March - April 2020
ISSN: 0193-4120 Page No. 7480 - 7483

Comparative Analysis of Mechanical Properties in Aluminium Based Metal Matrix Composite

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Abstract

Composites are focused on introducing a product made up of lightweight material which could replace conventional ferrous and non-ferrous alloys. Aluminium is one of the most commonly used metals for the production of metal matrix composites. Aluminium-based metal matrix composites are sought over other matrix-based composites in the field of aerospace, automotive and marine application due to its valuable mechanical properties. The usage of Aluminium lowers the density, coefficient of thermal expansion, Improves the corrosion and wear resistance as compared to the conventional counterparts. Al-Zr system is used to form a thermally stable strengthening phase in high-temperature aluminium-based casting alloys. These alloys have good strength at elevated temperatures. Zirconium strengthens the alloy by a precipitation hardening mechanism and chromium further enhances the strength of the alloy. Different specimens are fabricated with varying the composition of Zirconium to achieve optimum performance of the alloy for the required application. A comparison of properties between the different alloys is performed by various testing methods and analysing the results with mathematical values of the standard component.

Keywords; *Metal matrix composites, thermal expansion, Al-Zr, precipitation hardening.*

I. INTRODUCTION

A composite is made up of two or more different materials which are unique in physically and as well as chemically. The formed composite will have superior physical and chemical properties when compared to that of the parent component. As a solution to modern material requirements composites are more preferred over traditional monolithic components. There are many ways to form a composite, the individual constituent's materials combine to form a composite. The matrix materials are the base materials, the reinforcement are the materials which lie between the matrix materials. The matrix so formed is termed as Metal Matrix Composites. The metal matrix composites are preferred for performing research and new products are developed throughout the globe which has a diversified area of application. The composite so formed will have high strength, energy absorbing capacity, and good wear resistance compared to reinforced alloys. The recent trends in MMCs is the particle reinforced type of composites The composite where aluminium is used as the matrix material and reinforces with other suitable materials for enhancing the property of aluminium. Aluminium is preferred for its properties like availability, low cost, castability and its property to combine with other materials to form a composite. Aluminium based MMCs which are reinforced with particulate matter have superior properties than

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unreinforced MMCs. The particulate composite are prepared by introducing the reinforcing particle into the matrix when it is in a liquid state during the process of casting. Casting methodology is followed to form a composite for its low cost of production and can be used for mass production as well. Stir casting is a type of casting process which is widely used in the formation of MMCs. Stir casting process are preferred over other procedures due to their simplicity and low production cost. The main disadvantage in this process is that it cannot control the distribution of the reinforcement particle into the matrix due to poor wettability and gravity segregation. In particle reinforces MMCs the interaction zone which lies between the matrix and the reinforcement plays a major role in defining the property of the composite, the factors which play a major role are size, shape and volume fraction of the reinforcement. Properties and Strength of aluminium composite could be gauged using the-described process and material which are elaborated in the succeeding chapter.

II. EXPERIMENTAL SETUP

This process which is done by pouring the mixture melt into the mould that is designed as a sand casting set up. The three composite materials are solidified separately at room temperature. Thus three specimens are casted as per the chemical composition described in the following table. The specimen is casted with 95mm X 55mm X 20mm as overall dimension.

Table 1.1 Composition of prepared samples

Name	Aluminium 6061 (Percentage %)	Weight (gms)	Zirconium (Percentage %)	Weight (gms)	Chromium (Percentage %)	Weight (gms)
Sample 1	98.8	988	0.4	4	0.8	8
Sample 2	98	980	0.4	4	1.6	16
Sample 3	97.2	972	0.4	4	2.4	24

Fig 1.2 Sample 1

Fig 1.3 Sample 2

Fig 1.4 sample 3

III. RESULT AND DISCUSSION

I. Mechanical testing

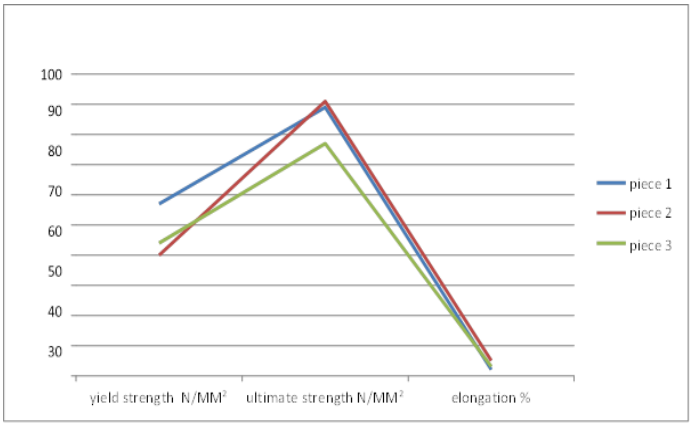

Figure 1.5 comparison of tensile strength

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ISSN: 0193-4120 Page No. 7480 - 7483

Figure 1.5 represents the comparative representation of the three specimen under a Universal testing machine, Representing parameters like yield strength, ultimate strength and percentage of elongation.

II. Hardness test

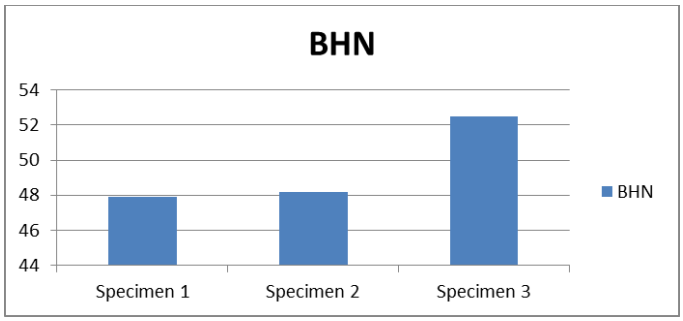

Figure 1.6 Hardness testing

Figure 1.6 represents the hardness number for each specimen by Brinel hardness testing method. An average of three readings is taken to find the average hardness value.

III. Impact test

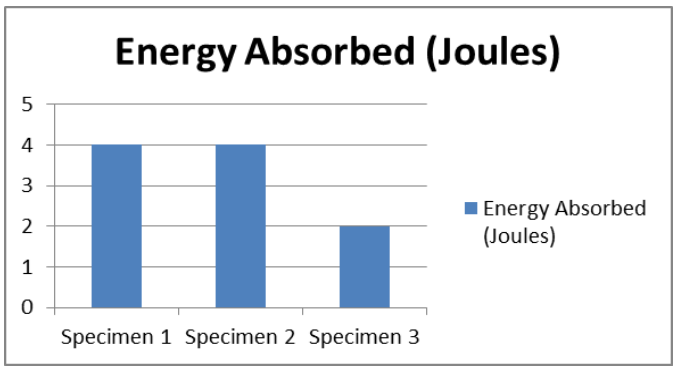

Figure 1.7 Impact test

Figure 1.7 represents the energy absorbed by each specimen during impact testing by Charpy method with a “V” notch.

IV. SEM Analysis

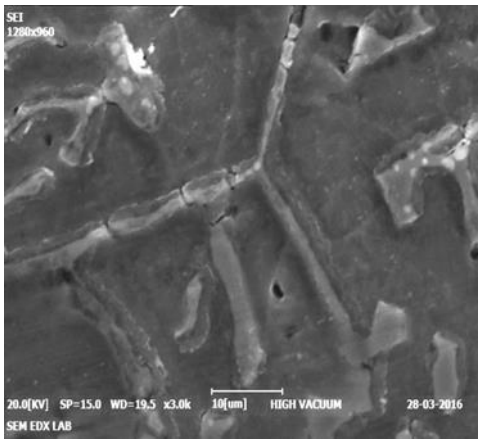

Figure 1.8(a) SEM analysis of specimen 1

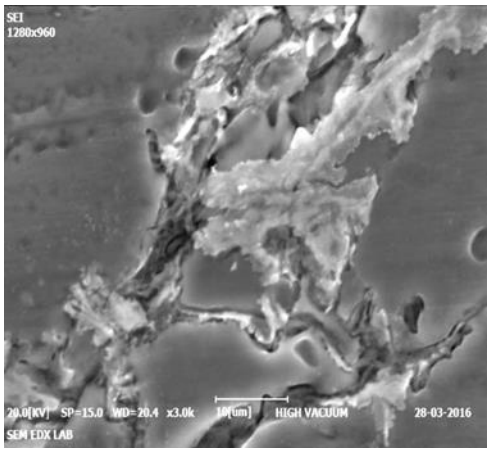

Figure 1.8 (b) SEM analysis of specimen 2

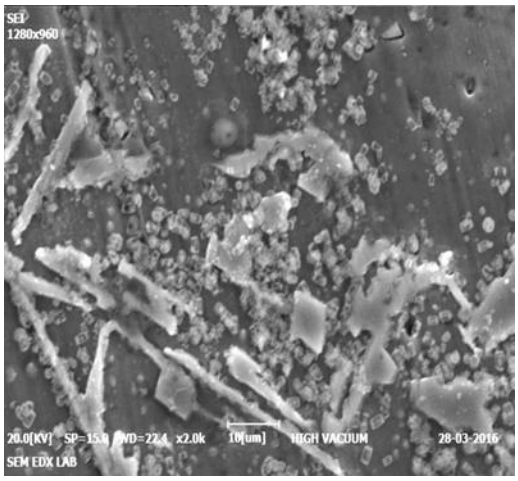

Figure 1.8(c) SEM analysis of specimen 3

IV. CONCLUSION

Based on the report, the first composition yield strength is better than other composition .In second composition ultimate tensile strength is better than other composition. in third composition hardness is

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improved and impact strength is higher than the other composition. From that we analysis is second composition is suitable for tensile application and also it have average hardness, yield strength. Third composition is suitable for brittle application. We have analysis the practical structure of the alloy through SEM analysis.For future work we are plan to add scandium, titanium with current composition to increase the mechanical properties and it can be used in aerospace applications.

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