Original Article
Bulletin of Pure and Applied Sciences.
Chemistry , Vol.42 C, No.2
July-December 2023: P.51-56

http://www.bpasjournals.com/chemistry
DOI: 10.48165/bpas.2023.42C.2.1
Print version ISSN 0970 4620
Online version ISSN 2320 320X

Electrochemical Studies of Aluminium 7075 Alloy in Green Tea Leaf Powder as an Efficient Green Inhibitor

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Received on 06.06.2023, Revised on 18.07.2023, Approved on 07.10.2023, Accepted on 18.11.2023, Published on 23.12.2023

ABSTRACT
Corrosion is a major issue in every industrial system. As a result of its widespread application, aluminum suffers enormous annual losses due to corrosion. Scientists are continually on the lookout for effective anti-corrosion strategies. Corrosion may be reduced in a number of ways, but many of them are harmful to the environment, so it's important to find a green alternative. Corrosion inhibitors in aluminum alloys can be found in green tea. In this research, we found that aluminum alloy 7075 (Al-7075) in a 3.5% NaCl solution was inhibited by both green tea. Samples of Al alloy are submerged in 3.5% NaCl solutions with and without an inhibitor for a total of 4 days. The weight-loss technique is used to determine the effectiveness of an inhibitor, with green tea with the best efficiency of 83.93% compared to the greatest efficiency of 14.29% for green tea.

Keywords: Corrosion, Aluminum, Green Tea.

How to cite this article: Pruthviraj R.D. and Jahgirdhar A.A. (2023). Electrochemical Studies of Aluminium 7075 Alloy in Green Tea Leaf Powder as an Efficient Green Inhibitor. *Bulletin of Pure and Applied Sciences-Chemistry*, 42C (2), 51-56.

1. INTRODUCTION

Aluminum and its alloys have several uses in fields as diverse as transportation, aircraft, building, and electricity production. Corrosion inhibitors, either organic or inorganic, are typically added to caustic media in industrial operations like alkaline washing, dissolving, and embossing, and to increase efficiency in devices like aluminum alkaline batteries however, a few of these inhibitors are poisonous, costly, and non-biodegradable .Aluminum corrosion can be mitigated in an alkaline media with the use of inhibitors. Only a select few researchers have looked at the possibility of slowing aluminum's rate of self-corrosion by adding chemicals to an alkaline solution. Most of them are harmful to humans and animals, costly, and harmful to the environment. Therefore, it is important to create a corrosion inhibitor for aluminum alloys in an alkaline media that doesn't harm the environment. To that end, we settled on plant extracts since they are naturally occurring, inexpensive, and easy to extract. Extracts' phytochemicals, which are largely heterocyclic molecules, can interact strongly with the metal surface, preventing corrosion. Plant extracts and chemical medications (drugs) are often used options to prevent corrosion that are safer for the environment. Plant extract contains phytochemicals like alkaloids and flavonoids, which adsorb on metal surfaces and prevent corrosion because they include heteroatoms like N, S, O, and π -electrons, aromatic ring. Aluminum and its alloys benefit from tea plant extracts' corrosion prevention properties. Oleanolic acid, ursolic acid, rosmarinic acid, eugenol, carvacrol, linalool, and beta-caryophyllene are the primary chemical components of the majority of the carbon chain in the compounds is between C10 and C12, which has the highest IE%. Green tea also have some active constituent's but they don't have most carbon chain between 10 and 12, that's why they effect less than. When comparing and green tea, it's important to keep in mind that their chemistries are distinct enough that not all of their contents are involved for inhibition. Further detailed studies may be conducted to determine things like the precise absorption system of those compounds and the precise constituents responsible for inhibition, since it was previously stated that lengthy carbon chains inhibit better. In such case, we may make better use of plant active components in our fight against corrosion. All sorts of advanced technologies, from space travel and alternative energy to electronics and more, rely on aluminum's versatility. Most aluminum alloys offer impressive corrosion resistance to the elements and other factors because they are coated with a biological oxide layer of around 5 nm in thickness. Strong acids and bases, however, quickly dissolve oxide coatings. Degradation of the protective layer allows chloride and other hostile ions to penetrate and begin the corrosion process locally [1-2].

2. MATERIALS AND METHODS

2.1 Material preparation

The sheets of Al-7075 alloy were purchased from Chemical Industries. Plates of 1.5 by 1 by 0.2 cm were cut from clean, sanitized aluminum sheets. Distillation water is used to clean the surface, and then emery paper (P 600) is used to polish it. Elemental make up of Al-7075 by weight is 99.00–99.95% aluminum, 0.05–0.20% cooper, 0.95% (Max), 0.05% (Max) manganese, 0.95% (Max) silicon, 0.10% (Max) Zinc, 0.15% (Max) Residuals. Sodium Chloride (3.5% NaCl) in concentrated form was procured from the regional chemical Store. Green tea leaves were purchased in the market [3-5].

Figure 1: Crushed powder from the leaves green tea.

2.2 Leaves extract preparation

The NaCl that was obtained was in a solid state and was 3.5% NaCl. An end result pH of 11.51 was achieved by adding NaCl to100 ml of water. Green tea was thoroughly cleansed with distilled water. In order to obtain the extract, the leaves were first dried, powdered, and then mixed. Finally, 8 g green tea leaf powder was adjusted to a pH of 10.5 by combining it with 5 ml 3.5% NaCl solution and immediately after we immersed the Al alloy into the solution. Green solution preparation is depicted in Fig. 2

Figure 2: Prepared green solution

3. ELECTROCHEMICAL TESTS.

Electrochemical tests were carried out at room temperature using three-electrode conventional corrosion cells. The working electrodes were embedded in a resin with 1 cm^2 exposed area. A platinum rod was an Ag/AgCl electrode served as a reference electrode. The electrochemical experiment was conducted using a potentiostat/galvanostat CH-I 608E Series (USA) connected with software. The electrode was first stabilized for 1 h to attain quasi-equilibrium values at an open circuit potential. From the current density potential line fitted Methyl Imidazole Pyridine-5-carboxylate the polarization resistance (Rp) was determined using the software. Electrochemical corrosion data, corrosion current density (icorr) and potentials (Ecorr) were estimated from the polarization curve by Tafel approximation [7-8].

The cleaned aluminum samples were weighed, before immersion into the green tea solutions, with 0, 200, 400, 600, 800, and 1000 ppm green tea, for 24 h. The samples were cleaned green tea wing the ASTM standards and reweighed. The tests were conducted three times, with approximately 99% reproducibility. The test sample preparation and experimental process for electrochemical, surface, and weight green tea techniques were related to the one reported in the literature. Equations 2 and 3 were green tea to evaluate the corrosion rate (CR) and percentage inhibition efficiency at different inhibitor concentrations, respectively. W D A T CR 87.6 = × × (2) where T is the exposure time (hour), D is density (g/cm^2), A is area (cm^2), and W is weight (mg). IE (%) CR 100 (uninhibited) (inhibited) uninhibited = × (3) where uninhibited and inhibited are the corrosion rate in the absence and presence of an inhibitor, respectively [9].

4. SURFACE ANALYSIS

Surface analysis was conducted on exposed samples for 168 h immersion in uninhibited and inhibited solutions using the backscattered electron signals recorded with a JEOL JSM-7600F microscope (Peabody, MA, USA) with a probe current of approximately 700 nA and 15 kV accelerating voltage[10-11]. A scanning electron microscope equipped with energy-dispersive X-ray spectroscopy (EDX) was used for determining the elemental compositions on the sample surface.

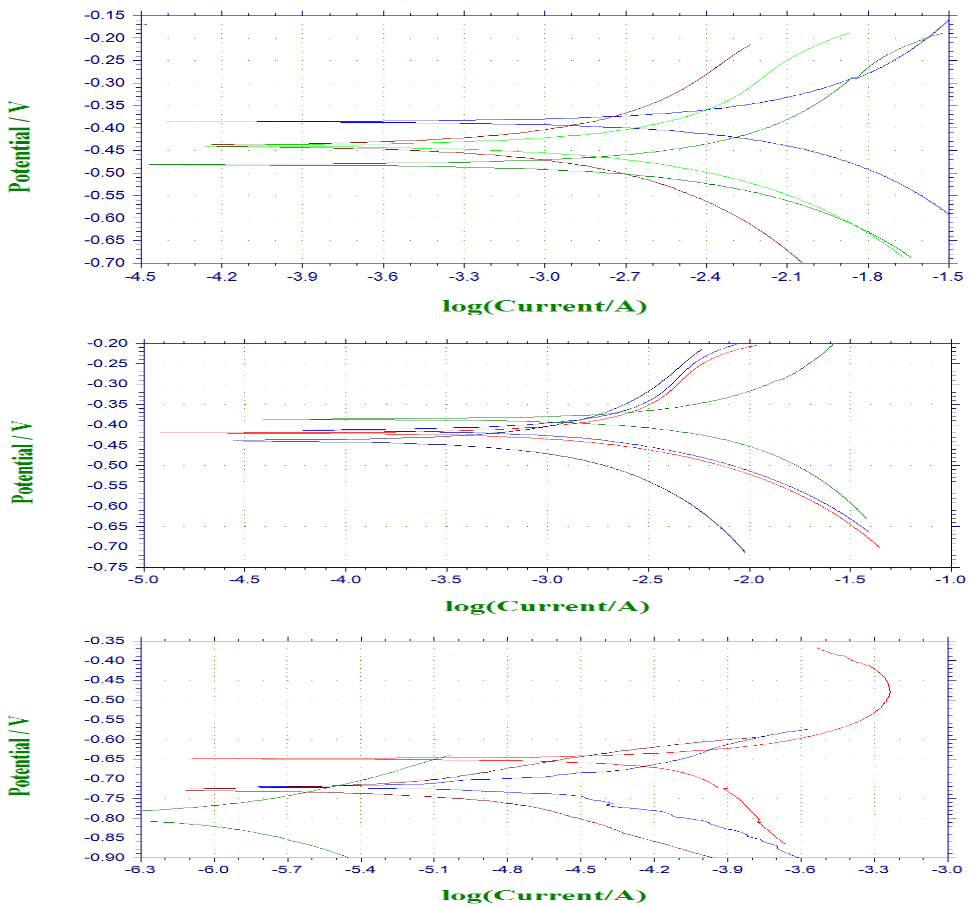

Figure 3: potential−current curve for aluminum in the green tea with and without diverse concentration of PEO (t = 298 k and sweep rate = 0.2 mv/s).[12]

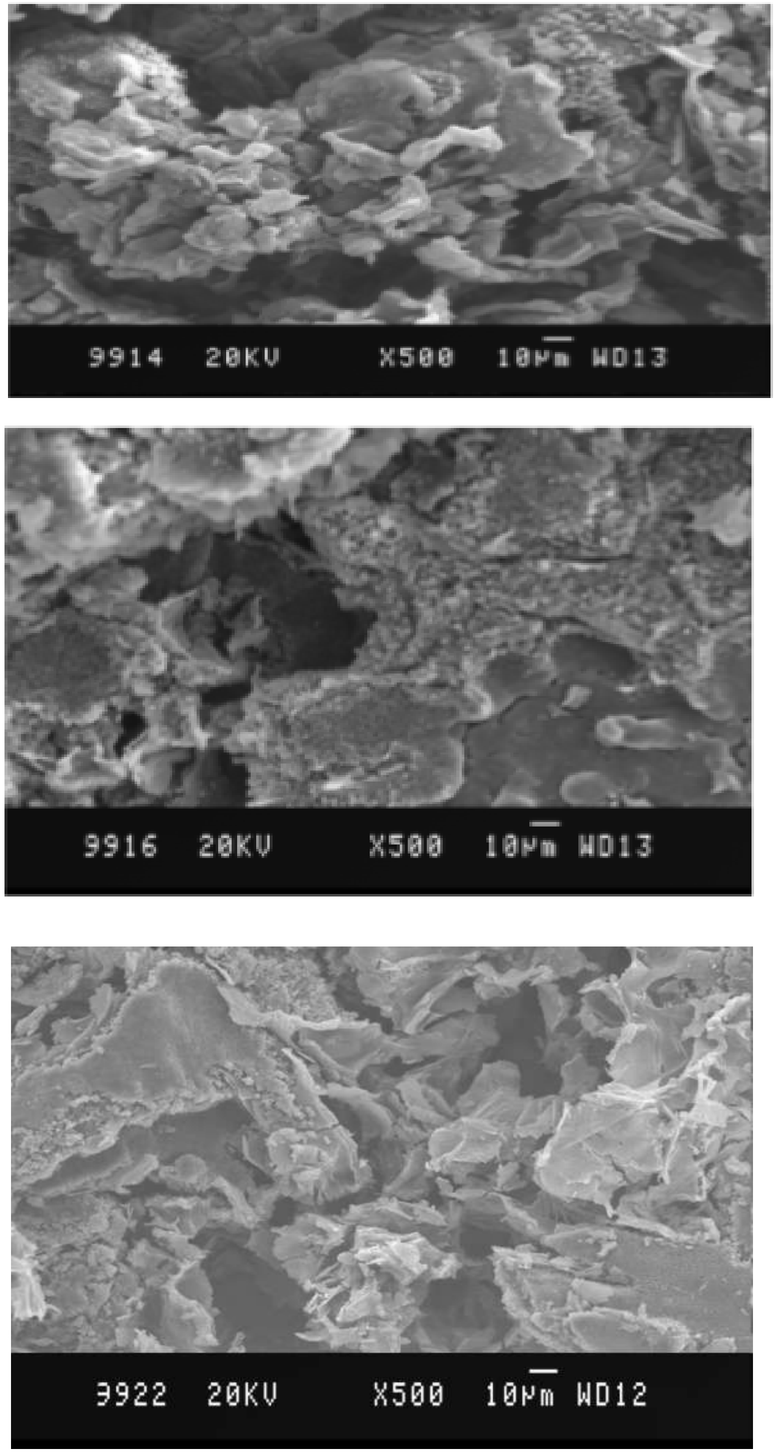

Figure 4: SEM micrographs for aluminum, after 24 h of immersion in green tea (a) without green tea (b) with 200 ppm green tea, (c) with 400 ppm green tea, (d) with 600 ppm green tea, (e) with 800 ppm green tea, and (f) with 1000 ppm green tea.[13]

CONCLUSIONS

The corrosion inhibition tendency of the potentiodynamic analysis validates that the green tea mitigates the aluminum corrosion via adsorption at the electrolyte/aluminum interface and thus forms protective layers on the aluminum surface. The corrosion inhibitive behavior significantly increased as the inhibitor concentration increased; 87.01% efficiency was achieved after 24 h of immersion with 1000 ppm inhibitor concentration. The obtained results from potentiodynamic polarization, and green tea characterization were in good agreement.

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