/mm^2	The best sample

The Protection system consists of two parts, includes a chromate coating layer unstable and then epoxy coating layer, the (2024-T4)alloy were coated with CrO3 ,epoxy coating .The coating applied in this work in List 3.

List (3) the specimen used in this work

specimen	Testing in salt water
A	(2024-T4)alloy
B	AL-alloy +Chromate
C	AL-alloy+ Chromate+ Epoxy

Before testing Samples should create and process configurations include the treatment of the sample with a solution of ethyl alcohol to clean them and then leave them to dry then start coated in chromate dissolved in distilled water, Prepare solution consisting of 5 grams of chromate in distilled water at 25C° then immerse the sample in solution for 5 minutes and it returned the same experience to sample other but in the latest solutions consisting of 25 grams chromate with distilled water and immerse the sample for 10 minutes the solution, it is possible to determine for the interaction between the ingot and chromate by the difference is made up by weight coating layer are not visible and part of the alloy can be clearly seen optical microscope[8]. Before coating stage epoxy measure the surface roughness of the samples in order to select the appropriate sample of the coating. The polymer coating was applied by the simple immersion method for 5 min and Intervention oven at 80 C° for 10 min, and full treatment wanted up to 4 days wanting warming. This coated Al alloy rods (2024-T4), samples were cut into disc shapes a section area of (20×8.5) mm^2 using a diamond sawfish. Samples were examined in artificial salt solution .The NaCl solution had used consist of 3.5% NaCl in distilled water at 27C°.

2.2 Corrosion Test (Tafel technique)

The corrosion rate this sample coatings was examined using suite Created from a three-electrode system connected to the electrochemical workstation. The samples were loaded onto corrosion chamber setup. erosion rate was produce from the Tafel curve [8]. However it had augment the erosion rate of the alloy systems in 3.5 wt.% chloride sodium sol due to galvanic cell pointing between the basic layer & the internal layer in the part of due- consistency fault ,then evaluated the corrosion rate from the curve Tafel technique[9-10] .Calculate the corrosion rate from the equation later :

$$Corrosion\ rate = \frac{Icorr \times K \times Ew}{\rho} \quad \text{.....Eq (1)}$$

K=3.27×10-3 mm g/µA cm yr,
Ew = 9.09.
ρ = 2.66 g/cm3 (for the 2024-T4 alloy).

1.1 Optical Microscopy

The specimens were examined optical microscopy strongly different Zoom (10,40)X&(80)X has been taking pictures of different samples for the purpose of knowledge is a coating chromate by different rates and through this examination determine any appropriate proportion of chromate coating

3. THE RESULT

3.1. The Corrosion Rate (Tafel test)

Tafel curve of the base sample and the sample epoxy coated test shown in the following Figures and a summary of the test illustrated in Table (3)

Table (3) Summary of The Result Tafel Test

specimen	A(base alloy)	C(alloy coated epoxy)
Ecorr (mv)	-726	-725.8
ba (mV/dec)	65.6	39.7
bc (mV/dec)	-59.9	-36.0
Icorr(µA mm-2)	59.15	34.43
C.R(mm/yr)	0.661	0.385

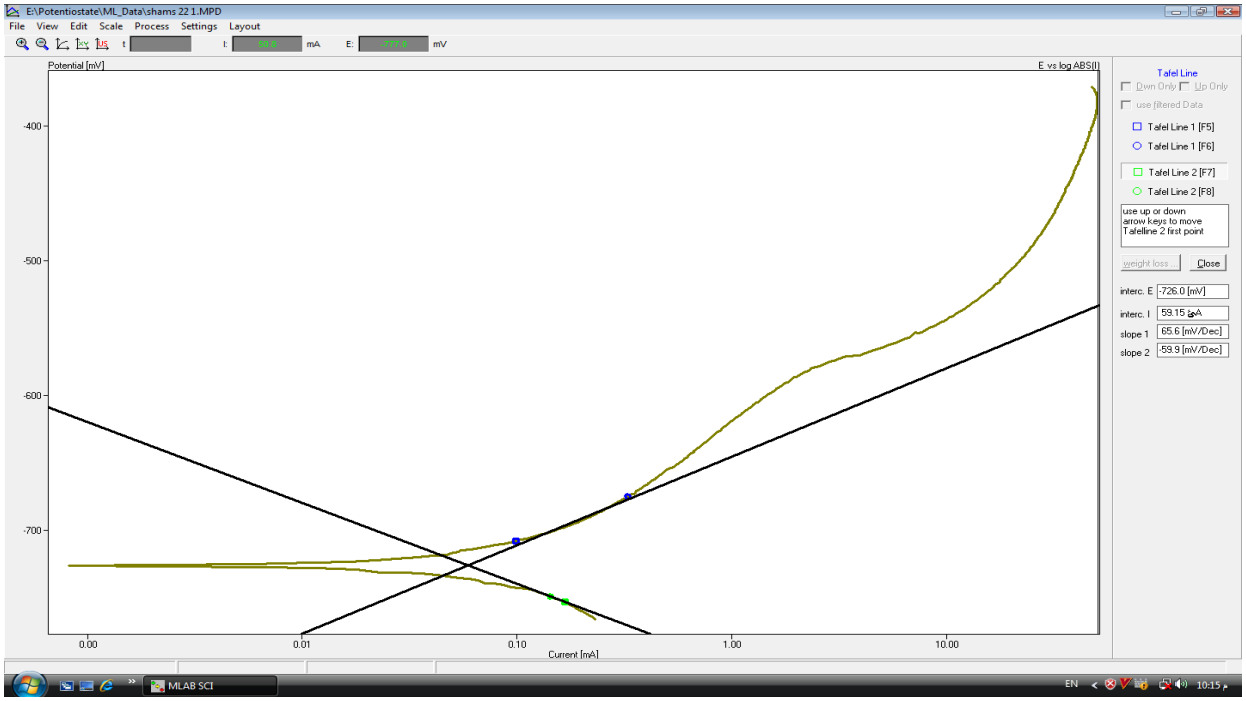
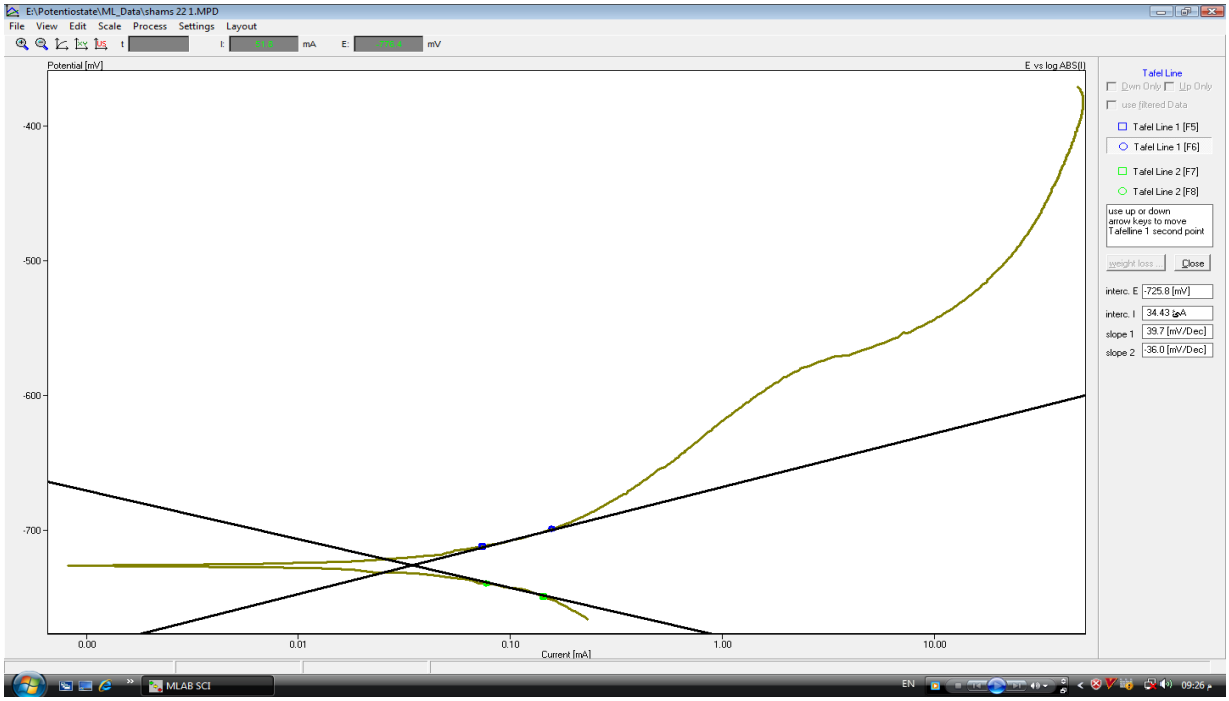


Figure (1) The base sample(A) (uncoated)



Figure(2) The sample (C) coated chromate and epoxy

Figure 1 and Figure 2 between curves Tafel for corrosion testing and measurement of the corrosion rate of the base sample(A) and the sample coated chromate &epoxy where the corrosion rate less than what can sample (C) coated chromate and epoxy and equals (0.385mm/y) The reason for this is the contribution of chromate and epoxy to prevent corrosion alloy of aluminum and the composition layer to protect the alloy, which more effective to less corrosion of al- alloys and thus reduce corrosion rate. The erosion rates of base alloy(specimen A) and specimen coated (C) were examined in salt sol . Specimen C, which was painted with two films, overall (CrO3) and polymer coating. The base alloy (specimen A) had the elevated erosion rate, that equal to (0.661mm/y). The lowering of the erosion rate was largest between specimen A and specimen C, creating layer that the CrO3 film was good active for prevent the erosion . This result could be refer to obtained a rough surface of base alloy had more reduction, scrub & abrasion, which were treated CrO3 film, Figure3 observed the reaction obtained between the surface of alloy and chromate in salte water .

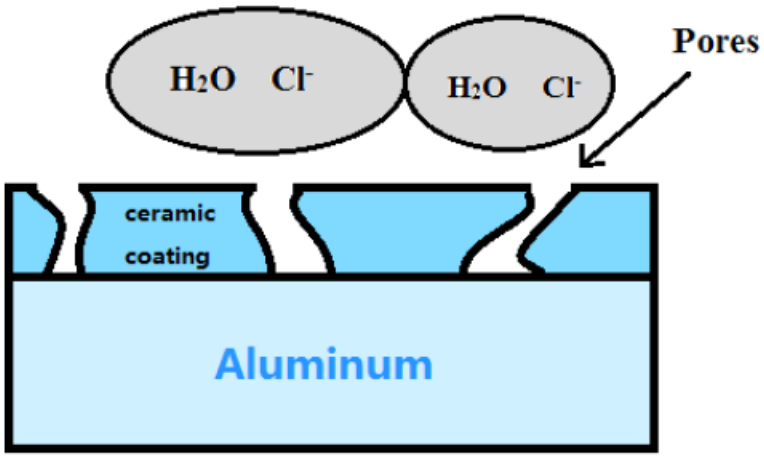


Figure (3) the sample coated in NaCl solute

was applied then addition the epoxy layer which less a corrosion rate to quantity reduce than of specimen A. The result existed in order to the coating on specimen C as long as better coating layer (surface roughness), leading to increasing the corrosion resistance.

3.2. Measurement of surface roughness:

Been using different ratios of chromate for the purpose of alloy aluminum coating basis for their choice of the ratio the better of the coating must be inspected surface roughness of the samples coated chromate was the surface roughness of the specimen coated by (5%) chromate to be readings rate of surface roughness (0.774 µm) and then the surface roughness of the sample coated measuring rate (25%) to be readings rate of surface roughness (0.594 µm) it was found that the sample in which the chromate percentage increases are even tougher, making it more suitable than others.

3.3. Measure the thickness of the coat layer:

Overwhelmed samples required painting different periods (5 minutes) and once again (10 minutes) and we used to measure the thickness of the coat device was the thickness of the coating layer situation first (10.6µm) and thickness (21.1µm) for the second case shall be the appropriate class for corrosion test.

4. DISCUSSION

Chromate layer formed as a result of coating had efficiency is very high to form a wall corrosion resistance in sodium chloride solution. The (CrO3), which is keep in the transformation layer, Insoluble, oxidizing, and pores (in CrO42- or Cr2O72-) [11]. It is formed when the protective layer is converted ion to a non-soluble and has a low-valence form (Cr2O3 or Cr (OH)3) [12]. The word appear in equations follows:

$$Cr2O72- + 8H+ + 6e- \rightarrow 2Cr(OH)3 + H2O \quad \text{Eq. 2}$$

The presence of Cl- had speed up the chromium hydroxide, in which the reduction products serve as prevent the corrosion [8]. This effect was observed in many works, If increased chromate increase the corrosion resistance of the sample exposed to sea water [13].

Microscopic images of the samples help determine oxide be chromate on the surface of the alloy base is a sample of the alloy mainly filmed before coating and strongly enlarge dysfunctional and returned the imaging process after coating and the same previous magnification powers, found to be a thin layer of oxide, chromate on the surface of the alloy of aluminum and be part of it , Figure 4 ,image (a) and (b) were specimens (A) and (C), respectively.

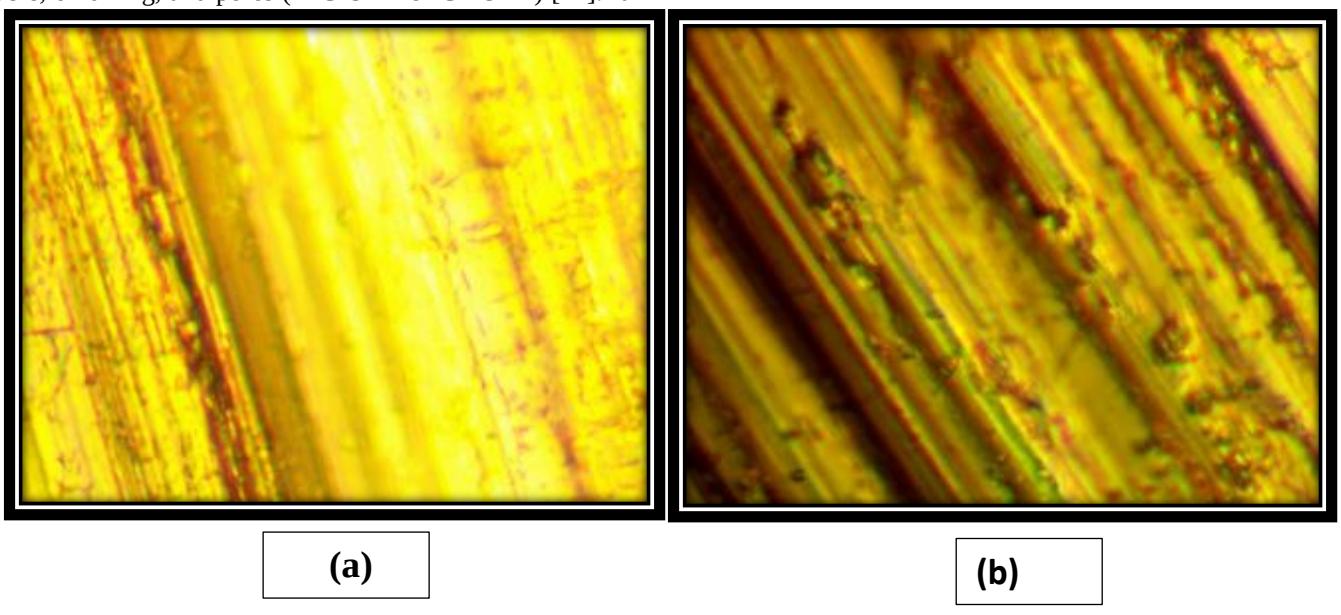


Figure (4) OM of specimen A (2024-T4 alloy) (Fig (a) and specimen C (coated with chromate and epoxy coating)(Fig(b)

OM (Figure 4 a) obviously defect the presence of rougher surfaces on specimen A than on specimen C (Figure 4 b), which had a create paintings. For rougher plans, the specific plan area was high , major of the dynamic of corrosion . This influence slightly participate to increase the corrosion resistance that

were appeared for specimen A than for specimen C, proportionate with the mentioned erosion resistance of specimen A and specimen C. Furthermore implementing to acquired specimen photos specified that coating on specimen C had better coating on the role plan in the tested surface, signal an reasonable likeness of the coating application. moreover, no fault were exposed on plan of specimen C on a (n m) measure, though low point were conformity that were high or low stout then else accessories of the plan. For their epoxy coat there must be a layer form the primer layer of the alloy basically it is necessary to be even tougher as the surface roughness is high for a good coat penetrates epoxy to fill in the blanks in the primer coating layer (chromate coating)

4. CONCLUSIONS

Assays were conducted corrosion resistance of a group of samples of aluminum alloy with different coatings were the main results have been reached and are as follows:

1-Corrosion rate is low in salt water for each sample and epoxy coated sample basis, but it becomes more resistant to corrosion after coating (chromate and epoxy).

2-Unique characteristics of the chromate coating is being porous coating allows the epoxy good cup mount as shown in the examination of an optical microscope to get an excellent coating layer, add epoxy at least the size of these pores are the future of this reduces the corrosion rate.

3-Epoxy coatings rely on the thickness of the coat layer and the cleanliness of the surface and must be level and regularly to get the correct and good results.

ACKNOWLEDGEMENTS

My thanks to the employees of the laboratories college material / Babylon University engineering to bring them to assist in conducting the tests required for research and testing.

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