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The Corrosion Characterization of Al7075-Aluminium Nitride Metal Matrix Composites

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***Abstract*— In automotive and aerospace industry for production of different components Aluminium 7075 alloy is used. In the present work, study is made on Al7075/AlN particulate composites. The Al7075 having aluminium nitride of 2wt% to 10wt% in steps of 2wt% of particulate composites was prepared by stir casting method. The As – Cast composite were heat treated at 470° C solutionizing temperature ice quenched and at 120° C artificially aged. The specimens were machined as per ASTM standards. The microstructure analysis shows uniform distribution of aluminium nitride reinforcement particulates in Al7075 matrix alloy. Corrosion test was conducted by immersing the specimens in 3.5% NaCl solution for time duration of 96 hours with increment of 24 hours. The corrosion study reveals that corrosion rate decreases with increase in AlN particulates at different exposure time in both heat treated and As-Cast composite.**

Keywords: Ceramic matrix composite, solutionizing temperature, Artificial Ageing, 3.5% NaCl solutioin

I. INTRODUCTION

In several sector metal matrix composites are gaining more popularity due to its lighter density and improved properties when compared with metals, especially in application where strength and weight are important. Al/Al alloy based MMC's are being used in several applications as a material system such as push rods, cylinder, connecting rod, brake disc and piston etc.[1] in particular, the properties of composite materials depends on the nature of the reinforcement and the matrix and relative content of reinforcement [2]. Aluminium nitride is selected as the reinforcement material taking in to consideration of its superior properties like good thermal expansion co-efficient, high strength, thermal suitability and its good dispersion with aluminium matrix [3]. Al7075 alloy have lots of benefits like corrosion resistance, formability, weldability and low cost. For production of aluminium particulate reinforced composite stir casting method considered to be promising method among various conventional processing methods [4].

As the piston and cylinder areas are exposed to high temperature environment, the MMCs used here should have sufficient stability as well as good mechanical and chemical strength (oxidation). Oxidation occurring at grain boundaries in alloys and at the interface between particle and matrix in mmcs usually increases intergranular fracture, resulting in premature failure and severe brittleness8-10. Therefore, in high-temperature applications, it is essential to have a thorough understanding of the oxidation behaviour of the aluminum MMCs.

Normality of NaCl plays a significant role in the corrosion of MMCs. Corrosion rate of the alloy and MMCs increased with increase in the concentration of NaCl solutions. The cathodic polarization curves were function of the normality of

NaCl and reinforcement concentration with hydrogen reduction increasing with increase in reinforcement [5]

In this present work, an attempt has been made to develop of As-cast aluminium alloy (Al7075)-Aluminium nitride particulate composite to study the mechanical properties by varying the Wt% of Aluminium Nitride particulate.

II MATERIALS AND METHODS

A. Materials

Aluminium alloy (Al7075) as matrix material and aluminium nitride is used as reinforcement material in the preparation of composites. Table.1 shows the chemical composition of Al7075 matrix material

Table .1 chemical composition of Al7075 matrix material

Elements	chemical composition
Cu	1.539
Mg	2.191
Si	1.783
Fe	0.290
Mn	0.275
Cr	0.117
Zn	4.416
Ti	0.047
Al	89.3

Aluminium nitride has good compatibility with aluminium alloy, good thermo-physical properties, and proper interfacial adherence without interfacial reaction. Aluminium nitride of average particle size 75-150 µ is used as reinforcement

B. Method of preparation

The clean extruded Al7075 alloy is put inside the graphite crucible with 0.5% of magnesium to the total weight of Al7075 alloy is added in the crucible were as magnesium acts as a wetting agent to bind matrix and reinforcement. The

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furnace heating temperature is increased to 750° C, hold for 30 minutes until aluminium alloy melted completely. Aluminum draft is removed from the surface of the molten metal. Aluminium nitride reinforcement is preheated and was added First, confirm that you have the correct template for your paper size. This template has been tailored for output on the A4 paper size. If continuously to the molten metal through the side of vertex created by mechanical stirring by stir impeller. The ideal speed of 450 rpm is determined and selected prior to this experiment. This is to avoid unacceptable porosity content in the casting due to excessive gas content that resulted from over agitating of metals [5]. The impeller and stirring rod is coated with liquid alumina this to avoid metals contamination in the molten metal, stirring process is carried out to facilitate incorporation and uniform distribution of particulate aluminum nitride in the molten metal, the composite mixture melt is stirred for 5 minutes and immediately the cast is poured in to permanent mould. The solidified metal matrix composite (Al7075/AlN) is take out from the mould and specimens are prepared as per the ASTM standards for microstructural analysis and to examine mechanical properties.

C. Corrosion Test

The Al7075/AlN particulate composite specimens were machined as per ASTM G69-80 standard. The specimens were machined in to cylindrical shape of dimensions 20 mm X 20 mm, then specimens were polished using emery paper of 120 grit size to 640 grit sizes, the specimens were degreased in acetone and rinsed with distilled water. The specimen initial weight was recorded and experiment was conducted using 3.5% NaCl solution for time intervals of 24 hours to 96 hours in steps of 24 hours. Finally the specimens were cleaned with acetone and weighed. The corrosion rate was calculated for each and every specimen by weight loss method.

III RESULTS AND DISCUSSION

D. Microstructure analysis

The specimens were subjected to optical microstructure analysis is first rough polished with a series of silicon carbide papers of 100,200.400,600 and 1000 grit size, then finely polishing is done using magnesium oxide paste followed by 3 thick diamond pastes on a velvet cloth.

Figure 1 shows samples for microscopic examination are prepared by etching with killer's reagent and examine under optical microscope

The uniform dispersion of aluminum nitride particulates in Aluminium (Al7075) matrix at different weight percentage is observed. The size of the aluminium nitride particulates appears to be homogeneous throughout the aluminium (Al7075) matrix. This can be achieved by the effective stirring action and the use of appropriate process parameters. Uniform distribution of AlN particle enhance mechanical properties the matrix alloy

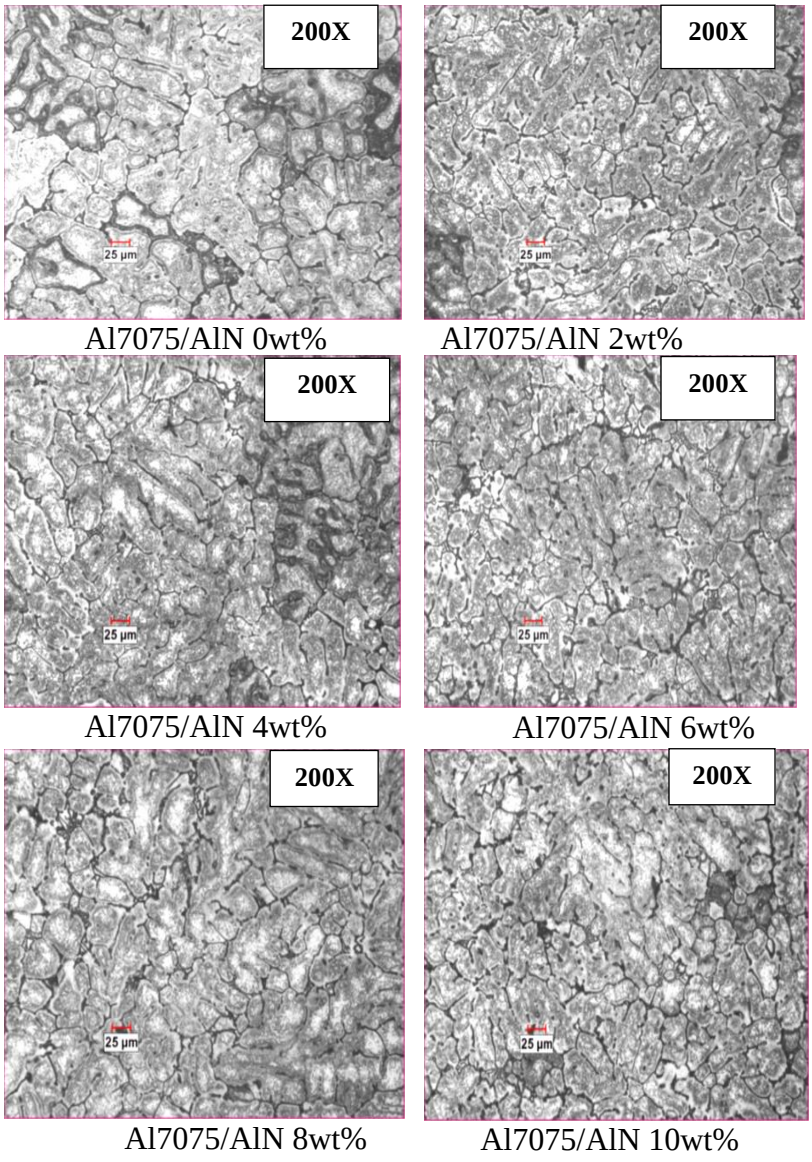

Figure 1: optical microstructure of Al7075 – AlN composites

E. Corrosion

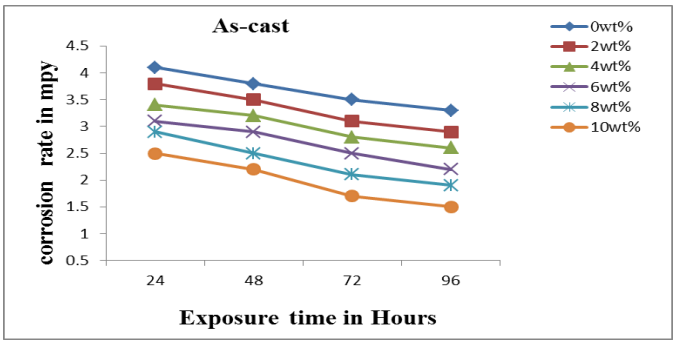

Figure 2: Effect of corrosion rate in As - cast composites by varying Aluminium nitride particulates wt% in Al7075 alloy at different exposure time

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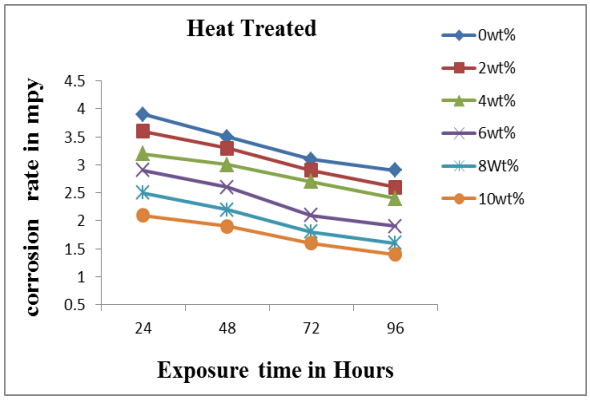

Figure 3: Effect of corrosion rate in Heat treated composites by varying Aluminium nitride particulates wt% in Al7075 alloy at different exposure time

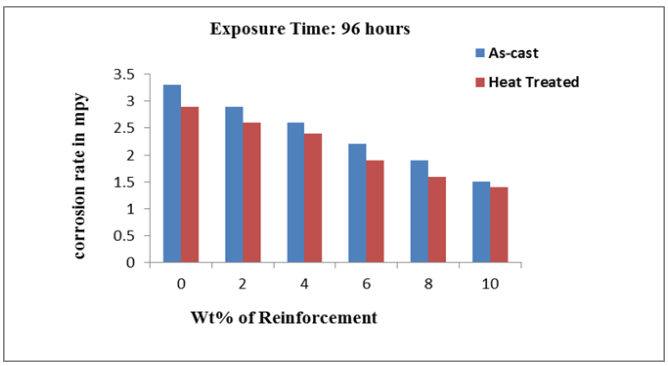

Figure 4: comparison of corrosion rate between un- heat treated and heat treated composites by varying Aluminium nitride particulates wt% in Al7075 alloy at 96 hours exposure time

The figure 2, 3 & 4 clearly weight loss method followed to find the corrosion rate with 3.5% Nacl solution at different exposure time. The result shows that decrease in corrosion rate gradually which specifies that passivation in the metal matrix alloy results in the development of permanent layer which affect the process of corrosion. De Salazar [10] reported that the presence of hydrogen –hydroxyl-chloride which acts as the protective black film lead to gradual forward reaction. The Al7075/AlN particulates decrease the corrosion rate with increase in weight percentage of AlN particulates and exposure in time. The hard aluminium nitride particulates is clearly indicating no effect in the composite at acidic median under different duration of test time with that of ceramic particulates acting as the corrosion resistant material similar type of results were also obtained by other researches. Wu. Jinaxin et al [11] the silicon carbide reinforced with aluminium composite the corrosion rate is not affected due to silicon carbide is acting as physical barrier playing as secondary role and the formation of corrosion pits it will also changes the microstructure of metal matrix composite which results in decrease in corrosion rate. Jameel. A. et al [12] Al6061 – Zircon MMC's tested with OCP method. Zircon reduces the corrosion rate with at 0wt% to 7wt%. From the present research work Al7075/AlN particulate composite with 3.5% Nacl solution as corroding the corrosion rate is decreased at different exposure time with increase in the wt% of AlN particulate composite under both as – cast and heat treated conditions.

IV CONCLUSIONS

From the present research work of Al7075 reinforced with aluminum nitride particulate composites following results were obtained

1. Al7075-Aluminium nitride particulate composites were successfully produced by stir casting method.
2. The microstructural analysis results show that the uniform distribution of Aluminium nitride particulates matrix alloy.
3. The percentage of aluminium nitride particulate increased in terms of different weight percentages in Al7075 matrix alloy showed the significant improvement in the corrosion resistance at different exposure to test duration time.
4. Corrosion rate of Al7075 –Aluminium nitride particulate composites is decreased in both as –cast and heat treated condition

REFERENCES

[1] N.Vinoth Babu and Dr.T.V.Moorthy. 2014. Synthesis and Characterization of Al7075/Sic composite by stir casting, Applied Mechanics and Materials: 592-594.
[2] C.Saravanan and K.Subramanian.2015.Effect of Particulate Reinforced Aluminium Metal Matrix Composite-A Review, Journal of Mechanics and Mechanical Engineering, 19(1).
[3] B.Ravi.2017.Fabrication and Mechanical Properties of AL7075-SiC-TiC Hybrid Metal Matrix Composites. International Journal of Engineering & Science Invention, 6(10):12-19.
[4] Hemanth raju T, Ramamurthy.v.s.2018. Development and Mechanical characterization of Al6061-Zr composite. International Journal of Engineering &Technology, 7: 579-583
[5] M.Mamatha, P.V.Krupakara, K Sreenivasa,2015, Corrosion Characterization of Aluminium 7075 / Red Mud Metal Matrix Composites, IOSR Journal of Applied Chemistry (IOSR-JAC), 2278-5736.Volume 8, Issue 9Ver. I (Sep. 2015), PP 07-11.
[6] V.Balaji, N Sateesh, M.Manzoor Hussain.2015.Manufacture of aluminium metal matrix composite (AL7075-SiC) by stir casting Technique, ELSEVIER, 2: 3403-3408
[7] Asegid Tadesse, Selva Ganesh.2020.An Overview on Metal Matrix Composite Processing and Al7075 based Mechanical Properties. International Journal of Engineering Research & Technology, 9(9)
[8] Bamgrsh Bihari,Srijan Prabakar,2018, Corrosion Behaviour ofAl7075/Al2O3/GraphiteHybrid Composite in 3.5% Sodium ChlorideSolution, International Journal of Engineering Research & Technology (IJERT), Vol. 7 Issue 01,ISSN: 2278-0181.
[9] C Emmy Prema , S Suresh, ,GRamanan and M Sivaraj,2020,Material reaserch express,1591-2053.
[10] J. M. G. Desalazar, A. Urefia, S. Mazanedo and M. Barrens, 1999, Corrosion behavior of AA6061 and AA7075 reinforced with Al2O3 particulates in Aerated 3.5% chloride solution potentiodynamic measurement and microstructure evaluation, corrosion science, Vol.41, No. 3, pp. 529-545.
[11] Wu. Jianxin, Liu Wei Lipeng Xing and Wurenjie, 1993, "Effect of matrix alloying elements on the corrosion resistance of C/Al composites materials, Journal of material science letters, Vol. 12, pp. 1500-1501.
[12] A. Jameel, H. P Nagaswarupa, P. V. krupakara and K. C. Vijayamma, 2009, Corrosion characterization of Al6061/Zircon metal matrix composites in acid chloride mediums by open circuit potential studies, International Journal of applied chemistry, Vol. 5, No. 1, pp. 1-10.