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Development of Aluminium-Silica Sand Metal Matrix Composite and Its Improved Hardness

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Abstract

This paper deals with the development of metal matrix composite using silicasand as reinforcement and aluminum as metal matrix. Silica sand waste is the most inexpensive reinforcement available in the large amount at from villupuram district, tamilandu, as the solid waste by- product of glass industries being dumped in the land for land filling. Metal matrix composites have been playing major role in recent times as it has got significant properties. In this research, Stir casting technique was used to prepare the Al-SiO_2MMC. For structural characterization studies and phase identification of silica sand, X-ray diffraction test has been conducted. The height and sharpness of the peak showed higher crystallinity. Due to the addition of silica sand 10%wt particles in aluminium matrix resulting improvement of the hardness

Keywords: Reinforcement, Hardness, Solid Waste, Metal Matrix Composite, silica sand Introduction

Introduction

Metal Matrix Composite materials have been giving higher wear resistance and longer life with improved hardness and strength. Aluminium based discontinuously reinforced MMCs are very popular due to their better strength, higher hardness and increased wear resistance over conventional aluminium alloys. Automotive, medical and railway industries pushed advances in materials further to introduce new

materials particularly having low density and very light weight with high hardness. One of the important of these advanced materials is composites (Matthew and Rawlings, 1994). In aerospace and shipping industries, Al composites are used essentially in structural applications such as helicopter parts, rotor vanes in compressors and in aero-engines and turbine blades (R.S. Rawal2001). There has been a continuous effort by the researchers in the pursuit of finding a material for the production of automobile components that shows improvement in mechanical properties and wear behavior with reduced weight. R.K. Uyyuru, M.K. Surappa, S. Brusethaug, (2007). It is important to determine the most suitable areas and limits of application of these aluminium based composites reinforced with industrial wastes. Silica sand is a non-organic materials and utilisation of silica sand as reinforcement in to aluminium matrix is a novel idea. Intoroducing silica in to aluminium matrix will improve hardness and density RohatgiP.K(2010). The output from this research will be helpful in understanding the hardness of these peculiar aluminium silica sand metal matrix composites. Moreover it would also be resource information in utilizing the aluminium scrap and silica sand wastes in to useful material.

Raw Material Selection

Silica Sand powder from marakkanam ,villupuram district ,tamilnadu had been taken as reinforcement. This silica sand was the glass factory wastes being dumped in the land for land filling .This silica sand has been used for land filling as the grain size was not suitable for preparation of glass bottles. Silica sand was collected and brought in powder form by crushing and grinding to the size of 50µm and pure aluminium scraps from electrical appliance industry-were used as metal matrix.

Experimental Setup

Procssing of Silica Sand

The silica sand was first preheated for 900^0C.The properties of silica sand have been presented presented in table.1.

Table 1: Properties of Silica sand

Crystal Name	Monoclinic
Mineral Name	Moganite
Chemical Formula	SiO_2
Size	53 microns
Melting Point ^{0}C	1760^0C.
Boiling Point ^{0}C	2240^0C.
Density G/Cm^3	2.33

XRD Analysis

For structural characterization studies and phase identification of silica sand, X-ray diffraction test had been conducted.Figur.1.shows X-ray diffraction peaks of silica

sand. Diffractions patterns were obtained and matched with the standard diffraction pattern of the silica sand. The height and sharpness of the peak show higher crystallinity and its Crystallite Size was 53.28 nm.

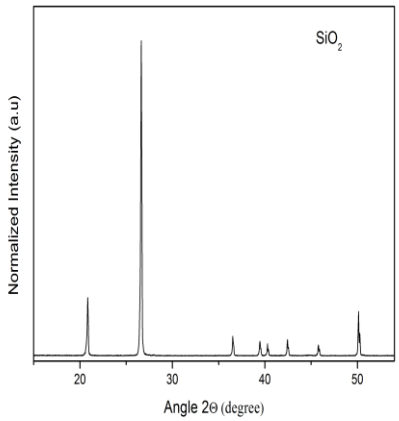

Figure 1: X-Ray Diffraction Pattern of Silica Sand

Synthesis of Aluminium- Silica Sand MMC

The schematic arrangement of the experimental set up is shown in figure 2 with graphite crucible, motor and stirrer. The synthesis of Al- SiO_2 composites (Al-10% Silica sand by weight) were carried out by stir casting technique with the help of stirrer. Pure aluminium scrap (99.5) was taken in to graphite crucible furnace and melted in a coal fired furnace. A vortex was created at 770^0C temperature and silica sand was then added gradually in the molten metal and it was then mixed thoroughly with the help of a stirrer. The molten metal with reinforced particulates had been poured in to the sand mould for solidification. Finally synthesis of aluminium - silica sand metal matrix composites was completed. Figure.3.shows casting of aluminium-silica sand metal matrix composite

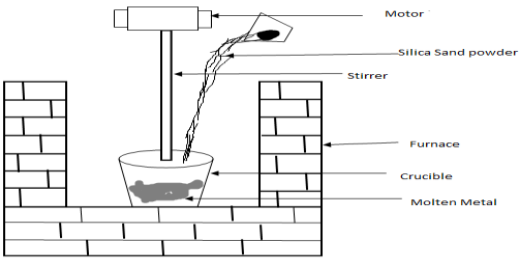

Figure 2: Schematic Diagram of The Experimental Set Up

Hardness Test

Hardness test had been conducted on aluminium specimen and Al-SiO_2MMC using a load of 250 N and a steel ball of diameter 5mm as indenter. The corresponding values

of hardness (BHN) were calculated. The results in table 1 show the increasing of hardness with increase in weight percentage of silica sand particles. Figure 4 shows the increasing hardness with increase in wt percentage of silica sand particles

Table 2: Hardness (BHN) of the MMCs at different wt% of silica sand

Material	Aluminium	Avg	Al-Silica Sand-10wt%	Avg
Hardness(BHN)	30.30	31.38	32.80	32.18
	31.45		31.85	
	32.40		31.90	

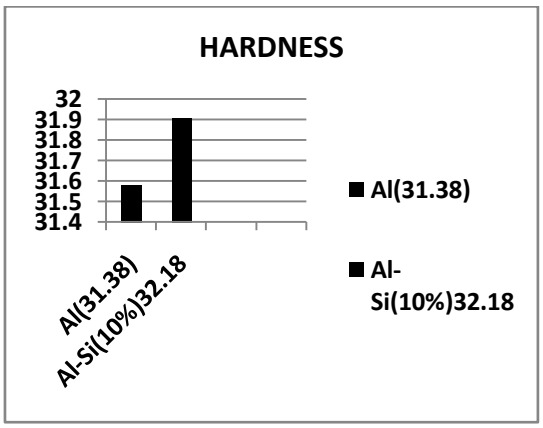

Figure 4: Hardness of the MMC's and Al

Result and Discussion

The major aim and objectives of this paper is to utilize the waste silica sand and scrap aluminium in to useful composite materials. These objectives have been achieved by adopting stir casting technique. Pure scrap Aluminium had been taken as matrix and waste Silica sand had been chosen as reinforcement material. These metal matrixes are very cheap and beneficial for the modern engineering fields. XRD test has been conducted on silica sand. The height and sharpness of the peak show higher crystallinity and its Crystallite Size was 53.28 nm.Testing results showed increase in hardness by adding 10% silica sand with pure aluminium. Thus the hard metal matrix composite had been prepared and this would be cheap and beneficial for the modern engineering field. Further tension test, compression test and wear test with different metals may be carried out. Percentage of silica may be varied for further research and similarly aluminium series may be varied.

Conclusion

The Aluminium -Silica sand metal matrix have been prepared successfully by using stir case method with uniform distribution of silica sand particles. Introduction of

silica sand particles in aluminium matrix improves the hardness of the metal matrix composites. Further other mechanical tests like wear test, compression test may be conducted in future.

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