WWW.IJRPR.COM

International Journal of Research Publication and Reviews

Journal homepage: www.ijrpr.com ISSN 2582-7421

Studies on Mechanical behavior of SiC reinforced Aluminium Metal Matrix

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A B S T R A C T

The intention of this work is to understand the impact of reinforcing Silicon Carbide (SiC) into Aluminum Matrix Composite (AMC). The samples were prepared by powder metallurgy technique. The composite prepared with 0.5% of SiC.and studied itsMicrostructure and Vickers hardness. By introducing the SiC in the aluminum matrix, the hardness has been increased by 2times. The distribution of SiC particulate was uniformly achieved by powder metallurgy process. And this was confirmed by X-Ray diffraction material characterization technique. By these analyses it is understood that, by reinforcing SiC in other metals like metallic lead, might have better advantages which can be drawn to energy storage applications.

Keywords:Silicon Carbide; Aluminium; Composite; Microstructure; Vickers Hardness.

1. Introduction

Metal matrix composites (MMC's) has gained importance in the last few decades due to its unique properties. Specially, Silicon Carbide used in various metals as an reinforce material has gained lot of attention. When metals reinforced with Silicon Carbide behaved quite differently like improved tensile strength, corrosion resistant, low thermal expansion etc., [1-3] Aluminum- (Silicon Carbide) is a metal-ceramic composite material consisting of silicon carbide particles dispersed in a matrix of aluminum alloy. It combines the benefits of high thermal conductivity of metal and low CTE (coefficient of thermal expansion) of ceramic.With its composite features, Al-SiC is an advanced packaging material for high technology thermal management. Al-SiC is compatible with a wide range of metallic and ceramic substrate and plating materials used in microelectronic packaging for aerospace, automotive, microwave applications [4-5]. Al-SiC allows for a new packaging technology that can replace traditional W-Cu, Mo, BeO, Kovar, Mo-Cu, AlN, AlSi, Al2O3.Silicon carbide is formed in two ways, reaction bonding and sintering. Each forming method greatly affects the end microstructure.Reaction bonded SiC is made by infiltrating compacts made of mixtures of SiC and carbon with liquid silicon. The silicon reacts with the carbon forming more SiC which bonds the initial SiC particles.Sintered SiC is produced from pure SiC powder with non-oxide sintering aids. Conventional ceramic forming processes are used and the material is sintered in an inert atmosphere at temperatures up to 2000ºC or higher [6-7].Both forms of silicon carbide (SiC) are highly wear resistant with good mechanical properties, including high temperature strength and thermal shock resistance. Our engineers are always available to best advise you on the strengths and weaknesses of each ceramic for your particular needs.

Typical silicon carbide characteristics include [8]:

- Low density
- High strength
- Good high temperature strength (reaction bonded)
- Oxidation resistance (reaction bonded)

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- Excellent thermal shock resistance
- High hardness and wear resistance
- Excellent chemical resistance
- Low thermal expansion and high thermal conductivity

Typical silicon carbide applications include [9]:

- Fixed and moving turbine components
- Seals, bearings, pump vanes
- Ball valve parts
- Wear plates
- Kiln furniture
- Heat exchangers
- Semiconductor wafer processing equipment

Here, in this work we attempted Silicon carbide (SiC) as an reinforce material to study the mechanical behavior of the aluminum material.

2. Materials and Methods

Aluminium and Silicon Carbide powders were supplied by M/s Metal Powder. Co Ltd, Chennai. Atomized Aluminium powder with particle size in between 45 to 75µm is used. Particle size more than 75 µm is maximum of3% according to dry sieve analysis as per ASTM B-214 standards. Silicon Carbide in the form of amorphous powder withparticle size less than 45 µm according to ASTM D-185 wet sieve analysis is used. Silicon Carbide powder with more than45 µm is maximum 5% and more than 75 µm is maximum 1%. Powder mettellurgy process is adopted to make the composite. Figure 1 shows the SiC reinforced aluminium composite and was in line to the ICDD No. 01-080-4984.

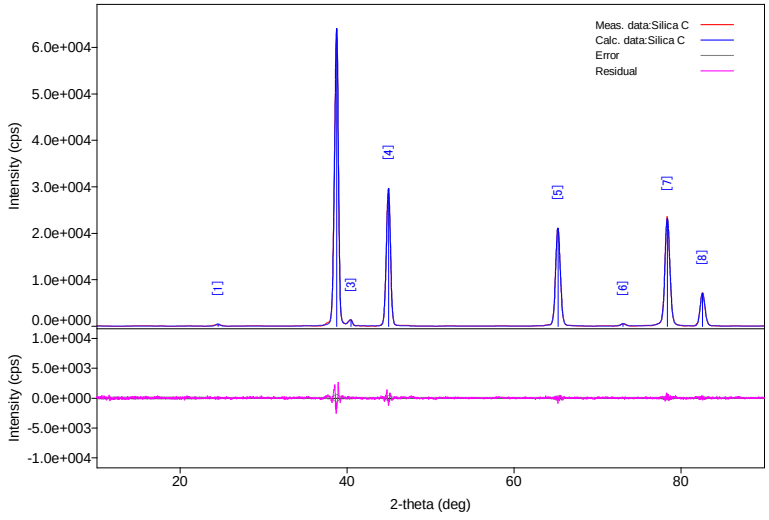

Fig. 1 - XRD Spectra of SiC reinforced Al.

Comparison of pure aluminiumwith SiC reinforced Al was tested as per ASTM E92and tabulated in the below Table 1.

Table 1 –Vickers Hardness comparison.

Material	HV
Pure Aluminium	42.1
SiC Reinforced Aluminium	86.5

Fig. 2 - Microstructure (x200)of SiC reinforced Al.

Microstructural image (Fig. 2) reveals us the reinforcement was done neatly and the SiC particulates distributed uniformly and merged with the aluminium matrix.

3. Conclusion

SiC reinforced material was successfully prepared by powder metallurgy process. This was confirmed by XRD spectra. By microstructure analysis it is visible that the SiC particulates are uniformly distrusted across the Aluminum matric improving the hardness. An 2times improvement was observed with Vickers hardness. Therefore, we can use SiC as reinforced material in lead metal, to reduce the lead usage for energy storage application.

Acknowledgements

The authors would like to thank the management and the staff of Amararaja Batteries Limited, India, and Sreenidhi Institute of Science and Technology, Hyderabad, India for this work's assistance and support.

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