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Review Article

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"A Review on the study of mechanical properties and tribological behavior of AL7079 reinforced with silicon carbide and graphite"

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Abstract

In this present generation, due to extensive demands of low cost, high efficiency and performance along with superior quality has led to a decline in the simple and traditional research and new advance research has taken over. Hybrid composites have proved their great performance with excellent versatility. Aluminium based Hybrid Metal Matrix composite (HMMC) Exhibit Excellent Wear Resistant, Strength – Weight Ratio and Tribological Properties in comparison with the base alloy for wide variety of Engineering Applications in Automotive, Aerospace and Heavy Machinery Industry. However the Particulate Reinforced Hybrid–Metal Matrix Composites for Engineering Applications has been challenged by several reasons such as High Manufacturing Cost, Poor Machinability and achieving uniform distribution of Reinforcement within the Matrix. However economical Liquid Metallurgy technique – Stir casting, can be used to overcome these challenges. This paper presents a review on the mechanical properties and tribological behaviour of Al7079 reinforced with Silicon carbide and Graphite. And also to study the strength and heat treatment properties.

1. Introduction

Alluminium Alloys

Metals such as aluminium and its alloys are one of the most used material systems in the automotive and aerospace industry due to their high strength to weight ratio as well as because of their high thermal conductivity. It is mostly used in high temperature applications such as in automobile engines and in other rotating and reciprocating parts such as piston, drive shafts, brake rotors and in other structural parts which require light weight but high strength material [1,2]. One of the main drawbacks of this material system is that they exhibit poor tribological properties. Hence the desire in the engineering community to develop a new material with greater wear resistance and better tribological properties, without much compromising on the strength to weight ratio led to the development of metal matrix composites [3,4]. A composite may be defined as a material system comprising of two or more constituent materials that

remain separate and distinct while forming a single component. The bulk material forms the continuous phase that is the matrix (e.g. metals, polymers, etc) while the other acts as the discontinuous phase that is the reinforcements (e.g. fibers, whiskers, particulates, etc). While the reinforcing material usually carries the major amount of load, the matrix enable the load transfer by holding them together [5].

The properties of ceramic reinforced metal matrix composites has been reported much better to that of its unreinforced counterpart [6, 7]. The addition of reinforcing phase significantly improves the tribological properties of aluminium and its alloy system. The thinking behind the development of metal matrix composites is to combine the desirable properties of metals and ceramics. The combination of refractory particles with metallic matrix produces a material system with properties intermediate to that of matrix alloy and ceramic reinforcements. Aluminium have useful properties such as high strength , ductility, high thermal and electrical conductivity but have low stiffness whereas ceramic reinforcements are stiffer and stronger and have excellent high temperature resistance but they are brittle in nature[8].

Now a days the particulate reinforced aluminium matrix composite are gaining importance because of their low cost with advantages like isotropic properties and the possibility of secondary processing facilitating fabrication of secondary components. Cast aluminium matrix particle reinforced composites have higher specific strength, specific modulus and good wear resistance as compared to unreinforced alloys.

While investigating the opportunity of using fly-ash as reinforcing element in the aluminium melt, R.Q. Guo and P. K. Rohatagi observed that the high electrical resistivity, low thermal conductivity and low density of fly-ash may be helpful for making a light weight insulating composites. The particulate composite can be prepared by injecting the reinforcing particles into liquid matrix through liquid metallurgy route by casting. Casting route is preferred as it is less expensive and amenable to mass production. Among the entire liquid state production routes, stir casting is the simplest and cheapest one. The only problem associated with this process is the non uniform distribution of the particulate due to poor wet ability and gravity regulated segregation. It is also attractive because, in principle, it allows a conventional metal processing route to be used, and hence minimizes the final cost of the product. This liquid metallurgy technique is the most economical of all the available routes for metal matrix composite production, and allows very large sized components to be fabricated.

There are number of processing techniques which have been developed in recent years for processing metal matrix composites. According to the type of reinforcements, the fabrication techniques also vary considerably. The different techniques employed for metal matrix composites are powder metallurgy, spray deposition, liquid metal infiltration, squeeze casting, stir casting, etc [9, 10]. All of them have their own advantages and disadvantages. At the early stage of development of metal matrix composites, emphasis was on preparation of fiber reinforced composites. But the high cost of reinforcement fibers, restricted the commercial exploitation of this class except for some high technology applications. The particulate reinforced metal matrix composites are gaining importance nowadays because of their low cost with advantages like isotropic properties and the possibility of secondary processing. Among the various processing techniques available for particulate or discontinuous reinforced metal matrix composites, stir casting is the technique which is in use for large quantity commercial production. This technique is most suitable due to its simplicity, flexibility and ease of production for large sized components. It is also the most economical among all the available processing techniques.

2. Literature Review

[1] Basavaraju. S et al. (2012) have investigated on Al LM25 used as a base metal in this work graphite and fly ash are added for 2% of aluminium weight separately & silicon carbide are varied for 2,4,6 &8% weight of Al. The mechanical properties such as tensile strength, hardness and wear rate have analyzed.This composite results in reduced density of material which gives best results.

[2] Mr. Prasanna et al. (2014) in this work experimental investigation of mechanical properties of SiC, E-glass and red mud reinforced Al Alloy(LM25)were analysed. The main mechanical properties studied were the tensile strength, ductility, impact strength and hardness, this results in improved tensile strength, impact strength and reduces % of elongation.

[3] G. Saravanan et al. (2014). This study investigates the mechanical and tribological characteristics of Al, SiC & Graphite. Composites were fabricated by stir

casting process at 800-1000oC. Tribological test were carried out in 10N-50N normal load using pin on disc by considering temperature in dry sliding condition with sliding velocity of 1m/s. This combination results better wear resistance, hardness & tensile strength.

[4] B. Pavithran et al. (2015). In this research work they have concluded that the Al based hybrid metal matrix composites Exhibit excellent wear resistant, weight ratio & Tribilogical properties in comparison with the base metal. Results gives raise to the hardness, tensile strength, compressive strength and toughness are tested as per ASTM standard, wear test were also carried out to improve the wear resistance.

[5] Ashok Kr. Mishra et al. (2012). Tribological behavior of Al-6061 reinforced with SiC particles was investigated. Experiments were conducted by Taguchi Technique L9 orthogonal array was selected for analysis of the data. ANOVA & Regression equation for each response were developed for both 10% & 15% SiC reinforced Al-6061 MMC's.

[6] Kamat et al. (1989) have used Al2O3 as the reinforcing agent in Al alloy and reults showed that the yield strength & tensile strength of Al-MMC increased with an increase in volume fraction of the Al203 particulate.

[7] Krishna et al. (2014) used Al 6061 alloy and reinforced it with SiC from 5 to 15 wt. % using stir casting technique. The tensile strength of the metal matrix composite was observed to in-crease more when graphite was added to Al/SiC as compared to SiC addition in Al matrix.

[8] Venkat Prasad et al. (2011) studied the wear characteristics of Al/Gr/fly ash hybrid metal matrix composite and observed that addition of fly ash and graphite lowered the wear rate.

[9] Suresha et al. (2012) studied the wear behavior of Al-MMC in which SiC and graphite was used as reinforcement. They concluded that the coefficient of friction is mainly dependent on load and sliding velocity. There was a gradual increase in the coefficient of friction with increasing load and sliding ve-locity. They also concluded that the average coefficient value was lower as compared to the base alloy.

[10] Asif et al. (2011) stud-ied the comparative wear behavior of Al/SiC and Al/ SiC/Gr and both the composites were fabricated with the application of powder metallurgy technique. The results showed a lower wear rate for the Al/SiC/Gr and compared to the binary Al/ SiC composite.

[11] Ramachandra et al. (2007) studied the tribological behavior of Al/SiC/Fly ash metal matrix composite. The wear resistance is improved for the MMC as the concentration of fly ash is increased. Load and sliding velocity lowered the wear re-sistance gradually.

[12] Pramila Bai et al. (1992) studied the wear characteristics of Al/SiC metal matrix composite and observed an improvement in the tribological properties when the con-centration of SiC is between 10-20 wt. %.

[13] S. V. Sujit et al. (2018). An investigation into fabrication of characterization of Al7079 TiC in-Situ metal matrix composites uses mechanical testing and metallography. Tradition casting and rapid solidification techniques are used to produce the Al7079 TiC in-situ components. The variables used for this investigation are Temperature, Time, Cast environment and controlled stirring are the major variables which leads to successful direct reaction synthesis of in-situ TiC reinforced Al7079 MMC.

[14] Singh et al. (2018). Dry sliding wear tests conducted on pin-on-disc wear test machine. In this study Al5083 matrix reinforcement used to test for hardness and tensile strength. The mechanical properties like hardness can be increased by reinforcing Al5083 alloy 5% boron carbide particles & tensile strength. Scanning Electron Microscope analysis & EDS is done which helps to study topography of composites.

[15] Gurpreet Singh et al. (2017). They made the parametric study of the wear behavior of aluminium matrix composites has been carried out. Dry sliding wear tests were conducted using pin-on-disc apparatus at room temperature and process optimization was done using Response surface methodology (RSM).The two predictive models were validated by conducting confirmation tests and certified that the developed wear predictive models are accurate and can be used as predictive tools for wear applications.

[16] B. Stojanovic et al (2013). In his study he concluded that Hybrid Al/SiC/Gr composites have a lot of better tribological characteristics in comparison to Al–SiC and Al–Gr composites. By changing percentage content of reinforcement, mechanical and tribological characteristics of the obtained hybrid composites with aluminium matrix are changed.

Conclusion

From the literature, it is been found that the tribological characteristics have been found for different material combination such as Hybrid Al-SiC, Al-Gr, Al5083, and some methods used were Scanning Electron Microscope analysis & EDS which helps to study topography of composite.

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