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Research Paper

EFFECT ON PROPERTIES OF ALUMINUM BY ADDING ALUMINA SLAG AS A STRENGTHENER

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In this paper we describe the behavior of Metal matrix composites. As we know that these metal matrix composites are used mostly in liberty ships, aerospace, automotive, and nuclear. In the present paper the study on sharp show off activities of Aluminum metal matrix composite reinforced with Alumina slag, SiC and Al_2O_3 has been carried out. There are various production technique offered where the value fraction of Strengtheners could be inflamed and are likely to vary the wear performances of the composite. Composites posses excellent Strength and Stiffness and this describes that these are very light Materials. So this paper describes that these possess high resistance to oxidization, chemicals and other weather agents. Our paper also describes the advantages of MMC's as it provides Dimensional stability. Wear and Corrosion resistance, Reduced Weight. As we know that Alumina slag emerges as the major slag material during production of alumina from bauxite by the Bayer's process. Enormous efforts have been directed worldwide towards alumina slag management issues, i.e., of utilization, storage and disposal. Different avenues of alumina slag utilization are more or less known but none of them have so far proved to be economically viable or commercially feasible. It is studied that micro hardness and resistance to wear of MMCs is produced by Strengthener and also the wear properties are improved remarkably by introducing hard intermetallic compound into the aluminum matrix.

Keywords: Alumina slag, SiC, Al_2O_3

INTRODUCTION

A composite material is a material composed of two or more constituents. The constituents are combined at a microscopic level and are not soluble in each other. Generally, a composite material is composed of Strengthener (fibers, particles/particulates, flakes, and/or fillers) embedded in a matrix (metals, polymers). The matrix holds the Strengthener to form the desired shape while

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the strengthener improves the overall mechanical properties of the matrix. When designed properly, the new combined material exhibits better strength than would each individual material. The most primitive man-made composite materials are straw and mud combined to form bricks for building construction (Vishal and Sanjeev, 2007; and Narinder *et al.*, 2010). Composites posses excellent Strength and Stiffness. They are very light Materials and they possess high resistance to corrosion, chemicals and other weathering agents. They have High strength to weight ratio (low density high tensile strength). High creep resistance, High tensile strength at elevated temperature and high toughness.

For many researchers the term metal matrix composites is often equated with the term light Metal Matrix Composites (MMCs). Substantial progress in the development of light metal matrix composites has been achieved in recent decades, so that they could be introduced into the most important applications. In traffic engineering, especially in the automotive industry, MMCs have been used commercially in fiber reinforced pistons and aluminum crank cases with strengthened cylinder surfaces as well as particle strengthened brake disks. These innovative materials open up unlimited possibilities for modern material science and development; the characteristics of MMCs can be designed into the material, custom-made, dependent on the application.

MATRIX AND MATRIX MATERIAL

The matrix is the monolithic material into which the strengthener is embedded, and is completely continuous. This means that there is a path through the matrix to any point in the material, unlike two materials sandwiched together. In structural applications, the matrix is usually a lighter metal such as aluminum, magnesium, or titanium, and provides a compliant support for the Strengthener. The most common matrix materials used in composite are as follows:

- Aluminum matrix
- Copper matrix
- Titanium matrix

OBJECTIVES OF METAL MATRIX COMPOSITES

Increase in yield strength and tensile strength at room temperature and above while maintaining the minimum ductility or rather toughness.

Strengthener

The role of the Strengthener in a composite material is fundamentally one of increasing the mechanical properties of the neat resin system. All of the different particulates/fibers used in composites have different properties and so affect the properties of the composite in different ways. The desirable properties of the Strengtheners include:

- High strength
- Ease of fabrication and low cost
- Good chemical stability
- Density and distribution

Alumina Slag as Strengthener

Alumina slag is the caustic insoluble slag residue generated by alumina production from bauxite by the Bayer’s process at an estimated annual rate of 66 and 1.7 million tons, respectively, in the World and India (Narinder *et al.*, 2010). Under normal conditions, when one ton of alumina is produced nearly a ton of alumina slag is generated as a slag. This slag material has been accumulating at an increasing rate throughout the world.

Figure 1: Alumina Slag as Strengthener

Need for the Strengthener of Alumina Slag into Aluminum Matrix

To obtain Optimum performance from composite materials there is an advantage to selecting the shape and size of the Strengthener material to fit the application. It is apparent that different material types and shapes will have advantages in different matrices. There are so many researchers have worked out separately to reinforce SiC, Al_2O_3 (i.e., carbides, Nitrides and oxides) TiC, Boron and Graphite in to the Aluminum matrix to achieve different properties and are expensive.

RESULTS AND DISCUSSION

Effect of Different Strengtheners on Weight Loss of MMCs Under Dry Sliding Condition

A pin-on-disc tribometer is used to perform the wear experiment. The wear track, alloy and

Table 1: Weight Loss of Sample No. (1-13) Under Dry Sliding Condition

Length (mm)	Diameter (mm)	Velocity (m/s)	Track Diameter (mm)	Weight (Kg)	Time (Sec)
50	8	1.6	60	2	1800

Sample No.	Specimen Name Al alloy 6061+	Initial Weight (gm)	Final Weight (gm)	Weight Loss(gm)
1	2.5% Sic	6.71898	6.70330	0.01568
2	5% SiC	6.86166	6.84660	0.01506
3	7.5% SiC	6.62918	6.61820	0.01098
4	10% SiC	6.30940	6.29884	0.01056
5	2.5% Al_2O_3	5.84633	5.82111	0.02522
6	5% Al_2O_3	6.16840	6.15064	0.01776
7	7.5% Al_2O_3	5.50940	5.49290	0.01650
8	10% Al_2O_3	5.89106	5.87688	0.01418
9	2.5 % Waste	6.15920	6.13370	0.0255
10	5% Waste	5.82509	5.80113	0.02396
11	7.5% Waste	6.17206	6.15575	0.01633
12	10% Waste	5.71050	5.68728	0.02322
13	Base alloy (Al alloy 6061)	6.64630	6.62088	0.02542

composite specimens are cleaned thoroughly with acetone prior to test. Each specimen is then weighed using a digital balance having an accuracy of ±0.0001 gm. After that the specimen is mounted on the pin holder of the tribometer ready for wear test. For all experiments, the sliding speed is adjusted to 1.6 m/s, track diameter 60 mm, load 2 kg and total time is 30 minute under room temperature.

As shown in the Table 1 results predict that as the Strengthener wt. % increases, the weight loss of MMCs decreases. But in the case of alumina slag Strengthener, the weight loss decrease upto 7.5 wt. % then increases. This happens may be due to either the improper dispersion of alumina slag into the matrix due to high viscosity of molten composites or weak interfacial bonding in between the Al alloy 6061 and alumina slag interfaces.

Comparing the weight loss properties of composites reinforced with silicon carbide, alumina and alumina slag, it is observed that despite their higher hardness, composites reinforced with alumina and alumina slag particles show greater weight loss as compared to composites reinforced with SiC particles. It can be attributed to the comparatively poor bonding between alumina slag-matrix and in alumina-matrix. There might be particle pull out, in the case of composite reinforced alumina and alumina slag particles during wear test, which enhances weight loss.

CONCLUSION

Aluminum based metal matrix composites have been successfully fabricated by stir casting technique with fairly uniform distribution of Alumina slag, Silicon carbide and Aluminum oxide particulates. For synthesizing of composite by stir casting process, stirrer design and stirrer position, stirring speed and time, particles preheating temperature, particles incorporation rate, etc., are the important process parameters. It is found that wear rate tends to decrease with increasing particles wt. percentage (2.5- 10%), which confirms that silicon carbide; alumina slag and alumina addition is beneficial for reducing the wear rate of MMCs. Alumina slag, the alumina slag generated from alumina production can be successfully used as a reinforcing material to produce Metal-Matrix Composites (MMCs). It can be replaced by other expensive Strengthener materials such as SiC and Al_2O_3. Thereby saving of expensive Strengtheners could be achieved.

FUTURE SCOPE

Same metal matrix composites can be manufactured by using other manufacturing techniques like spray casting etc. and results can be compared with stir casting technique. In this study alumina slag, SiC and Al_2O_3 particles of sizes 103-150, 60- 90 and 30-50 microns have been used. This can further be extended by varying the particle size and then effect of particle size on the wear behavior of the composite can be studied.

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