Mechanical Properties Of Al 6063 Metal Matrix Composite Reinforced With Graphite

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Abstract:Metal matrix composites are gaining wide spread acceptance for automobile, military, aerospace, sports, marine, etc. because of their high mechanical properties as light weight, high tensile and compressive strength at room temperature, creep and fatigue resistance at high temperature, good corrosion resistance, malleability etc. In this paper the effect of addition of different weight percentage graphite on the mechanical properties of Al6063 metal matrix is observed. The percentage of graphite was varied from 0% to 6% in step of 2%. There is a number of process available to prepare metal matrix composites but stir casting is the best suited method for preparing aluminum metal matrix composites (AMMCs). In this study stir casting process is used to prepare aluminum metal matrix composites (AMMCs). There are other parameters also which affect the mechanical properties of composite prepared by using stir casting process like string speed, shape of stirrer, time for string type of reinforcement et.. From the various experiments carried out in this study we can conclude that the physical and mechanical properties of prepared composite is higher than the metal matrix.

Keywords: Metal Matrix composites, AI 6063, AMMCs, Stir casting.

I. INTRODUCTION

In the past few years, materials R&D has shifted from monolithic to composite materials. Metal Matrix Composites comprise a class of advanced composites materials that are achieving acceptance as diverse as high-end consumer goods, transport (land, sea and air), defense healthcare and industrial applications. Metal matrix composites are metallic materials that have been reinforced with a secondary high performance material. Metal matrix composites are preferred and widely used over metal matrix because of their high performance application. A metal matrix composite is a mixture of metal matrix and reinforcement. E. Manikandanet. al investigated Al6061 reinforced with varying weight percentage of MgO to 1%, 1.5%, and 2%. The process used for preparing composite was powder metallurgy. It was concluded from the experiment that compressive strength and hardness of the metal matrix increases in the presence of MgO and maximum at 2%. Wear resistance of the composite increases as the percentage of reinforcement increases[1]. A. Chennakesava Reddy et. al. fabricated composite by using stir casting process. Mechanical property of Al6061, Al6063, and Al7072 reinforced with 20% wt% of aluminum oxide Al2O3 (particle size 10μm) increases in all three metal matrix. Al6061 shows higher yield strength, ultimate tensile strength and ductility compared to other two metal matrix. Microstructure of AMMC were studied using scanning electron microscopy (SEM). Al2O3 particles were observed to refine the grains and were distributed homogeneously in the aluminum matrix. Al2O3 particles cluster were also seen in few places. It also improved the micro hardness and ultimate tensile strength of AMMC[2]. Al6061- TiB2 composite material was used as metal matrix and graphite as reinforcement. Itwas investigated that thermal stability of Al6061-TiB2 higher than that of Al6061 which further increases by mixing graphite particles. It was found that as we increase the percentage of TiB2 from 10% to 20 % ignition period of Al6061 increases and there was further improvement in ignition period by the addition of 2% of graphite[3]. Aluminum LM13/MgO composites were prepared at 2%, 4%, 6%, 8% of MgO. It was found from the experiments that expansion of MgO particulate enhances rigidity of composite maximum at 6%. However a definitive elasticity start to diminish over 6% of MgO particles[4]. Different tests were conducted to check the mechanical properties of metal matrix composites prepared by using aluminum as base metal and Al2O3, SiC, MgO as reinforcement. High reduction in the grain size is observed before and after addition of reinforcement[5]. Composite prepared by using Al6061, Zircon as matrix and reinforcement respectively was study. Composites were prepared by stir casting process at 0%, 3%, 6%, 9%, and 12% volume percentage of Zircon. Hardness and UTS of composite increases and found maximum at 9%[6].DevarajuAruriet. al. investigate the effect of tool rotation speed on the wear property of hybrid composite was studied. Composites was prepared at the different rotational speed. It

was found from the experiments that as speed increases wear rate of the composite increases. It is because of high heat generation at higher rotational speed which leads to softening of the material[7]. R.S. Mishra et. al. used Friction stir casting method to fabricate AMMC by using 27% volume % of SiC (particle size .7μm) as reinforcement. It was found that addition of SiC almost doubles the micro hardness of the matrix[8]. J. Hasimet. al. investigated stir casting technique and variables which effect the mechanical properties of cast MMCs. They suggested various parameter like holding temperature, stirring speed, stirring time, size of impeller, shape of impeller blade and position of impeller in the melt. They also studied the intimate contact between reinforcement and metal matrix[9]. Madhu Kumar YC et. al. Al356 was reinforced with glass particle using stir casting method. Results show that mechanical property like hardness and tensile strength in glass reinforced composite increases. An aluminumbased MMC was fabricated by using Al6061 as metal matrix and fly ash as reinforcement. Three types of samples was prepared by varying the particle size and amount of fly ash. Results shows that as the weight % of reinforcement increases mechanical property of composite increases but if we increase particle size than mechanical properties will decreases.[10]. Biswajit Das et al. fabricatedaluminum composite metal matrix with copper and Titanium carbide using flux assisted synthesis technique by attaining a high temperature using induction resistance furnace. Aluminum ingot was kept in a crucible made of Graphite and melted, then pure copper is added to the molten aluminum and followed by the activated charcoal while the pure Titanium was added at the later stage [11].

II. Material and Methods

Various processing techniques for the fabrication of Aluminum matrix composites, testing of their mechanical properties are available. Several processing techniques like ultrasonic assisted casting, powder metallurgy, high energy ball milling, friction stir casting are recently being used for the production of aluminum matrix Nano composites. The processing technique used for the manufacturing of composite in this study is stir casting process. Procedure is given below.

2.1 Procedure

1. Firstly the metal matrix and reinforcement are measure in the proportion of 2%, 4%, and 6% of reinforcement. The total weight of metal matrix and reinforcement is kept below 1 Kg because of the capacity of furnace.
2. After this ingots of Al6063 in put inside the furnace and heated upto a temperature of 7500C. Reinforcement is also heated upto a temperature of 2000C simultaneously in the other furnace attached in the stir casting machine.
3. When the ingots are completely melted then, these preheated graphite particles are added to the molten metal and stirred continuously with the help of mechanical stirrer at 300 rpm for 10 minutes in order to get uniform mixing of filler particulate in the matrix material.
4. Now before pouring the composite in the mould it is preheated upto a temperature of 2000C. The mould used for the solidification of the composite is of cylindrical shape having 30mm diameter and 300mm length.
5. After preheating the mould molten metal is poured into the mould.
6. Casting takes some time to completely solidify. After complete solidification casting is taken out from the mould.

Figure 1 View of Final casting

In this study Brinell Hardness Test is used to calculate the hardness of the prepared composite. In this study three specimens are prepared for tensile test on for each percentage of reinforcement i.e. for 2%, 4% and 6%. Diameter of specimens are 23.5mm and gauge length is 136mm.

Different operations are carried out to get the final specimen foe the testing. A brief discussion After getting the casting samples from the stir casting various operation are carried out to get the final specimens for the testing.

III. Results and Discussions

*3.1 Effect on density:*The decrease in the values of density of Al6063 metal matrix composites reinforced with graphite shows that composites are light in weight as the reinforcement is added into it.

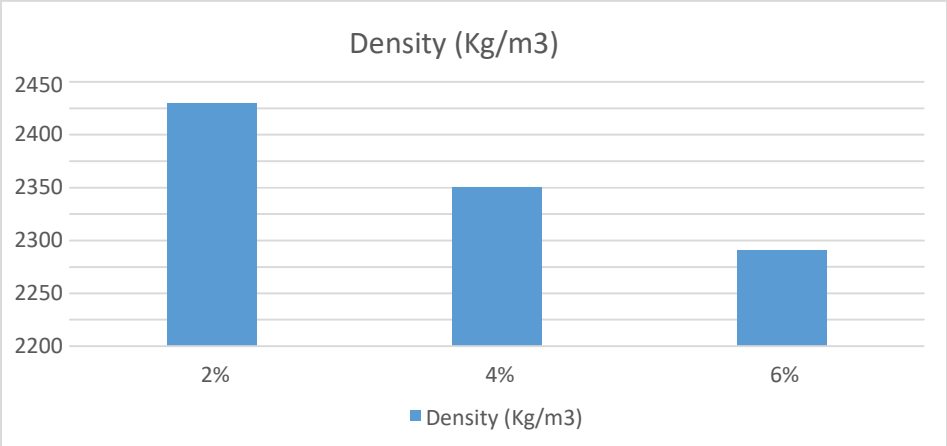

Figure 2 Density variation on Bar graph.

*3.2 Effect on Hardness :*Hardness test is carried out at room temperature using Brinell Hardness Tester. From various reading obtained from hardness test on different specimen average value is used as Brinell hardness number. As we can conclude from the above trend, the hardness of the composite will increase with rise in percentage by weight of graphite reinforcement. This may be attributed to presence of harder ceramic particles of graphite then the Al6063 alloy in the composite.

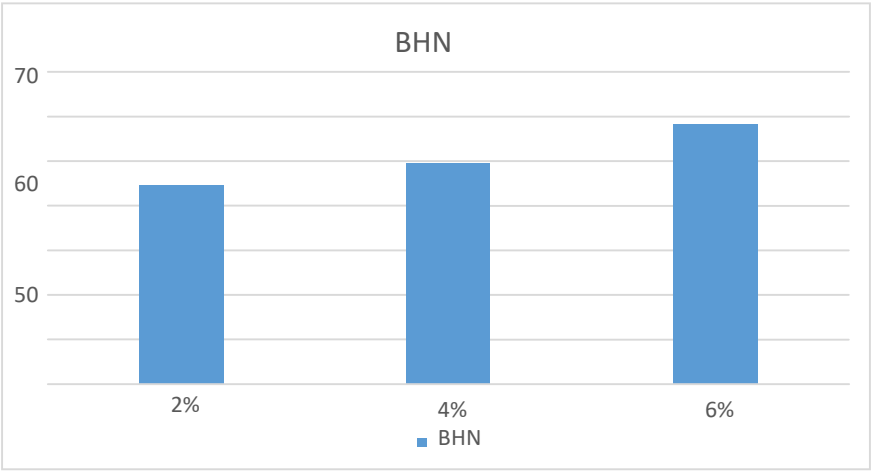

Figure 3 Hardness variation on Bar graph.

*Effect on Tensile Strength:*The tensile tests were conducted on these samples at room temperature, using a universal testing machine. The specimens used were of diameter 23.5 and Gauge length 136mm, machined from the cast composites with the gauge length of the specimen parallel to the longitudinal axis of the castings.the tensile strength of the composite will increase with rise in percentage by weight of graphite reinforcement. With addition of graphite particles in the metal matrix composite gives more strength to metal matrix alloy by offering more resistance to tensile stresses.

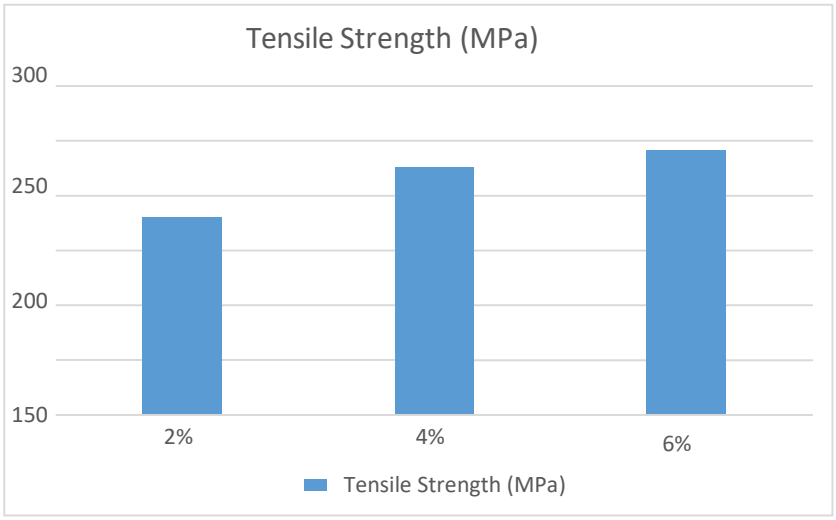

Figure 4. Tensile Strength Variation

IV. Conclusion

Processing variables in stir casting such as holding temperature, stirring speed, size of the impeller, and the position of the impeller in the melt are among the important factors to be considered in the production of cast metal matrix composites as these have an impact on mechanical properties. These are determined by the reinforcement content, its distribution, the level of the intimate contact of the wetting with the matrix materials, and also the porosity content. Therefore, by controlling the processing conditions as well as the relative amount of the reinforcement material, it is possible to obtain a composite with a broad range of mechanical properties. It can be seen from the results the as the amount of reinforcement in the composite increases density of the composite starts decreasing it means we get a lighter material in comparison to the previous Al6063 alloy. With increase in the weight percentage of graphite hardness of the composite increases. Higher value of hardness is clear indication of the fact that the presences of particulates in the matrix have improved the overall hardness of the composites. This is true due to the fact that aluminum is a soft material and the reinforced particle material being hard, contributes positively to the hardness of the composites. As we can see from tensile test there is an improvement in tensile strength of AL6063 alloy. Tensile strength of alloy increases as we increase the weight percentage of reinforcement in composite. It is also clear from the results that the tensile strength of composite increases with increase in weight percentage of reinforcement.

References

[1] Manikandan E, Balaji P, Ram IM, Sozhamannan GG. 2015. Tribological Behavior of Aluminum (Al) - Magnesium Oxide (MgO) Composite. 2:61–65.
[2] A. Chennakesava Reddy and Essa Zitoun; Matrix Al-alloys for silicon carbide particle reinforced metal matrix composites; Vol. 3 No. 12 (Dec 2010)
[3] Suresh S, Vinayaga NS, Vettivel SC, Selvakumar N, Jinu GR. 2014. Materials Science & Engineering A Effect of graphite addition on mechanical behavior of Al6061 / TiB 2 hybrid composite using acoustic emission. *Materials Science & Engineering A*. 612:16–27.
[4] Sagar CSR, Chandrashekar TK, Chandra BT. 2018. THE STUDY ON MECHANICAL PROPERTIES OF ALUMINUM LM13 / MgOp METAL MATRIX COMPOSITES. 8:225–229.
[5] Marahleh GS. 2011. Strengthening of Aluminum by SiC, Al2O3 and MgO. 5:533–541.
[6] Chandra B, Singh H. 2017. ScienceDirect Fabrication and characterisation of Al 2 O 3 / aluminum alloy 6061 composites fabricated by Stir casting. *Materials Today: Proceedings*. 4:2783–2792.
[7] Aruri D, Kumar A. 2013. Wear and mechanical properties of 6061-T6 aluminum alloy surface hybrid composites [(SiC + Gr) and (SiC + Al2O3)] fabricated by friction stir processing Wear and mechanical properties of 6061-T6 aluminum alloy surface hybrid

composites [(SiC + Gr) and (SiC + Al 2 O 3)]. doi:10.1016/j.jmrt.2013.10.004.
[8] Mishra RS, Ma ZY, Charit I. 2003. Friction stir processing : a no v el technique for fabrication of surface composite. 341:1–4.
[9] Hashim J, Looney L, Hashmi MSJ. 1999. Metal matrix composites : production by the stir casting method. 93:1–7.
[10] Yc MK, Shankar U. 2012. Evaluation of Mechanical Properties of Aluminum Alloy 6061- Glass Particulates reinforced Metal Matrix Composites. 2:3207–3209.
[11] Anilkumar HC, Hebbar HS, Ravishankar KS. 2011. Mechanical Properties Of Fly Ash Reinforced Aluminum Alloy (Al6061) Composites. 6:41–45.