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EXPERIMENTAL ANALYSIS OF MATERIAL CHARACTERIZATION IN AL/SIC/B4C METAL MATRIX COMPOSITE MATERIAL

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ABSTRACT

The objective of this research is to produce metal matrix composite (MMC) by stir casting technique and investigates the material characterization of Al, Sic and B4C based Metal Matrix Composite materials in this three material compositions are chosen (Al92%-SiC6%-B_4C2%)(Al90%-SiC5%-B_4C5%) and (Al92%-SiC4%-B_4C4%), The reinforced particles size of SIC, B_4C are 400 mesh respectively these three compositions material characterizations find out through Tensile testing, Hardness testing, Impact analysis and flexural analysis in this combinations (Al92%-SiC6%-B_4C2%) get the better results

Keywords: Al, SiC, B4C, Tensile test, Hardness Test, Stir casting method

1. INTRODUCTION

In recent years aluminium matrix composites (AMCs) are gaining widespread popularity in several technological sectors owing to their excellent corrosion and wear resistance, higher fatigue life, good high temperature oxidation resistance in addition to being light in weight when compared with conventional alloys. At present AMCs are attractive alternatives for aerospace and automotiveapplications because of their high stiffness-to-weight characteristics. Currently, focus on development ofaluminium, copper, magnesium, titanium based metal matrix composites is carried out to explore their possible applications in several high-tech areas. The various reinforcements that have been tried out to develop AMCs are graphite, silicon carbide, titanium carbide, tungsten, boron, Al2O3, flyash, Zr, Si3N4, TiB2.

Addition of Grparticulates facilitates easy machining and results in reduced wear of Al–Gr composites compared to Al alloy. It isreported that the surface finish of the hard reinforced metal matrix composites are inferior when compared with the matrix alloy. Further it is absorbed that during turning, the hard reinforced metal matrix composites resulted in higher flank wear with increased content of the reinforcement. It isreported that composites possessing softer reinforcement.

2. MATERIALS

2.1. Aluminium 6061

Al-6061 isa precipitation hardened aluminium alloy, containing magnesium and silicon as its major alloying elements. Originally called "Alloy 61S", it was developed in 1935. It has good mechanical properties and exhibits good weld ability. It is one of the most common alloys of aluminium for general-purpose use.

It is commonly available in pre-tempered grades such as 6061-O (annealed), tempered grades such as 6061-T6 (solutionized and artificially aged) and 6061-T651 (solutionized, stress-relieved stretched and artificially aged).

2.2. Boron Carbide (B4c)

Boron carbide (chemical formula approximately B_4C) is an extremely hardboron–carbon ceramic, and ionic material used in tank armor, bulletproof vests, engine sabotage powders, as well as numerous industrial applications. With a Vickers Hardness of >30 MPa, it is one of the hardest known materials, behind cubic boron nitride and diamond.

Boron carbide was discovered in 19th century as a by-product of reactions involving metal borides, however, its chemical formula was unknown. It was not until the 1930s that the chemical composition was estimated as B_4C.[3] There remained, however, controversy as to whether or not the material had this exact 4:1 stoichiometry, as in practice the material is always slightly carbon-deficient with regard to this formula, and X-ray crystallography shows that its structure is highly complex, with a mixture of C-B-C chains and B_{12}icosahedra. These features argued against a very simple exact B_4C empirical formula. Because of the B_{12} structural unit, the chemical formula of "ideal" boron carbide is often written not as B_4C, but as $B_{12}C_3$, and the carbon deficiency of boron carbide described in terms of a combination of the $B_{12}C_3$and $B_{12}CBC$ units.

3. EXPERIMENTAL METHODS

3.1. Stir Casting Furnace

In a stir casting process, the reinforcing phases are distributed into molten matrix by mechanical stirring. Stir casting of metal matrix composites was initiated in 1968, when S. Ray introduced alumina particles into aluminum melt by stirring molten aluminum alloys containing the ceramic powders. Mechanical stirring in the furnace is a key element of this process. The resultant molten alloy, with ceramic particles, can then be used for die casting, permanent mold casting, or sand casting. Stir casting is suitable for manufacturing composites with up to 30% volume fractions of reinforcement.

The cast composites are sometimes further extruded to reduce porosity, refine the microstructure, and homogenize the distribution of the reinforcement. A major concern associated with the stir casting process is the segregation of reinforcing particles which is caused by the surfacing or settling of the reinforcement particles during the melting and casting processes. The final distribution of the particles in the solid depends on material properties and process parameters such as the wetting condition of the particles with the melt, strength of mixing, relative density, and rate of solidification .The distribution of the particles in the molten matrix depends on the geometry of the mechanical stirrer, stirring parameters, placement of the mechanical stirrer in the melt, melting temperature, and the characteristics of the particles added.

Figure 1 Stir Casting Furnace

3.2. Tensile Test

The most common type of test used to measure the mechanical properties of a material is the Tension Test. Tension test is widely used to provide basic design information on the strength of materials and is an acceptance test for the specification of materials. The major parameters that describe the stress-strain curve obtained during the tension test are the tensile strength (UTS), yield strength or yield point (σy), elastic modulus (E), percent elongation (ΔL%) and the reduction in area (RA%). Toughness, Resilience, Poisson's ratio(ν) can also be found by the use of this testing technique.

Figure 2 Universal Testing Machine

3.3. Hardness Test

Hardness is a measure of how resistant solid matter is to various kinds of permanent shape change when a compressive force is applied. Some materials, such as metal, are harder than others. Macroscopic hardness is generally characterized by strong intermolecular bonds, but the behavior of solid materials under force is complex; therefore, there are different measurements of hardness: scratch hardness, indentation hardness, and rebound hardness.

3.4. Impact Test

The impact test is a method for evaluating the toughness and notch sensitivity of engineering materials. It is usually used to test the toughness of metals, but similar tests are used for polymers, ceramics and composites. Metal industry sectors include Oil and Gas, Aerospace, Power Generation, Automotive, and Nuclear.

3.5. Flexural Test

Flexure tests are generally used to determine the flexural modulus or flexural strength of a material. A flexure test is more affordable than a tensile test and test results are slightly different. The material is laid horizontally over two points of contact (lower support span) and then a force is applied to the top of the material through either one or two points of contact (upper loading span) until the sample fails. The maximum recorded force is the flexural strength of that particular sample.

Figure 3 Tensile Test, Flexural Test, Impact Test, Hardness Test Specimens

3. RESULTS AND DISCUSSION

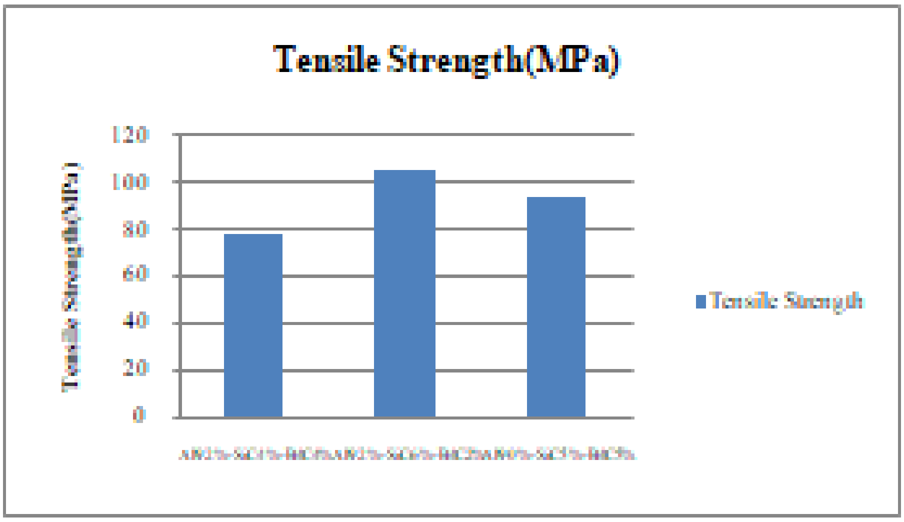

Figure 4 Tensile Strength for Different Composite Materials

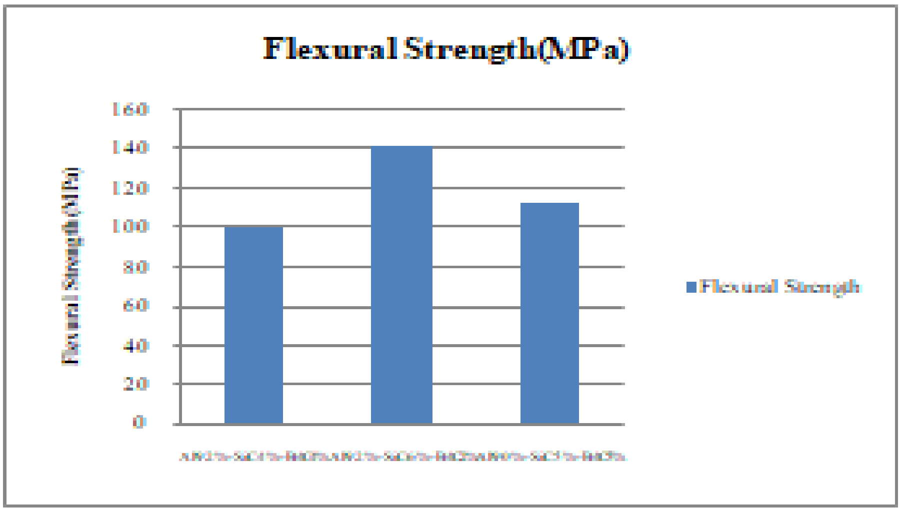

Figure 5 Flexural Strength for Different Composite Materials

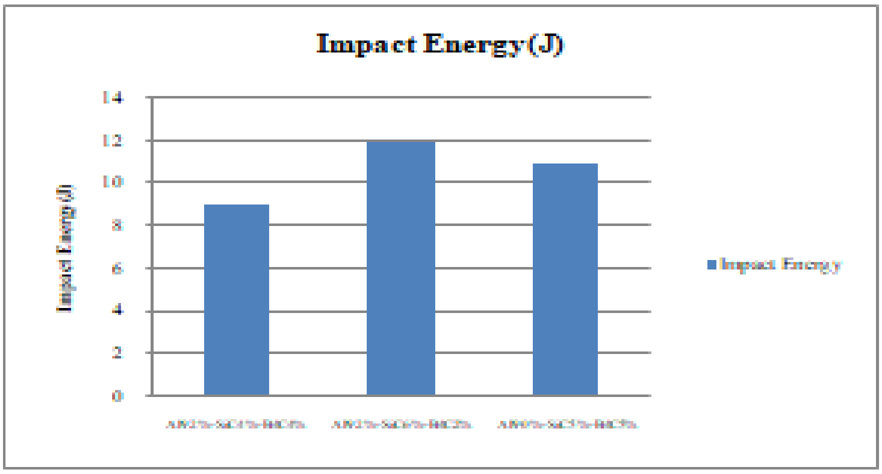

Figure 6 Impact Energy for Different Composite Materials

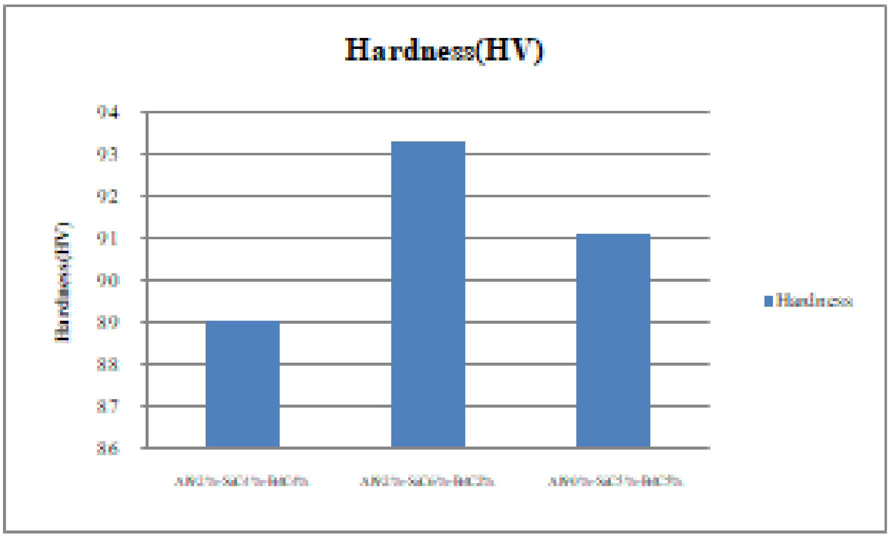

Figure 7 Hardness Value for Different Composite Materials

5. CONCLUSION

From the experimental analysis of Al+Sic+B_4C hybrid composite material was prepared by using stir casting furnace method with the three different compositions for tensile test, flexural test, impact test and hardness from the test comparisons Al92%-SiC6%-B_4C2% was obtained very high tensile strength, flexural strength, hardness value and Impact energy

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