EVALUATION OF MECHANICAL BEHAVIOR OF Al MMC USED IN STIR CASTING METHOD

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ABSTRACT--*This paper is about the Aluminum MMCs, which are preferred to other conventional materials in the fields such as aeronautics , automotive or automobiles and marine applications owing to their improved properties* ***like*** *good wear resistance, high strength to weight ratio. In this work we tried to synthesize MMC using a aluminium material called 6061Al as matrix material which is later reinforced with ceramic Al2O3 particulates using liquid metallurgy route using stir casting method.*

Keywords— *evaluation of mechanical behavior of al mmc used in Stir casting method*

I. INTRODUCTION

The reinforcement addition level is being varied from 6-12wt% . For every composite, reinforcement particles are preheated at 200 °C then dispersed in into the vortex of molten Al6061 alloy to strengthen the material than before, which also increases wettability and distribution. The microstructural characterization for the above prepared composites is done by taking few specimens from the central portion of the casting to make sure the particles are in homogeneous form. Tensile and hardness properties of the prepared composite were determined before and after addition of a the material (Al2O3) particulates to notice the extent of improvement. The microstructural characterization of the composites has been revealed uniform distribution and a few amount of small grain refinement within the specimens from the casting. The tensile properties and hardness properties are higher just just just in case of composites as compared to unreinforced aluminium material (6061Al) matrix, which also increases the addition level of reinforcement which results in further increase in both tensile and hardness strength.

II. AIM

The main aim of this review paper is to synthesize various aluminium materials such as 6061Al-Al2O3 particulate MMC by stir casting method. In order to enhance distribution and wetabiltiy of reinforcing particles, wghere a completely unique three stage mixing combined with preheating of the reinforcing particles is being carried out.

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III. METHODS AND EXPERIMENT

The matrix material used for this study is 6061Al-alloy. The chemical composition of Al MMC is determined using Atomic Absorption Spectrophotometer. Al2O3 particles with size of 125µm and with varying amounts of 6wt%, 9wt% and 12wt% are becoming used as reinforcing material within the preparation of composites. So Stir casting technique has been identified as the best method for the preparation of these composites. Initially calculated amount of 6061Al alloy was charged into SiC crucible and superheated to a temperature of 8000C in an electric resistance furnace. The furnace temperature was controlled to an accuracy of 500C employing a digital temperature controller. Specimens of 12mm diameter and thickness of 10mm were cut from the central portion of the casting for microstructural studies conducted using Optical microscopy(model DS X100,Olympus).SEM photographs were obtained using Scanning Electron Microscope (make-Joel, Japan).For XRD (Philips analytical) analysis, a plot of 2-theta verses intensity could be analyzed using origin plus software. The density of the samples were measured by Archimedes's method while theoretical density is computed by taking densities of 6061Al matrix and Al2O3 particles as 2.7 and 3.9gm/cm3 respectively. To investigate the mechanical behaviour of the composites the hardness and tensile tests were carried out using Zwickand computerized uni-axial tensile testing machine. Fig.1. Shows the size of the mould and specimen used for tensile studies. The hardness value reported is that the average value of 100 readings taken at various locations on the polished specimen. Similarly tensile tests were administered before and after addition of Al2O3 particles and for every of the composite three tests were conducted and average value is reported.

IV. MICROSTRUCTURAL STUDIES

Fabrication of metal–matrix composites with alumina particles by casting processes is usually difficult because of the very low wettability of alumina particles and agglomeration phenomena which results in non-uniform distribution and poor mechanical properties. In the current work, an effort has been made to organize Al6061 aluminum alloy matrix composites with micro size alumina particles by stir casting method with a completely unique three stages mixing combined with preheating of the reinforcing particles. The magnitude of alumina powder utilized in the composites was 6, 9 and 12wt. %. The optical micrographs of the 6061Al alloy with 0, 6, 9 and 12wt. % Al2O3 particulates.

V. DENSITY MEASUREMENTS

the comparison of theoretical density obtained by rule of mixture and measured density values by experiment for both the composites studied for various wt% of reinforcements. Experimentally, the density of a composite is obtained by displacement techniques employing a physical balance with density measuring kit as per ASTM: D 792-66 test method. Further, the density also can be calculated from porosity and apparent density values (sample mass and dimensions). It are often concluded that the experimental density of composite containing 6, 9 and 12 wt% Al2O3p is a smaller amount in comparison to the theoretical density. Further, measured density of composites is lesser than theoretical density, might be thanks to the presence of porosity. The porosity is probably due to i) increase in area in touch with air, ii) gas entrapment during stirring;, iii) gas injection of particles introduces a quantity of gas into the melt; iv) hydrogen evolution; v) the pouring distance from the crucible to the mold and vi) shrinkage during solidification

Composition	Theoretical density	Measured density
6061Al+6%Al_2O_3p	2.74	2.57
6061Al+9%Al_2O_3p	2.76	2.58
6061Al+12%Al_2O_3p	2.79	2.35

Chemical composition of Al6061 alloy assessed using Atomic Absorption Spectrophotometer

Element	Si	Fe	Cu	Mn	Pb	Zn	Ti	Sn	Mg	Cr	Al
Percentage	0.43	0.7	0.24	0.139	0.05	0.24	0.15	0.001	0.802	0.25	Balance

Parameters

S.NO	Matrix	Reinforcement	Reinforcement %	Stirring speed (rpm)	Stirring time (min)	Feed rate
1	A6061/1545K	B_4C	5 wt.%	450	-	-
2	A384	SiC	10 wt.%	500, 600, 700	5, 10, 15	-
3	LM25	B_4C/$Al2_2O3$	Wt. % (0,2,3)/ (0,2,3)	550	10	-
4	Al6061/Al7075	B_4C/graphite	Wt. % 10/5	500/700	5	0.9-1.5
5	Al 7075	B_4C	10 vol. %	500	-	-
6	Al 7075	Graphite	5, 10, 15, 20 wt. %	500	5	-
7	Al 6061	Nano Al_2O_3	0.5, 1, 1.5 wt. %	450	15	-

VI. TENSILE PROPERTIES

To examine the mechanical conduct of the composites the elastic tests were completed utilizing mechanized uni-pivotal malleable testing machine according to ASTM norms. Three examples were utilized for each test and normal worth is accounted for. The elastic properties, for example, rigidity, yield quality and % prolongation were separated from the pressure strain bends and are spoken to in Table 3.2. what's more, Fig. 3.3a-b. From fig. plainly crack quality of composites (6, 9 and 12wt %) is higher when contrasted with as cast 6061Al, while flexibility of composite is lesser that unreinforced combination. It is additionally obvious from fig. that the rigidity increments with increment in measure of fortification, while there is decline in malleability with expanding measure of support. Increment in quality is potentially because of the warm confuse between the metallic framework and the fortification, which is a significant component for expanding the separation thickness of the lattice and subsequently, expanding the composite quality. Notwithstanding, the composite materials showed lower extension than that of unreinforced examples. Clearly plastic misshapening of the blended delicate metal grid and the non-deformable fortification is more troublesome than the base metal itself. Accordingly, the malleability of the composite drops down when contrasted with that of unreinforced material.

VII. HARDNESS ESTIMATIONS

The consequences of small scale hardness tests directed on Al6061 compound and the 6061Al composite containing distinctive weight level of Al2O3particles. The Micro-Vickers hardness were estimated on the cleaned tests utilizing precious stone cone indentor with a heap of 20N and the worth revealed is normal of 100 readings taken at various areas. A noteworthy increment in hardness of the composite grid can be seen with expansion of Al2O3 particles. Higher estimation of hardness is away from of the way that the existences of particulates in the grid have improved the general hardness of the composites. This is valid because of the way that aluminum is a delicate material and the fortified molecule particularly pottery material being hard, contributes decidedly to the hardness of the composites. The nearness of stiffer and harder Al2O3 support prompts the expansion in limitation to plastic twisting of the network during the hardness test. In this manner increment of hardness of composites could be ascribed to the moderately high hardness of Al2O3 itself.

VIII. WEAR PROPERTIES

A pin-on-plate tribometer is utilized to play out the wear analyze. The wear track, amalgam and composite examples are cleaned completely with CH3)2CO preceding test. Every example is then gauged utilizing an advanced parity having an exactness of ±0.0001 gm. After that the example is mounted on the pin holder of the tribometer prepared for wear test.

For all tests, the sliding rate is acclimated to 1.256 m/s, track distance across 80mm, load 19.62N and absolute time is 40 moment under room temperature. The consequences of the weight reduction directed on 6061 Al compound and the 6061Al composite containing 0, 6, 9 and 12wt. % ofAl2O3 particles at a steady heap of 19.62N. From Fig.3.4 obviously weight reduction if there should be an occurrence of composites is diminished when contrasted with the base combination (6061 Al amalgam)

IX. FUTURE SCOPE

The future degree for of this work can be reached out to the accompanying zones:

- Use of different kick the bucket throwing process for higher pace of creation
- Use of Metal Injection Molding (MIM) for 'Fe' based composites
- Use of different fortification material to expand the properties of the material
- Use of Al composite grid and the multi-walled carbon nano tubes (MWCNTs)

X. COMCLUSION

The present work on readiness of 6061Al-Al2O3 metal grid composite by mix throwing and assessment of mechanical and wear properties has prompted following ends

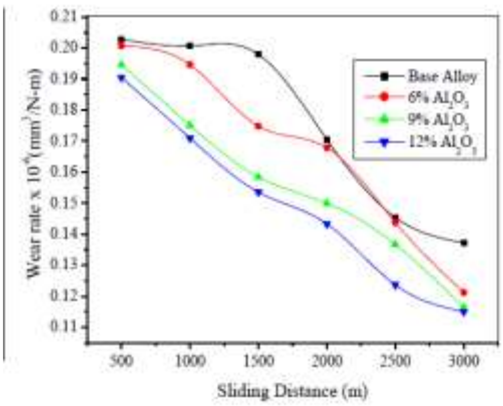
•The composites containing 6061Al with 6, 9 and 12wt% of Al2O3 particulates were effectively incorporated by dissolve mixing strategy utilizing three phases blending joined in with preheating of the fortifying particles.

•The optical micrographs of composites delivered by mix throwing strategy shows genuinely uniform dispersion of Al2O3 particulates in the 6061Al metal framework. The microstructure of the composites contained the essential.

•Al dendrites and eutectic silicon. While Al2O3 particles were isolated at interdendritic locales and in the eutectic silicon.

•The hardness of the readied composites builds withincreasingwt% of Al2O3 particulates and Strength of arranged composites both tractable and yield was higher in the event of composites, while pliability of composites was less when contrasted with as cast 6061Al. Further, with expanding wt% of Al2O3, the rigidity shows an expanding pattern.

•Maximum weight reduction was seen in as cast 6061Al amalgam and least weight reduction was seen in 6061Al+12%Al2O3 composites at a consistent heap of 19.62 N and speed of 300 rpm and higher wear rate was seen in as cast 6061Al combination when contrasted with 6061Al-Al2O3 composites at a steady heap of 19.62N and speed of 300 rpm.



XI. FUTURE SCOPE

The future scope for of this work can be extended to the following areas:

- Use of various die casting process for higher rate of production

- Use of Metal Injection Molding (MIM) for 'Fe' based alloys
- Use of various reinforcement material to increase the properties of the material
- Use of Al alloy matrix and the multi-walled carbon nano tubes (MWCNTs)

XII. CONCLUSION

The present work on preparation of 6061Al-Al2O3 metal matrix composite by stir casting and evaluation of mechanical and wear properties has led to following conclusions

- The composites containing 6061Al with 6, 9 and 12wt% of Al2O3 particulates were successfully synthesized by melt stirring method using three stages mixing combined with preheating of the reinforcing particles.
- The optical micrographs of composites produced by stir casting method shows fairly uniform distribution of Al2O3 particulates in the 6061Al metal matrix. The microstructure of the composites contained the primary.
- Al dendrites and eutectic silicon. While Al2O3 particles were separated at interdendritic regions and in the eutectic silicon.
- The hardness of the prepared composites increases withincreasingwt% of Al2O3 particulates and Strength of prepared composites both tensile and yield was higher in case of composites, while ductility of composites was less when compared to as cast 6061Al. Further, with increasing wt% of Al2O3, the tensile strength shows an increasing trend.
- Maximum weight loss was observed in as cast 6061Al alloy and minimum weight loss was observed in 6061Al+12%Al2O3 composites at a constant load of 19.62 N and speed of 300 rpm and higher wear rate was observed in as cast 6061Al alloy when compared to 6061Al-Al2O3 composites at a constant load of 19.62N and speed of 300 rpm.

XIII. ABBREVATIONS

Al – Aluminium

MMC – Metal Matrix Composities

Rpm – Rotation per minute

MIM – Metal injection moulding

ASTM – American society for testing materials

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