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Mechanical Properties of Al-Sic Composite Material By Melting Process

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ABSTRACT

To overcome the problems faced in conventional materials like high weight, corrosion, high cost etc., lots of studies are going on to replace them with alloys/composites. And also to reduce the cost of composites. Aluminium materials found to be the best alternative with its characteristics like high strength to weight ratio and low density. As development of lightweight materials has provided numerous possibilities for weight reduction. In this project we are casting aluminium based (Al 6061) composites with silicon carbide as reinforcement. Among the various methods, stir casting method is chosen as it is simple, less expensive and used for mass production. In this stir casting process, the reinforcing phases are distributed into molten aluminium by manual stirring. And then the casted samples are machined to required dimensions and different material testings had been conducted to obtain the material properties and characteristics. . In this Experiment have been conducted by varying weight fraction of SiC (5%, 10%, 15%, 20%, 25%, and 30%), while keeping all other parameters constant. The results indicated that the method used in this is successful to obtain uniform dispersion of reinforcement in the metal matrix. This composite material has improved mechanical properties like strength, stiffness, abrasion and impact resistant, and is not easily corroded. This material will have improved applications in aerospace, automotive industry etc.

Keywords: Metal matrix composite, Fabrication techniques, Aluminium alloy, Reinforcement, Silicon carbide

I. INTRODUCTION

Metal matrix composite (MMC) is engineered combination of the metals and hard particles (Reinforcement) to get different properties. MMC's are used in space shuttle, electronic substrates, bicycles ,automobiles, commercial airliners ,golf clubs, and a variety of other engineering and domestic applications(1).

MMC (Metal matrix composites) are metals reinforced with other metal and form like a ceramic or organic compounds. These MMCs are made by dispersing the reinforcements in the metal matrix. Reinforcement processes are usually done to improve the properties of the base metal like strength, stiffness, conductivity, hardness, tensile strength etc. Aluminium and its alloys have attracted most attention as base metal in metal matrix composites (2).

Composite materials are made of two or more materials that differ in chemical and physical properties and are not soluble in one another. The primary constituent in a composite material is the matrix phase (main metal) that provides load distribution and structural interface, while the reinforcement enhances mechanical properties like strength, hardness, toughness etc. The matrix materials can either be organic (polymers) or metallic (aluminum, titanium, etc.) and reinforcement materials can be inorganic (ceramic or glass) materials. The most common forms of reinforcement materials are fibers, whiskers, or particulates. Composite materials have superior specific properties (high strength to weight ratio) compared to metals, high stiffness, hardness, toughness and good wear resistance over a wide range of operating conditions, making them an best option in conventional materials for many engineering applications(3).

MMCp have good improved properties such as very light weight, high strength, and stiffness and exhibit

more resistance to corrosion, oxidation and wear. Fatigue resistance is an especially important property of Al-MMC, which is essential for automotive and aerospace application. Particulate metal matrix composites have nearly isotropic properties when compared to long fibre, short fibre and whiskered reinforced composite. But the mechanical behaviour will change with metal matrix composition, size, and weight fraction of the reinforcement and the method used to fabricate the metal matrix composite. The dispersion of the reinforcement particles in the metal matrix alloy is effected by several factors such as rheological behaviour of the matrix melt, the particle Incorp oration method, interaction of particles and the matrix before, during, and after mixing(4).

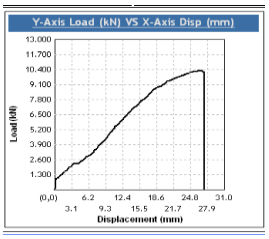
II. EXPERIMENTATION

These metal matrix composites are manufactured by stir casting method. In this process the matrix material (aluminium) is melted in casting furnace and reinforcing particulates (silicon carbide) are submitted in molten metal. Stirring is done manually by using graphite rod. This metal matrix composite is casted into samples and the reinforcing particulates are distributed thoroughly all over the metal matrix. This can be observed in microstructures of the samples.

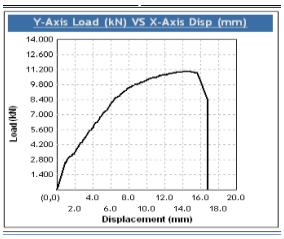
III. RESULTS AND DISCUSSION

A. Results Obtained in Tensile Test:

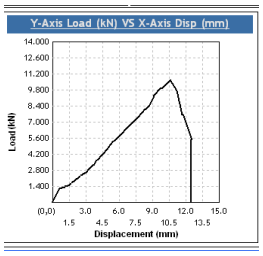
Material	**Ultimate load(kN)**	**Ultimate strength(N/mm^2)**	**Elongation (%)**	**Yield load(kN)**	**Yield stress(N/mm^2)**
CP Existing	9.000	110	17.000	9.000	105.000
CP(95%)	11.000	89.635	15.000	8.280	67.471
CP-85%	10.320	80.199	11.600	6.680	51.912
6061 existing	8.000	80.000	12.000	6.500	55.000
6061(95%)	10.480	83.254	4.600	7.080	56.244
6061(80%)	11.040	87.842	2.600	7.680	61.108



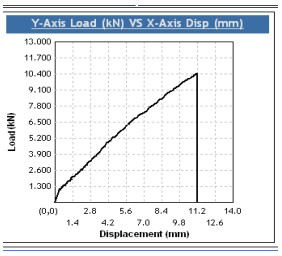
Load vs Disp CP 85%



Load vs Disp CP 95%



Load vs Disp Al6061 80%



Load vs Disp Al6061 95%

By observing above results and graphs the increase in SiC percentage results in increase of tensile strength of composite material up to certain percentage. There is a reduction in the inter–spatial distance between particulates, which cause an increase in the dislocation pile–up as the particulate content is increased. Because of this there is an irregular flow in the distribution of particulate in the matrix, thereby providing enhanced strength to the composites. The tensile strength is a function of volume fraction of reinforcement.

Results Obtained in Impact Test:

Type of Impact: CHARPY-V
Notch Depth : 2mm
Notch Angle : 45^0

Material	Location of the sample	Energy absorption (Joules)
6061 75%	Impact at room temperature	9
6061 85%	Impact at room temperature	8
CP 90%	Impact at room temperature	14

Charpy test results will shows whether a metal can be either brittle or ductile. A brittle metal will absorb a small amount of energy when impact tested; a tough ductile metal absorbs a large amount of energy. From the above results it is clear that aluminium grades 6061 (75%) and 6061 (85%) has absorbed less energy than the CP (90%) which says that with the increase in the percentage of silicon carbide in the composite material decreases the ductility and increases the brittle ness of the material.

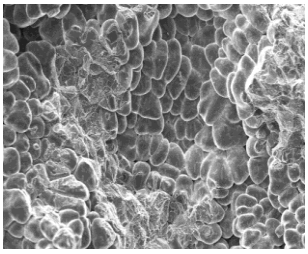
Results Obtained in Hardness:

Type of hardness: BHN
Indentor : 5 mm
Load applied : 250 kgs

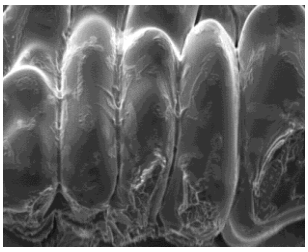
On Surface	Impression1	Impression 2	Impression 3	Avg
AL-CP 85%	47.5	46.7	47.1	47.10
AL-6061 80%	47.6	47.5	46.3	47.13
AL-CP 95%	51.2	51.1	48.9	50.40
AL-6061 95%	48.1	47.9	48.3	48.10

From above results observed that increase in hardness of (Al6061-SiC and Commercial pure Al-SiC) composite with increasing SiCp percentile. This is due to the fact that the reinforcement material is much harder than that of the material matrix for SiC and also could be due to better wettability of SiC by 6061 matrix which leads to good bonding in between the matrix and reinforcement. Hardness can be increasing with increasing in Sic content. A hardness reading showed a higher value of hardness indicating that the existence particulates in the matrix have improved the overall hardness of the composites.

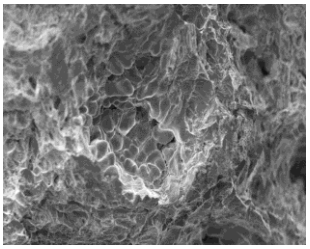
SEM Test Results (Surface Structure):



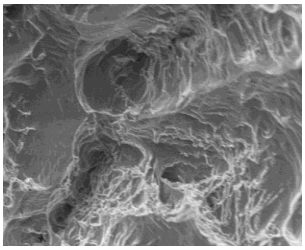
CP composite



CP composite



Al 6061 composite



Al 6061 composite

These figures reveal the microphotographs of Al6061 and commercial pure aluminium reinforced with SiC particulates. From figure it is clear that, the distribution of reinforcing particulates in both the composites is fairly uniform.

IV. CONCLUSION

- From the images of grain structure, SEM (scanning electron microscope) we can say that the silicon carbide particles are well reinforced with the aluminium and the distribution of reinforcing particulates in the composites is uniform.
- Both the strength and ductility properties get altered for different compositions of aluminium and silicon carbide.
- From SEM it is clear that there is a reduction in the inter–spatial distance between particulates, which cause an increase in the dislocation pile–up as the particulate content is increased. This leads to restriction to plastic flow due to the random distribution of the particulate in the matrix, thereby providing enhanced strength to the composites.

- Ductility of composite decreases as increase in the percentage of silicon carbide in material as it is a hard material.
- By comparing the results of both CP AL (commercial pure aluminium) and AL 6061 composites, AL 6061 has greater mechanical properties than CP composites.

Finally by studying experimental data the percentage of silicon carbide do not increase 25% due to which the brittleness of material increases and mechanical properties begin to reduce.

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