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EXPERIMENTAL INVESTIGATION AND MECHANICAL BEHAVIOUR OF HYBRID ALUMINIUM METAL MATRIX WITH VARIOUS REINFORCEMENT

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ABSTRACT

Aluminium (Al) metals and its alloys have very low weight and due to this low weight, those found applications in the manufacturing of composite materials and the new material prepared by using aluminum as the metal matrix and reinforcement particles (Sic, B4C, Al2O3, Si3N4, etc.) by a suitable manufacturing process is known as aluminum matrix composites (AMCs). These AMCs are the proficient materials in industrial applications. Because of their excellent mechanical properties, AMCs are widely used in automobile, aerospace, marine, sports, defense, etc. From the investigation the mechanical property of Al 7075metal matrix was analyzed finally found Silicon carbide reinforcement enhanced the tensile and compressive strength abnormally. The hardness, tensile and compressive strength were improved the second ratio of metal matrix AL7075+SiC-5 % and 2.5 boron carbide. It shows superior strength compared than others. Boron carbide and boron nitride reinforced composites shows low level of impact strength compared pure Al7075 aluminium alloy.

Keywords: Al-7075, Tensile Strength, Macro Analysis, Hardness.

I. INTRODUCTION

The ever-increasing demand for light weight, fuel efficiency and comfort in automobile industries has lead to the development of advanced materials along with optimized design. The increased demand for light-weight materials with specific strength in the aerospace and automotive industry has spread the development and use of one group of composites: metal-matrix composites (MMCs). MMCs are widely used in industries, as they have excellent mechanical properties and wear resistance. MMCs have slowly replaced some of the conventional light-weight metallic alloys such as the various grades of aluminum alloys in applications where low weight and energy saving are important considerations and yet without sacrificing the strength of the components.

A metal matrix composite (MMC) can be defined as a metallic matrix (usually an alloy of Al, Cu, Fe, Mg, Ti or Pb) containing three-dimensional inclusions (usually an oxide, carbide or nitride). In these MMCs, the good ductility of the metallic alloy as the matrix material is retained while the modulus and strength of the composites are increased as a result of the reinforcement phases. By the correct combination of matrix material and reinforcements, MMCs can be tailored to give superior electrical, mechanical and even chemical properties. This is especially important in cases when monolithic metals and alloys can no longer fulfill the increasingly stringent requirements demanded by designers and engineers in newer engineering applications.

II. METHODOLOGY

Machine ability

The heat-treated alloy has fairly good machining properties, but tools should preferably be of high-speed steel and must be kept sharp. A moderately high rate of tool wear may be expected. Liberal cutting lubricant should be employed.

Casting characteristics

FLUIDITY -Good, suitable for fairly thin castings. PRESSURE TIGHTNESS -Excellent, suitable for castings required to be leak tight

HOT-TEARING -Excellent, problems due to hot tearing are rarely seen.

TYPICAL POURING TEMPERATURE -710°C

CASTING PROCESS

The aluminum metal matrix composite materials is the combination of two or more constituents in which one is matrix and other is filler materials (reinforcements). Aluminum metal matrix may be laminated, fibers or

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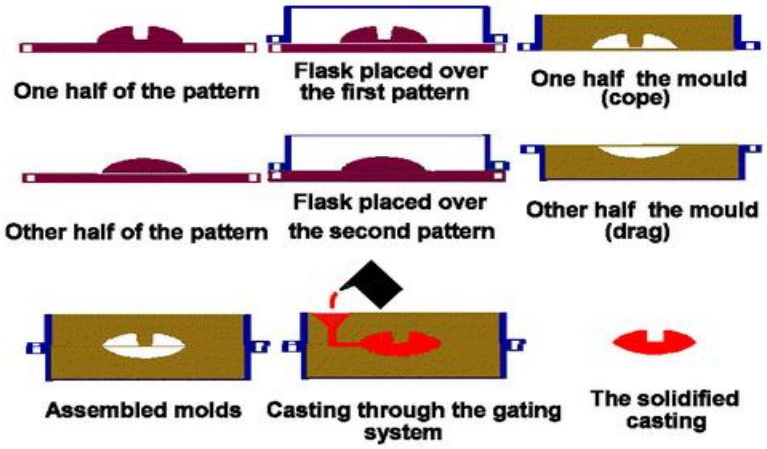
particulates composites. These materials are usually processed through powder metallurgy route, liquid cast metal technology or by using special manufacturing process. The processing of discontinuous particulate metal matrix material involves two major processes (1) powder metallurgy route (2) liquid cast metal technology. The powder metallurgy process has its own limitation such as processing cost and size of the components. Therefore only the casting method is to be considered as the most optimum and economical route for processing of aluminum composite materials. For alloy development aluminum 7075 rod and Alumina oxide average particles size 200µm were purchased from local market. The aluminum rod was melted in a graphite crucible and alloyed with required quantity of reinforcements.



ALUMINUM-7075

Al 7075 has a good surface finish; high corrosion resistance is readily suited to welding and can be easily anodized. Most commonly available as T6 temper, in the T4 condition it has good formability.

CHEMICAL COMPOSITION OF ALUMINUM 7075

ELEMENT	% PRESENT	
	MIN	MAX
Si	-	0.40
Fe	-	0.50
Cu	1.2	2.0
Mn		0.30
Mg	2.1	2.9
Zn	5.1	6.1
Ti	-	0.20
Cr	-	0.28
Al	-	-

BORON CARBIDE

Boron Carbide is one of the hardest materials known, ranking third behind diamond and cubic boron nitride. It is the hardest material produced in tonnage quantities. Originally discovered in mid-19th century as a by-product in the production of metal borides, boron carbide was only studied in detail since 1930.Boron carbide powder (see figure 1) is mainly produced by reacting carbon with B2O3 in an electric arc furnace, through carbothermal reduction or by gas phase reactions. For commercial use B4C powders usually need to be milled and purified to remove metallic impurities.

Nozzles

The extreme hardness of boron carbide gives it excellent wear and abrasion resistance and as a consequence it finds application as nozzles for slurry pumping, grit blasting and in water jet cutters

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SILICON CARBIDE

Silicon carbide (SiC), also known as carborundum is a compound of silicon and carbon with chemical formula SiC. It occurs in nature as the extremely rare mineral moissanite. Grains of silicon carbide can be bonded together by sintering to form very hard ceramics which are widely used in applications requiring high endurance, such as car brakes, car clutches and ceramic plates in bulletproof vests. Electronic applications of silicon carbide as light emitting diodes. In this metal matrix as reinforcement silicon carbide is .mixed 10 % volume based technique.

BORON NITRATE

Boron nitride is a thermally and chemically resistant refractory compound of boron and nitrogen with the chemical formula BN. It exists in various crystalline forms that are isoelectronic to a similarly structured carbon lattice. The hexagonal form corresponding to graphite is the most stable and soft among BN polymorphs, and is therefore used as a lubricant and an additive to cosmetic products. The cubic (sphalerite structure) variety analogous to diamond is called c-BN; it is softer than diamond, but its thermal and chemical stability is superior. The rare wurtzite BN modification is similar to lonsdaleite but slightly softer than the cubic form.

Because of excellent thermal and chemical stability, boron nitride ceramics are traditionally used as parts of high-temperature equipment. Boron nitride has potential use in nanotechnology. Nanotubes of BN can be produced that have a structure similar to that of carbon nanotubes, i.e. graphene (or BN) sheets rolled on themselves, but the properties are very different.

III. RESULT

HARDNESS VALUE

S.NO	MATERIAL	HRB
R1	AL7075--100%	33
R2	AL7075 + SiC-5% + B4C-2.5%	63
R3	AL7075 + SiC-5% + BN-2.5%	52

IMPACT STRENGTH VALUES

S.No	COMPOSITION	IMPACT STRENGTH (Joules)
R1	AL7075--100%	6
R2	AL7075 + SiC-5% + B4C-2.5%	4
R3	AL7075 + SiC-5% + BN-2.5%	2

TENSILE STRENGTH VALUES

sample	Dia (mm)	CSA (mm2)	YL (kN)	YS (N/mm2	TL (kN)	TS (N/mm2	IGL (mm)	FGL (mm)	%E
A1	16	201.06	17.54	87.24	19.11	95.05	94.8	96.5	1.79
A2	16	201.06	23.43	116.53	29.35	145.98	93.9	95.0	1.17
A3	16	201.06	20.16	100.32	27.77	138.12	96.3	97.5	1.25

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COMPRESSIVE STRENGTH VALUES

S.No	COMPOSITION	COMPRESSION STRENGTH N/mm2
R1	AL7075--100%	389.44
R2	AL7075 + SiC-5% + B4C-2.5%	495.87
R3	AL7075 + SiC-5% + BN-2.5%	412.81

IV. CONCLUSION

The present work was based on the development of aluminum alloy with the additions of different reinforcements in terms of constant volume percentages. Developed composites were characterized by mechanical testing in terms of hardness and tensile strength, and impact. Following points can be concluded from the work carried out. The hardness, tensile and compressive strength were improved the second ratio of metal matrix AL7075+SiC-5 % and 2.5 boron carbide. It shows superior strength compared than others. Boron carbide and boron nitride reinforced composites shows low level of impact strength compared pure Al7075 aluminium alloy.

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