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FABRICATION OF ALUMINIUM METAL MATRIXCOMPOSITES

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Abstract

In current scenario Metal Matrix Composites (MMCs) are increasingly becoming a new class of material in aerospace, automobile applications. Since their properties can be tailored through the addition of selected reinforcements, superior strength to weight ratio, wear and high temperature resistance. Aluminum alloy-based metal matrix composites (AMMCs) have been widely utilized in most of the industries and engineering sectors in present time. The current research work focuses on experimental investigation of aluminum 6061 metal matrix composite material. Four types of impurities are considered in the study namely, graphite, chromium, nickel and magnesium. The fabrication process is carried out using stir casting process with the required temperature and conditions. The results showed that sample having the composition wt % of graphite 3%, Mg 1%,Ni 2% and Cr 2% has the best most optimum mechanical properties compared to base material Al6061. Mechanical properties like tensile strength Impact and hardness, which were observed from the prepared specimens in theexperiment.

Keywords: Aluminium, Chromium, Magnesium, Nickel, Graphite, Tensile strength, Impact test, Hardness test.

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2. Introduction

The increasing demand for light weight, inexpensive, energy saving, stiff and strong material in aircraft, space, defense and automotive applications has stimulated a steadily growing effort to developed composite material. Nowadays, Metal Matrix Composites (MMCs) are under serious consideration to replace conventional materials for a large number of structural applications such as aeronautical / aerospace, transportation, defense and sports industries because of their superior properties. The excellent mechanical properties and comparatively low cost make them as an attractive option. In AMCs one of the constituent is aluminum alloy, is termed as matrix phase. The other constituent which is embedded in this aluminum alloy matrix is serves as reinforcement. The reinforcement is usually to be non-metallic and commonly ceramic. The aluminum matrix is getting strengthened when itis reinforced with the hard ceramic particles like Sic, Al2O3, and B4C etc. Aluminum alloys are still the subjects of intense studies, as their low density gives additional advantages in several applications. These alloys have started to replace cast iron and bronze to manufacture wear resistance parts. MMCs reinforced with particles tend to offer enhancement of properties processed by conventional routes. A356/LM25 find applications in the food, chemical, marine, electrical, many other industries and in road transport vehicles where it is used for wheels, cylinder blocks and heads, and other engine and body castings.

Among different kinds of the recently developedcomposites, particle reinforced metal matrix composites and in particular aluminum base materials have already emerged as candidates for industrial applications. Boron Carbide particulate reinforced aluminum composites possess a unique combination of high specific strength, high elastic modulus, good wear resistance and good thermal stability than the correspondingnon- reinforced matrix alloy system. In this papera new method of producing aluminum—graphite particle composite alloys is described in which the copper- or nickel-coated graphite particles are mixed with aluminum powder. These powder mixtures are pressed into pellets and plunged into aluminum alloy melts prior to the hand stirring of the melt, followed by casting. The variables examined were the optimum size and amount of aluminum powder, the pressure applied to make the pellet, and the size of the coated graphite particles. The pellet technique of producing graphitic aluminum alloys is attractive since it is easier to reproduce and control the composition using this technique than using either the gas injection or the vortex technique years. In an advanced society like ours we all depend on composite materials in some feature of our lives. Fiber glass, developed in the late 1940s, was the first modern composite and is still the most common. It makes up about 65 % of all the composites conceded today and is used for boat hulls, swimming pool linings, surfboards, building panels, sporting goods, and car bodies (Automobile bodies). Composites be present in nature. A piece of wood is a composite, with long fibers of cellulose held in concert by a much weaker core called lignin. Cellulose is also found in cotton and linen, but it is the compulsory power of the lignin that makes a piece of timber much stronger than a bundle of cotton fibers. In engineering materials, composites are created bycoatings.

3. Composite Material:

The use of composite materials has many advantages and can be used in a variety of applications. Because of their extreme lightness and low density, composites are easily formed into complex shapes and block constructions. These materials have improved friction and wear properties with high specific stiffness, creep resistance and strength. Due to their low thermal expansion and electrical conductivity, composite materials have good damping properties and goodfatigue resistance.

4. Metal Matrix

A metal matrix composite (MMC) is composite material with at least two constituent parts, one being a metal necessarily, the other material may be a different metal or another material, such as a ceramic or organic compound. When at least three materials are present, it is called a hybrid composite. An MMC is complementary to ceramets.

5. Literature Review

Blaza et. al. [1], studied on Hybrid aluminium metal matrix composites application in the automotive industries for the production of engines, piston rings, cedar shaft & sockets are studied. The use of Hybrid aluminium metal matrix composites instead of monolithic or metal matrix composites results in reduction of weight improves the decrease in fuel consumption of automobile vehicles.

G. Sivakaruna et. al. [2], conducted a survey was made on effects of reinforcement on aluminium metal matrix composites. The reinforcements are ceramics materials like Silicon Carbide, Aluminium-di-oxide, Boron Carbide & Tungsten Carbide which are reinforced with aluminium& their properties were studied. The survey results the ceramic reinforcement materials improves the

mechanical properties like Tensile strength & Hardness compared with base metal aluminium

6. Materials SelectionAluminum

Aluminum is the third most abundant element (after oxygen and silicon), and the most abundant metal, in the Earth's crust. Aluminum is remarkable for the metal's low density and for its ability to resist corrosion due to the phenomenon of passivation. Structural components made from aluminum and its alloys are vital role in aerospace industry, marine, transportation and structural materials.

Magnesium

Magnesium is a chemical element with symbol Mg and atomic number 12. It is a shiny gray solid which bears a close physical resemblance to the other five elements in the second column alkaline earth metals) of the periodic table: all group 2 elements have the same electron configuration in the outer electron shell and a similar crystal structure.

Nickel

Nickel is a chemical element with symbol Ni and atomic number 28. It is a silvery-white lustrous metal with a slight golden tinge. Nickel is a hard and ductile transition metal. Pure nickel is chemically reactive but large pieces are slow to react with air under standard conditions because a passivation layer of nickel oxide forms on the surface that prevents further corrosion. Even so, pure native nickel is found in Earth's crust only in tiny amounts, usually in ultramafic rocks, and in the interiors of larger nickel–iron meteorites that were not exposed to oxygen when outside Earth's atmosphere.

Chromium

Chromium is a chemical element with the symbol Cr and atomicnumber 24. It is the first element in group 6. It is a steely-grey, lustrous, hard, and brittle transition metal.

Graphite

Graphite is a crystalline form of the element carbon. It consists of stacked layers of graphene. Graphite occurs naturally and is the most stable form of carbon under standard conditions. Synthetic and natural graphite are consumed on large scale (300 kton/year, in 1989) for uses in pencils, lubricants, and electrodes. Under high pressures and temperatures it converts to diamond.

Construction Of Stir Casting Furnace

Here Aluminim Metal matrix Composite is fabricated by using Stir casting technique. For that, we require a stir casting furnace with 3 bladegraphite stirrer. Since stir casting is not a conventional casting method, we have to design a suitable one. Even though some stir casting furnaces are readily available in the market, a custom made conventional stir casting furnace is cheaper and it is best suited for the present work to various process parameters according the requirements.

7. RESULTS AND DISCUSSION

TENSILE TEST

For the tensile test of Al with graphite 3%, wt % of Mg 1%,wt % of Ni 2% wt % of Cr 2% composite is taken by universal testing machine FIE-UTN 40 with ASTM D3039 standards. Maximum operating load of the machine is 400KN.Figure represent the UTM. Tensile strength of aluminium with boron carbide reinforced hybrid composites is presented, in below table. For experimental purpose, a tensile specimen has been prepared and the value is presented. It is observed that reinforcement of hard particles significantly improved the tensile strength of aluminium alloy.

S.no	specimens	Tensile strength (Mpa)	%of elongation
1	Specimen 1	32.70	30
2	Specimen 2	33	20
3	Specimen 3	31	45

IMPACT TEST

In this test, the impact behavior of different Al-graphite 3%, wt % of Mg 1%,wt % of Ni 2% wt % of Cr 2% composites is presented. The Impact test was carried out on Izod Impact testing machine, as per the ASTM standards. The test specimens are prepared as per ASTM D256. All specimens were subjected to Impact

test and their values were reported. Above picture illustrates the specimen for Izod impact test withASTM Standards dimensions.

S.no	specimens	Impact strength (Mpa)	Impact Energy (J/mm2)
1	Specimen 1	345	8.72
2	Specimen 2	350	10.22
3	Specimen 3	290	6.41

S.no	Composition	Load KG	Rockwell hardness number (HRB)
1	Specimen 1	100	44.7
2	Specimen 2	100	47
3	Specimen 3	100	52

HARDNESS TEST

According to ASTM D 785 standards for composites, the specimens were prepared for Rockwell-B hardness test, the specimen is of 25mmX25mmx6mm. Configuration and volume fraction are two important factors that affect the properties of the composite. In this test, the configuration is limited to unidirectional and continuous equal to the length of the specimen. For the harness test of Aluminium with graphite 3%, wt % of Mg 1%,wt % of Ni 2% wt % of Cr 2% composite had done using hardness testing machine.

8. CONCLUSIONS

From the literature survey, it is clear to know therecent technology aided with the composite materials like Hybrid aluminium metal matrix composites manufacturing and its applications. Different methods for production of Hybrid aluminium metal matrix composites were studied. Selection of materials like graphite 3%, Mg 1%,Ni 2% and Cr 2% can be used for the fabrication of Hybrid aluminium metal matrix composites by stir casting process. From the study, Stir casting method can improves the distribution of reinforcement particulates withbase metal compared to other method. The investigation shows the increase in weight percentage of graphite 3%, Mg 1%,Ni 2% and Cr 2% with Aluminium can improves the mechanical properties of the composite.

The mechanical properties like tensile strength, impact strength, and hardness can be increased with increase in content of reinforcement. The tribological properties were concluded that the wear resistance increases with increase in contentof reinforcement. It was concluded that the use of Hybrid aluminium metal matrix composites instead of monolithic or metal

matrix compositesresults in reduction of weight which improves the decrease in fuel consumption of automobile vehicles, aero space machineries.

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