ISSN NO: 2770-4491
Date of Publication:20-07-2022

Determination the groundwater effects on corrosion in Nano composite material Silicon- Carbide reinforced aluminum alloys in Baghdad Iraq.

Mamoon A A Al-Jaafari[1] and Israa Fadhil Ibraheem[2]
[1]University of Al-Mustansiriya, Eng. College, baghdad.
[2]Middle Technical University, Technical Engineering College-Baghdad / Surveying Techniques Engineering .

Abstract: This article presents the results of a study to determine the effects of groundwater on the mechanical properties of an aluminum alloy. The corrosion was evaluated on this aluminum alloy that was subjected to an aqueous solution attack from a four-point extractor at a depth of (4-4.5) meter in an area west of Baghdad. The results indicated that the addition of silicon carbide nanoparticles improved the properties. The mechanical strength of the base alloy, especially at a ratio 2.0 wt.%, significantly reduced the rate of pitting

Keywords: Nanotechnology, Nano composite, SiC,Aluminum nano composite,Corrosion of material , Ground water .

Introduction:

The use of aluminum has become one of the basic things in many construction industries, means of transportation, equipment, household appliances, and others. Pipe networks for transporting oil, gas and water are among the basic industries that depend on the sixth family of aluminum alloys, which are exposed to many factors that contribute to corrosion, which reduce the operational life of these networks, which calls for finding mechanisms to measure and control corrosion. [1-3]

Nanotechnology is one of the very promising ways to improve many of the properties of engineering materials, and to reach new properties that help in the process of performing the materials to the functions required of them according to acceptable performance standards. In addition, the presence of the small size of the nano materials particles effectively helps them to change the properties of the crystal lattice and thus change the mechanical properties of the alloys under examination.[4-7]

Deqing et al. Pure aluminum was hot-plated on a steel substrate, and the subsequent oxidation process was deliberate to resistant to corrosion of hot-dip aluminum. The width of the pure aluminum coating on the steel substrate decreases with increasing time and temperature of initial aluminization, and the width of the aluminum layer decreases at a specific temperature between the same temperature as liquid aluminum and complete wetting. Does not upsurge with the surface of the substrate. The width of the Fe-Al between metals compound layer on the steel base increases with increasing bath temperature and time. Based on experimental data and mathematical models developed from research, the maximum width of Fe-Al intermetallic compounds is present at a particular immersion temperature. The alumina surface formed is in best condition after 240 hours of corrosion testing at 750 ° C with liquid metal and exhibits excellent resistance. .[8]

Scamans et al. Studied aluminum has and was recently produced commercially in the first century. The key to today's widespread use is the resistance of corrosion and great versatility, making it appropriate for a many products, from house hold foils to many plates and structural materials to engines of aircraft and spacecraft. Aeronautical engineering is one of the design areas of a group of contradictions, which is the need for light weight with strength, as well as corrosion resistance from air friction operations with metal

ISSN NO: 2770-4491
Date of Publication:20-07-2022

parts. Durable high-strength aluminum provides several uses from power transmission cables, and external cladding to types of buildings, multi-use in building houses, whether glass or metal. Reducing weight, thereby reducing emissions from automobiles and trucks, which are rapidly increasing in the world, is an increasingly selected metal. Aluminum alloys can have a wide range of multiple mechanical properties that can be adapted to use according to the needs of the required material and according to the working conditions, hardness and manufacturing process. Aluminum able to forged ,rolled , slitted and sheared and can be extruded through dies of various shapes or cast directly into the part., other important qualities are its high electrical and thermal conductivity, ,low temperature compatibility, non-ferromagnetic properties, and Hygienic and non-toxic properties. Aluminum as an engineering metal is second only to steel in terms of tonnage utilization, and its production growth is steadily [9]

The process of anodizing (2- step) It can be considered effective method to improve corrosion resistance by forming an adhesive continuous layer on aluminum. Anodized Aluminum Oxide has been produced by many types of anodizing processes: (one and two) step anodizing. Next, we assessed the protective effect against AL alloys corrosion in aggressive media (sodium chloride 3%)., the amorphous nature of the porous oxide film. Electrochemical impedance spectroscopy results show that there is a strong relishing between the resistance of corrosion and morphology of the anode developer. These results also showed that the anodized film formed by the 2-step anodizing process was significantly amended compared to the base one.[10]

Ofoegbu et al studied processes and current technologies and developing new technologies to meet the needs of sustainability in a use of resources. The development of new technologies must be based on a full understanding of existing technologies, such as the most energy-intensive in aluminum anodizing,. The focus is on the actual need to reduce consumption of both fossil fuels use in the anodizing path and environmental impact. Focusing on the use of these properties to improve the quality of the final products, the effect of anodizing The structure of the nanomaterial with large pores on the mass transfer and chemical interaction of relevant types of aluminum alloys during the final production process is highlighted. Determine the key factors to consider when starting a programming process that reduces the energy use and environmental impact of the stamping step and ensures the aluminum processing process/industry. The view is shown. [11]

Li et al studied Al-x (Cr, Fe, Co, Ni, Cu) with a (x is:different molar ratio), high-entropy alloy (HEA) coated laser Quality control of the degree of surface smoothness of aluminum ingot vapor deposition. Microstructure and corrosion resistance were verified. The base alloy coating structure was changed with the addition of Al from (FCC1) to (FCC1 + BCC1) and then to a phase (B.C.C1 + B.C.C2 + F.C.C2). Some cracks were found in the base coating. The hardness of the substrate increased with the increase of x, and the hardness of FeCoNiCrCu alloy (215HV0.2) It was the lowest value relative to the rest of the alloys of Al-HEA coatings and It is larger than the base alloy (79HV0.2). The practical results proved that the effect of the aluminum element on the corrosion resistance is similar to the effects on the hardness number. The rate of corrosion is both higher and lower to aluminum alloy Alx-HEA layers are indicated and obtained to be most suitable for improving the surface properties of the base alloy. [12]

Pan et al studied that LY12 AA was coated with a thin layer of sodium phosphate aggregate using a new surface improvement method based on the chemical adsorption of monosodium phosphate from a chemical solution. pH effect on the properties of the auto-assembled layer was recorded and the corrosion resistance of the auto-assembled layer in Cl-containing solutions and marine atmospheres was increased by electrochemical impedance spectroscopy and corrosion analysis. In contrast to auto-assembled films formed under acidic and alkaline conditions, dodecyl phosphate films formed with neutral solutions are thicker promoted by the neutral solutions. Showed a multi-layer structure and excellent corrosion resistance.[13]

Qin et al investigated The evolution of the microstructure of nickel-aluminum-bronze alloys has been by heat treatments such as, aging quenching normalizing, and annealing. The microstructure is micronized and homo-genized after quenching / aging at 440 ° C to effectively remove selective phase corrosion. Compared to the current manufacturing process, the rapid formation of the protective film reduced the rate of static corrosion by about 50%. In addition, the cavitation corrosion rate was reduced by 4.9-fold and 7.9-fold in the quenching sample and the 440 ° C quenching / aging sample, respectively. This can be due to increased hardness and reduced synergies..[15]

ISSN NO: 2770-4491
Date of Publication:20-07-2022

Nnaji et al they the study describes the behavior and corrosion of inhibitory materials which are of organic origin in aluminum and hydrochloric acid solution suppression performance. The organic inhibitors used are 4- (benzo [d] thiazole-2-ylthio) phthalonitrile and tetrakis [(benzo [d] thiazole-2-ylthio) phthalocyanine nato] gallium chloride (III) (ClGaBTThioPc). The corrosive inhibitors behavior is inspected using electro chemical methods. The results of the open circuit potential show the main cathode characteristics of the device of aluminum corrosion suppression by the inhibitor. The suppression efficiency value from the electro potential polarization measurement increases from (46.9 -70.8)% for BTT and (59.7 - 81.0)% for ClG in the 2-10 μM concentration range. (SEM) capacities show protection of the alloy surface from acid attack in the company of the inhibitor, and (EDX) capacities are the most likely that the inhibitor protects the metal surface. The high method protects it.[16]

Xiao et al studied the obviously formed oxide film on base alloy surface is easily damaged in the marine and marine setting, causing corrosion and damage to the matrix material of the aluminum alloy. Compared to aluminum oxide, Aluminum fluoride is a chemically stable substance and has no desire to convert to other materials Insoluble in acids, alkalis and reactant Poly vinyli-dene fluoride (PVDF) It is the main material in the surface treatment process. By the chemical vapor deposition process, the protective layer of aluminum fluoride is fixed on the surface of the alloy under test. The coating process led to a positive indicator of the possibility of reducing the surface impact of aluminum alloys, which led to a reduction in the corrosion current and thus that the corrosion resistance of base alloys increased significantly.[17]

Materials

This aluminum alloy was chosen for its wide uses in transmission pipes and in transmission poles of electric power lines as well as lighting poles and fencing used in highways and in fences for farms and gardens with the acceptable cost, Table No.**1** shows some of the physical properties of the alloy under study.

Table1. Physical Properties

Elastic Modulus	69 GPa	Elongation	34 %
Density	2.7 g/cm^3	Modulus of the Shear	26 GPa
Tensile Power: (UTS)	89 MPa	Proof Power: (Y.S)	49 MPa

A total of elements that are included in the composition of the elements of the alloy under study, and based on these elements, it is possible to support their diagnosis within the first group of aluminum groups with the same 1xxx, table number**2** shows the main chemical elements involved in the composition of this alloy.

Table 2.Alloy Composition standard [19]

No.	Elements	Percentage	No.	Elements	Percentage
1	Magnesium (Mg)	0.0 to 0.050	5	Iron (Fe)	0.0 to 0.7
2	Zinc (Zn)	0.0 to 0.050	6	Silicon (Si)	0.0 to 0.7
3	Manganese (Mn)	0.0 to 0.050	7	Aluminum	Balance
4	Copper (Cu)	0 to 0.1	8	Others	0 to 0.3

All values listed under the table above represent % wt. The ranges represent what is allowed within the specified acceptability to the applicable standards in international standardized measurements.

Reinforcement material

Silicon carbide powder with **10**nanometer dimensions was chosen to be the reinforcing material for aluminum alloys, as it has proven its success in improving the mechanical properties of these different alloys from aluminum families, and its high ability to maintain the appearance of external surfaces against scratching and surface damage. Its general characteristics are: Its appearance varies according to the method of production obtained from the materials. This substance can be in many types of color spectrum from yellow to green, or dark blue crystals or an array of iridescent colors. Density is 3.16 g/cm ^{3}, melting point is 2830 ° C. The existing phases of this substance have a poly-morphism: (α-SiC) hexagonal crystals and (β-SiC) cubic crystals. The molar mass is 40.11 g/mol. It is resistant to a wide range of acids and alkalis, including strong ones. In addition, silicon carbide is chemically inert. It has a high thermal conductivity. As for the mechanical properties, it has a high compressive strength, good corrosion resistance, therefore, it may

ISSN NO: 2770-4491
Date of Publication:20-07-2022

be considered a lightweight material, but it has great strength, as it upholds its elastic property at extraordinary temperatures. Silicon carbide is a material that can withstand high temperatures, which is why it is useful in building power transformers.[20-21]

Preparation of Composite

The stir casting method was adopted to produce the composite material required to conduct the tests, by cutting the base alloy into symmetrical cubes according to the dimensional dimensions and then cleaning them with water and methyl alcohol and placing them inside the furnace and after melting the addition of the nanomaterial and then pouring it into pre-prepared metal molds, to obtain For details of the preparation and casting process, refer to the sources. [2-3, 22]

Methods

The erosion associated with ground aqueous solutions depends on the concentrations that can be determined in different ways. In the case of erosion, different actual experimental techniques of the submerged samples of groundwater were used to determine the erosion. First, three samples of groundwater were taken at three points, respectively, from north to south in West of Baghdad, as shown in Figure No.1 Samples were taken in December, and the groundwater distance was between (4-4.5) meters. Water samples were taken 90 minutes after the end of the excavation process. The researchers took care not to take any sample for 150 meters from any residential or industrial construction or serve me The samples were completely submerged in groundwater for (90) days, then experiments were carried out according to the approved contexts.[23]

Figure No.1 Specific sites for groundwater sampling in the study area in western Baghdad

Below are the projected points according to the Gibbs system, according to which samples were taken for the groundwater to be used to accomplish this work. A table number**3** showing the points and their actual projection.

Table no.3 the points that have been approved for taking water samples with their location

No.	Points	Total Dissolved Salt(p.p.M)
1	Ground point 1(**G1**)	1120
2	Ground point 2(**G2**)	1210
3	Ground point 3(**G3**)	1315
4	Ground point 4(**G4**)	1480

ISSN NO: 2770-4491
Date of Publication:20-07-2022

The salinity of the ground water increases in central Iraq, reaching 1000 mg / liter in the upper sedimentary plain in the north which can be used for Irrigation water, then the salinity of groundwater begins to gradually increase towards the south until it reaches 10,000 mg / liter in the south of Baghdad city and north of (Kut) governorate which can be Rarely used for irrigation water. [24]

Results and Discussion

Several tests were conducted to obtain reliable results to study the changes due to factors resulting in high susceptibility to abrasion resistance. One of the basic tests used is the tensile test. Table No.4 shows the results of the tensile test for a group consisting of several samples subject to standard specification

Table No.4 shows the results of the tensile**.**

No.	Material	U.T.S	U.T.S/ G1	U.T.S/G2	U.T.S/G3	U.T.S/ G4
1	As Resaved	89.01(MPa)	86.33	84.55	81.88	64.97
2	AA/1.0 %wt. SiC	99.68(MPa)	97.68	96.68	95.69	91.70
3	AA/2.0% wt. SiC	114.81(MPa)	113.66	113.08	112.51	111.36

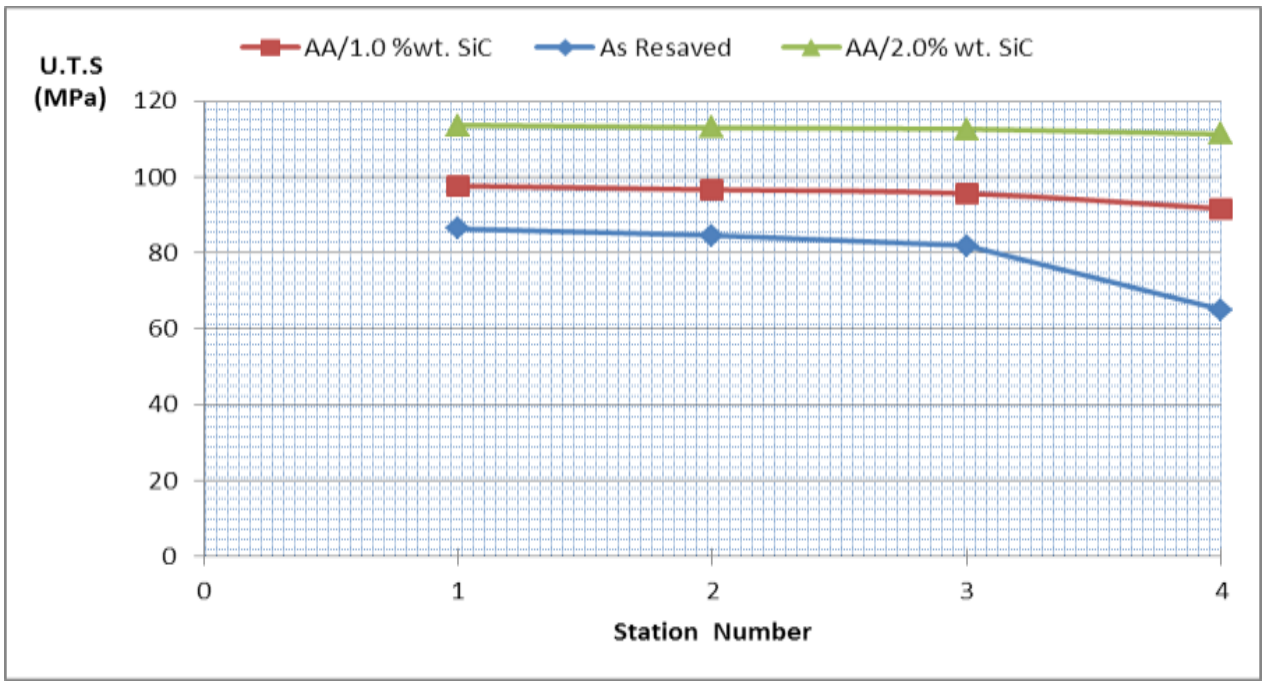

Figure No. 2 Ultimate Stress for different Stations.

Figure No.**3** shows the amount of change of the yield stress for the different ground stations, which reflects the reality of the groundwater taken from the aforementioned ground points. The results indicate a decrease in the yield stress of the stations as we move from north to south as a result of the increase in the effect of dissolved salts in groundwater, which can be It is a major factor in increasing the severity of corrosion, whether it is electrochemical or pitting corrosion. This increase may be attributed to the presence of nitrate and chloride ions mainly because they have no effect on the elements that have two valence numbers (+2, +3) Significant in removing the element from the circuit of self-protection. It is also shown from the same figure that the presence of the reinforced nanomaterial has greatly inhibited the corrosion that may be behind this change in the distribution of crystal lattice patterns. Increasing the density of terminal dislocations, as well as the presence of crystal structures at the grain boundaries that have a region Variable potential difference allows more freedom of transfer of electrons through covalent bonds.

ISSN NO: 2770-4491
Date of Publication:20-07-2022

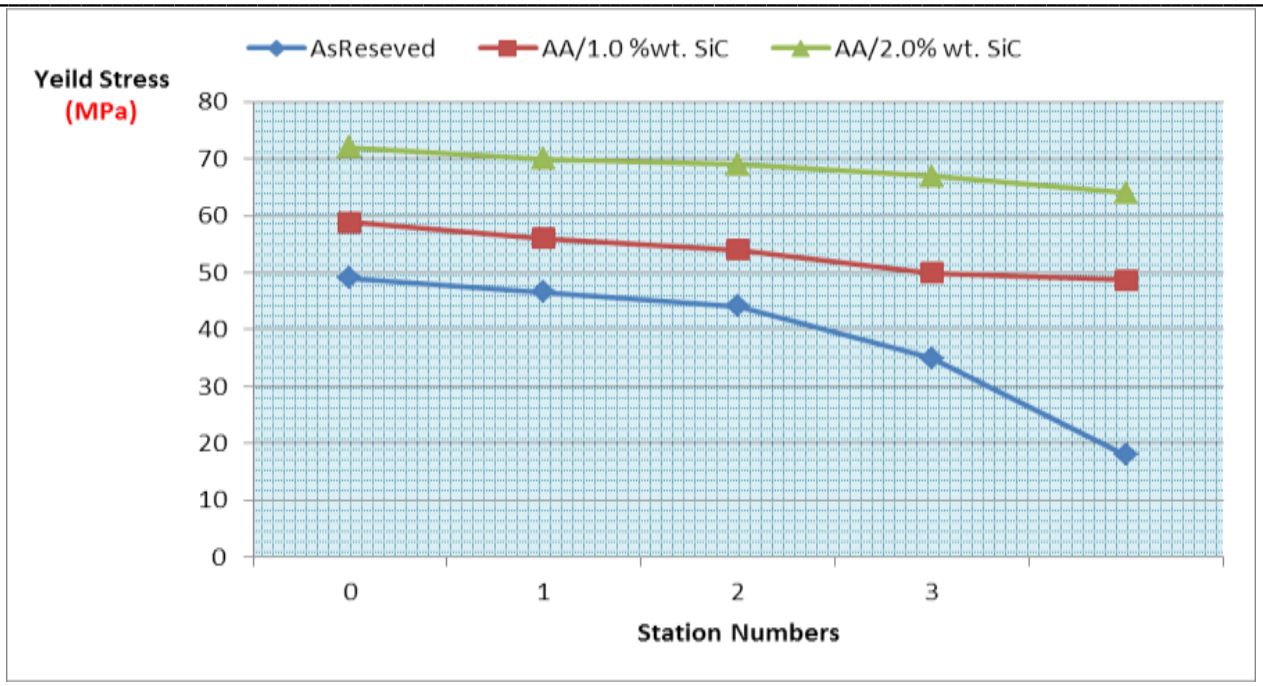

Figure No. 3 Yield Stress for different Stations

Conclusions

A number of conclusions can be drawn regarding the determination of the amount of corrosion in aluminum alloys exposed to groundwater and reinforced with alumina and its impact on these waters:

- It was found that the addition of nano materials to the aluminum alloy under study has generally led to an improvement in the property of the highest tensile stress that the material can bear, especially at a ratio (2.0%) wt. nano material , where the tensile stress reached the maximum.(115)MPa.

- A slight improvement was observed in the corrosion resistance property of the material after adding the nano-material and all the added ratios over the corrosion ratio in the base alloy.

- It may be that the added nanomaterial, the base alloy, or the process of overlapping and mixing between them did not give the desired results from adding the nanomaterial to improving the corrosion resistance property in a way that changes this property drastically or at a higher rate to prevent corrosion.

References

1. Al-Jaafari, M.A., 2021. Heat Treatments Effects on the Fatigue Behaviors of Aluminum Nano-Composite Alloys. *Iraqi Journal of Science*, pp.4397-4405.
2. Mohammed, A.A.H.J., Abd Al-Rasiaq, A. and Al-Jaafari, M.A., 2018. Studying the effect of Different wt% AL2O3 Nanoparticles of 2024Al Alloy/AL2O3 Composites on Mechanical Properties. *Al-Khwarizmi Engineering Journal*, *14*(2), pp.147-153.
3. Al-Rasiaq, A.A., 2017. Mechanical Properties of 7075 Aluminum Alloy Matrix/Al2O3 Particles Reinforced Composites. *Engineering and Technology Journal*, *35*(3 Part A).
4. Al-Jaafari, M.A., 2021. Study the effects of different size of Al2O3 nanoparticles on 6066AA and 7005AA composites on mechanical properties. *Materials Today: Proceedings*, *42*, pp.2909-2913.
5. Mohammed, A.A.H.J., Abd Al-Rasiaq, A. and Al-Jaafari, M.A., 2017. EFFECT OF CRYOGENIC TREATMENTS ON MECHANICAL PROPERTIES OF 7075 ALUMINUM ALLOY MATRIX/AL2O3 PARTICLES REINFORCED COMPOSITES.
6. Mohammed, H.J., Mahmood, I.A. and Al-Jaafari, M.A., 2018. An Estimation Study on Fatigue transition Life of Nanocomposites Reinforced by AL2O3. *Association of Arab Universities Journal of Engineering Sciences*, *25*(4), pp.185-202.
7. Al-Jaafari, M.A., 2021, June. Study the Effects of Titanium Dioxide nano particles reinforcement on the mechanical properties of Aluminum Alloys composite. In *IOP Conference Series: Materials Science and Engineering* (Vol. 1105, No. 1, p. 012062). IOP Publishing.

8. Deqing, W., Ziyuan, S. and Longjiang, Z., 2003. A liquid aluminum corrosion resistance surface on steel substrate. *Applied Surface Science*, *214*(1-4), pp.304-311.
9. Scamans, G.M., Birbilis, N. and Buchheit, R.G., 2010. Corrosion of aluminum and its alloys. In *Shreir's Corrosion* (pp. 1974-2010). Elsevier.
10. Bouchama, L., Azzouz, N., Boukmouche, N., Chopart, J.P., Daltin, A.L. and Bouznit, Y., 2013. Enhancing aluminum corrosion resistance by two-step anodizing process. *Surface and Coatings Technology*, *235*, pp.676-684.
11. Ofoegbu, S.U., Fernandes, F.A. and Pereira, A.B., 2020. The sealing step in aluminum anodizing: A focus on sustainable strategies for enhancing both energy efficiency and corrosion resistance. *Coatings*, *10*(3), p.226.
12. Li, Y. and Shi, Y., 2021. Microhardness, wear resistance, and corrosion resistance of AlxCrFeCoNiCu high-entropy alloy coatings on aluminum by laser cladding. *Optics & Laser Technology*, *134*, p.106632.
13. Pan, C., Wang, X., Behnamian, Y., Wu, Z., Qin, Z., Xia, D.H. and Hu, W., 2020. Monododecyl phosphate film on LY12 aluminum alloy: pH-controlled self-assembly and corrosion resistance. *Journal of the Electrochemical Society*, *167*(16), p.161510.
14. Li, G., Jiang, W., Guan, F., Zhu, J., Zhang, Z. and Fan, Z., 2021. Microstructure, mechanical properties and corrosion resistance of A356 aluminum/AZ91D magnesium bimetal prepared by a compound casting combined with a novel Ni-Cu composite interlayer. *Journal of Materials Processing Technology*, *288*, p.116874.
15. Qin, Z., Zhang, Q., Luo, Q., Wu, Z., Shen, B., Liu, L. and Hu, W., 2018. Microstructure design to improve the corrosion and cavitation corrosion resistance of a nickel-aluminum bronze. *Corrosion Science*, *139*, pp.255-266.
16. Nnaji, N., Nwaji, N., Mack, J. and Nyokong, T., 2019. Corrosion resistance of aluminum against acid activation: Impact of benzothiazole-substituted gallium phthalocyanine. *Molecules*, *24*(1), p.207.
17. Xiao, W. and Wang, Y., 2021. Corrosion resistance of aluminum fluoride modified 6061 aluminum alloy. *Materials Letters*, *298*, p.129932.
18. González-Rovira, L., González-Souto, L., Astola, P.J., Bravo-Benítez, C. and Botana, F.J., 2020. Assessment of the corrosion resistance of self-ordered anodic aluminum oxide (AAO) obtained in tartaric-sulfuric acid (TSA). *Surface and Coatings Technology*, *399*, p.126131.
19. https://www.makeitfrom.com/material-properties/1230A-O-Aluminum
20. Mamoon, A. and Al-Jaafari, A., 2020, June. Fatigue behavior of aluminum SIC Nano composites material with different reinforcement ratio. In *IOP Conference Series: Materials Science and Engineering* (Vol. 870, No. 1, p. 012159). IOP Publishing.
21. Al-Jaafari, M.A., 2022. A comparative study using silicon carbide and zirconium dioxide nano material's to improve the mechanical properties of 6261AA. *Periodicals of Engineering and Natural Sciences (PEN)*, *10*(3), pp.323-333.
22. Al-Jaafari, M.A., 2022. Investigated the effects of Different casting methods on the mechanical properties of 2014 Aluminum Alloy reinforced by Alumina. *Eurasian Journal of Engineering and Technology*, *8*, pp.43-50
23. Ibraheem, I.F. and Al-Jaafari, M.A., 2021, June. Evaluation of photovoltaic potential application in urban environments using GIS-based method: the particular case of Baghdad/Iraq. In *IOP Conference Series: Materials Science and Engineering* (Vol. 1105, No. 1, p. 012083). IOP Publishing.
24. Saleh, S.A., Al-Ansari, N. and Abdullah, T., 2020. Groundwater hydrology in Iraq. *Journal of Earth Sciences and Geotechnical Engineering*, *10*(1), pp.155-197.