SYNTHESIS OF
AL5052-SIC-GRAFPHTIE METAL
MATRIX COMPOSITE AND
ASSESSMENT OF ITS
TRIBOLOGICAL PROPERTIES

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Abstract
The current work deals with the concoction associated
tribological analyse of the Al5052-sic-graphite composite. The
metal elite was Al5052 and sic-graphite contents in nu-
merous percentages were strengthened in it to fabricate the
specified metal matrix composite(MMC). Stir casting pro-
cess was accustomed to fabricate the MMC with five-hitter
of assault content and three of carbon content in Al5052.
Tribological ananlysis of the composite fashioned between
sleek — the graceful — the sleek surface of forged iron disc
and smooth MMC pin has been thought-about and fric-
tion force and wear of the MMC were examine by mistreat-
ment pin-on-disc setup. it absolutely was discovered that
the MMC with weight of ceramic content in metallic element matrix ends up in less wear and weight of ceramic content provides the low constant of friction between the tribo braced of forged iron surface and MMC surface. Among all the fabrication method we elect stir casting as the procedure and for good reinforcement of ceramics casting method area unit simplest and therefore the tribological analysis area unit wear, sem analysis and are evaluated.

1 INTRODUCTION

The metal alloys and composite necessaries have a massive application within the automobile, aircraft and allied industries. Reinforcement utilized in the metal matrix intensify the strength and sturdiness of the fabric as contrast to their constituent parent materials. gift state of matter directly links the mechanical field and its analysis with the auto and craft industries. it’s the necessity of the society to decrease the speed of consumption of the fuel. so as to attain it, the potency of the auto has to be improved. this may be done by condensing the full weight of the auto whose major parts square measure the engine and therefore the frame. aluminum in its alloy type is currently being employed for the producing of varied engine elements. The limitation of aluminum is that it’s at risk of lacerates and concavity terribly simply. So, a necessity arises to fabricate Associate in Nursing aluminum-based composite which would be wear resistant in nature by the inclusion of appropriate reinforcements in outlined proportion. aluminum matrix composites have wonderful ability in grips tensile additionally as compressive forces. analysis has been occurring by making an attempt completely different reinforcement materials into the aluminum. matrix to enhance and magnify the properties of the composite matrix. For the prevarication of the composites, metallurgy, stir casting process, ball edge and hot plunge and vacuity hot imperative a number of the performances that are utilized by researchers. but casting method is basically used because of its low price and high production rate. however formation of clusters and agglomeration of bolstered molecules having the base metal is one in all the most issues of casting method. Recently a semi solid metal (SSM) process-ing for the exaggeration of the compos-
ites. Widespread inspection has been done to check the wear and wrench etiquette of the metal MMCs because it provides higher wear resistance as analogize to the alloy.

Literature survey that inorganic compound Al2o3, Sic, graphite, are the foremost used augmentation material for MMCs. Recently non-metallic parts like rock dirt particles, rice husk ash (RHA), few-layer graphene (FLG) ar used as reinforcement and these all resulted in improvement in tribological premises of the composites. Sic micro particles were strengthened into the matrix. The addition of vellication particles enhances the hardness of the atomic number 13 alloy and thence decreases the wear and wrench rate.

In the recent time, the main focus of the researchers has been on the utilization of non-metallic particulates with rock dirt particles. the surplus of rock dirt particles diminish the properties of the composite however the low quantity of within the vary of 100% helps in up the wear and wrench confrontation of the composites. a mixture of ball edge and also the hot rolling method was adopted by Shin and Bae [20] to supply a composite of Al alloy 2024 Al2024) with few-layer gra-phene FLG). Sem ananlysis and mechanical premises were tested by the authors for the developed composite. At seven-membered vul of Flz the Al showed improved durability properties.

The actual performances that are measured by adding ceramic in various values gives a different mechanical and tribological properties. Because every ceramic that develops the different properties as the amount of molecules combine with the other metal that reinforcing with that metals also with alloys by so many researches gone through knowing of this composites because to find a good metals that which can be helpful to us in our modern life as the availability the researches of composites taking place for improving the various properties that will help to us to comproving of good metals for usage. We have chosen stir casting process because the reinforcement of particles can combine with the metal to improve it properties.

Target the result of black lead molecules on the microstructure of Al6082 metal matrix composite. Authors used typical casting Stir) method for the assembly of the com-posite material. The extension of black lead as reinforcement within the Al matrix isn’t desired since it decreases the firmness of the composite. nearly same detec-
tion were rumored by Alamensar and Samuhi [2]. However, strength and toughness of the 0.5% black lead and up to five hundredth RHA got hyperbolic. Authors conjointly rumored that with black lead part the composites resulted in larger susceptibleness to wear but because it is hyperbolic from 0.5 to 1.5% the wear and wrench resistance decreases. supported the previous analysis articles it can be over that argentiferous in addition non-metallic reinforcement is being employed to fabricate the Al2O3 matrix composite. The number of strengthened is mostly terribly less for non-metallic strength. Therefore as a non-metallic strengthened within the sort of flyash was designated because the reinforcement into the Al matrix. Fly-ash is created as a by-product from the aflame of fine coal in power generation plants. it’s harmful to humans if indrawn through the air. therefore by gazing harmful effects and to cut back then flyash gratified from the atmosphere, it absolutely was set to use flyash during a positive thanks to enhance the mechanical properties of the Al composites. during this paper, the influence of flyash contents on the Al matrix was studied and a possible stuff is planned for numerous mechanical applications like engines and bearings.

2 MATERIAL SELECTION

Al5052 alloy was chosen because the base material as a result of of its wide unfold engineering applications and low temperature. during this work, the MMC preparation has been tried in stir casting technique. silicon carbide and graphite is employed as reinforcement for its smart temperature resistance and abrasive resistance. sic as a compound will increase the strength and wear and also the graphite for increasing the wear and tear of the matrix.
The powders were placed into the muffle furnace in separate crucibles. 1st liquified liquid metal taken out from the muffle chamber operational at 900\textdegree C was poured into combining pot then the silicon carbide and graphite ceramic powders was poured into the pot. The ingredients were mixed by mistreatment steel stirrer. Steel stirrer was used as a result of steel has high freezing point, so it'll not soften throughout the stirring method. The stir casting was allotted in correct manner to get a standardized distribution. ab initio the die was absolutely cleansed by mistreatment the sand paper. The mixed liquified metal was poured into the appropriate die to solidify them and placed within the atmosphere. it had been allowed to solidify. Then it had been taken out of the die. inexperienced sand because it popularly famed is employed with binding material to make the cope and also the drag or the cores of the mould. The material has to be sized as a needed.

3 EXPERIMENTATION

MMC was factory-made with the assistance of a stir casting method. Stir-casting is that the method of softening the fabric with continuous stirring and straightaway gushing the melt into a preformed cavity, then cooling it and permitting it to solidify. In stir-casting, the parti-cles usually tend to make agglomerates, which may be

<table>
<thead>
<tr>
<th>S.NO</th>
<th>MATERIALS</th>
<th>COMPOSITE</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>AL 5052</td>
<td>92%</td>
</tr>
<tr>
<td>2</td>
<td>SiC</td>
<td>5%</td>
</tr>
<tr>
<td>3</td>
<td>Gr</td>
<td>3%</td>
</tr>
</tbody>
</table>
solely dissolved by vigorous stirring at heat. The stir casting established consists of a chamber, vessel and a rotor hooked up to the motor. The metallic element metal was fusible within the vessel that was heated to a temperature of regarding 900 °C, whereas the reinforce-ment material (sic-gr)) was side outwardly in an exceedingly mounted proportion of 5% and 3% weight. Al5052 and sic-gr were mixed with the assistance of a specially designed stirrer, at a motion speed of a hundred revolutions per minute with the help of the rotor for uniform mix. The stirrer used had a length of 95 cm and precisely sign blade having zigzag angle 90° of every aspect.

The liquid mixture of Al5052 mix with sic-gr was poured within the predefined cavity of needed dimensions. when future cooling and secondary machining processes, completely different specimens were created for testing of wear and tear and constant of friction. The percentage of various parts of the composite were analyzed.

A pin on disc setup was wont to live the wear and tear and resistance force. For the pin-on-disc wear check, 2 specimens square measure needed. One, a cylindrical pin that is positioned perpendicular to the flat circular counter disc. during this work, the disc rotates at some movement speed and pin specimen was ironed against the disc at a such load by suggests that of a lever with hooked up weights. the quantity of damage is set by advisement pin specimens before and once the check.

A solid specimen of a 165mm diameter and 8mm thickness was used as a counter disc. Surface grinding and overlapping processes were used on the disc to create it sleek. Al5052-sic-gr stuff was used as pin specimen of 30mm length and 10mm diameter.
The check was done below dry conditions while not victimization any grease. For performing arts the damage tests ASTM G99 standards were used. The quantity of wear and tear of the samples was recorded victimization the burden distinction technique, for that a weighing machine with least count of zero.00001 g has been used. The pin on disc machine is supplied with friction sensors that area unit wont to get the resistance force. The resistance force was wont to calculate the constant of friction.
Figure 1 stir casting setup
Figure 2 pin and disc setup
4 REPORT AND DISCUSSION

The performance of the metal matrix composite depends on the uniformity of the bolstered particles in its matrix. Agglomeration and geological phenomenon of the bolstered particle ends up in the fabrication of non-homogeneous composite. To work out the distribution of ceramic particles Associate in Nursing presence of the body within the composite an optical magnifier was used. For optical micro-graphs, the 3 samples surfaces were taken properly.

<table>
<thead>
<tr>
<th>TABLE III Wear test results</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Velocity (m/s)</strong></td>
</tr>
<tr>
<td><strong>Distance (m)</strong></td>
</tr>
<tr>
<td><strong>Track dia (mm)</strong></td>
</tr>
<tr>
<td><strong>Speed (rpm)</strong></td>
</tr>
<tr>
<td><strong>Time (sec)</strong></td>
</tr>
<tr>
<td><strong>Time (min)</strong></td>
</tr>
</tbody>
</table>

10
### TABLE IV Wear test readings

<table>
<thead>
<tr>
<th>TIME;</th>
<th>WEAR;</th>
<th>FF;</th>
<th>TEMP</th>
</tr>
</thead>
<tbody>
<tr>
<td>661.6100;</td>
<td>54.80;</td>
<td>0.66;</td>
<td>287.64</td>
</tr>
<tr>
<td>662.5890;</td>
<td>55.32;</td>
<td>0.63;</td>
<td>287.60</td>
</tr>
<tr>
<td>663.5700;</td>
<td>54.57;</td>
<td>0.64;</td>
<td>287.63</td>
</tr>
<tr>
<td>664.5500;</td>
<td>54.58;</td>
<td>0.54;</td>
<td>287.75</td>
</tr>
<tr>
<td>665.5300;</td>
<td>54.72;</td>
<td>0.60;</td>
<td>287.61</td>
</tr>
<tr>
<td>666.5100;</td>
<td>54.53;</td>
<td>0.41;</td>
<td>287.48</td>
</tr>
<tr>
<td>667.4900;</td>
<td>54.58;</td>
<td>0.35;</td>
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</tr>
<tr>
<td>668.4710;</td>
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<td>287.76</td>
</tr>
<tr>
<td>669.4510;</td>
<td>55.35;</td>
<td>0.40;</td>
<td>287.71</td>
</tr>
<tr>
<td>670.4310;</td>
<td>55.70;</td>
<td>0.52;</td>
<td>287.68</td>
</tr>
</tbody>
</table>
The Load parameters for this sample description is 14.715 N. By using this report we have calculated the wear loss, wear rate, wear volume and coefficient of friction.
### TABLE V: SEM analysis report on composites

<table>
<thead>
<tr>
<th></th>
<th>Description</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Density of composite</td>
<td>2.6809 g/cc</td>
</tr>
<tr>
<td>2</td>
<td>Wear loss</td>
<td>0.1893 g</td>
</tr>
<tr>
<td>3</td>
<td>Wear volume</td>
<td>0.0706 mm³</td>
</tr>
<tr>
<td>4</td>
<td>Wear rate</td>
<td>2.39 x 10⁻⁴ mm³/Nm</td>
</tr>
<tr>
<td>5</td>
<td>Coefficient of friction</td>
<td>0.66</td>
</tr>
</tbody>
</table>

**Figure 3: SEM analysis sample-1**
Figure 4 sem analysis sample-2
In this microanalysis samples we can see ploughings, wedges, debris also we can see the varying stages of ceramic particles mixing taking place that which occurs micro graphic representation. The weight loss of the Al5052 composite strengthen with sic-graphite is utterly clear weight loss of the composite reduces as the ceramic content is adding to composite increased at limit of its percentage. The Ceramic content present in the aluminum matrix endure the catastrophic action of wear test and therefore increases the wear confrontation of the composites. For sample the portion of wear obtained when testing alone Al5052 was 0.24g, after testing the wear for the composite matrix it was 0.18g respectively. The cosmos of wear is mostly mordant. The coefficient of friction is lay with respect to sliding time, It was assemble for the coefficient of friction with the assist of fractional sensor. Which is linked to pin on disc machine along the computer aided software. That the coefficient of friction is extreme for a sample retain the appease of ceramic parti-
cles.it is also distinguish that the coefficient of friction in the al5052 alloy alone appease sample is less compare to matrix composites. It is detected that when ceramic particles are reinforced to al5052 matrix the coefficient of friction improve with sliding time. Alarge number of ceramic particles come in to contact with disc and these molecules start destructing itself and thus increases the coefficient of friction.

5 CONCLUSION

Based on the inspect result ananalysis the following termination were drawn to find a new metal composites for industrial equipment, automotive and sporting good industries. Al-Sic-Gr of various concentration composites were successfully counterfeit by stir casting process. Based on the preliminary observation the subsequent conclusions have been taken: substance of the Composites decline by adding of ceramic content through reinforcement. Ceramic content present in the aluminum matrix endure, the detrimental action of wear test and hence increased the wear confrontation of the composites. For sample the amount of wear loss obtained when testing alone Al5052 was 0.24g, after testing the wear loss for the composite matrix it was 0.18g respectively. It is also observed that the coefficient of friction in the al5052 alloy alone contented less compare to matrix composites coefficient of friction is more. From the above results we can culminate that of Al-Sic-Gr composites could be considered as an exceptional material in sectors where light weight and emphasize tribological properties are essential.

References


[16] Rajan et al. Production and characterisation of Al7Si0.35Mg/fly ash metal matrix composites processed by different stir casting routes. Composites Science and Technology, 2007.