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EXPERIMENTAL INVESTIGATIONS ON MECHANICAL CHARACTERISTICS OF FLY ASH AND SiC REINFORCED AA2014 MATRIX NANO-COMPOSITES

[1]LINGAM HARISH,[2] K SUDHAKAR,

[1]P.G. Student (Machine Design) Department of Mechanical Engineering[1], Kakinada Of Institute of engineering & Technology-II, Korangi, Yanam Rd., 533461

[2] Assistant Professor, Department of Mechanical Engineering[1], Kakinada Of Institute of engineering & Technology – II, Korangi, Yanam Rd., 533461

Abstract: *Though the research is being done from long back on these materials, somehow there is always an improvement in their properties and performance. Alloys have played a vital role and have become the major part in the industries as well as in many areas, once. But now, composites are replacing every other material with their high strength with low weight, not only the strength but also the hardness and thermal properties are also reaching the industrial needs. As the fiber reinforced composites are of one kind and the nano particles reinforced composite are of other type. Both are playing their roles effectively in their respective areas. In this thesis, we are going to make a particle type composite by reinforcing silicon carbide and fly ash with aluminum 2014 and to calculate the mechanical properties.*

INTRODUCTION

Engineering applications presently require materials that are stronger, lighter and less expensive comparing with all. We can see an example with the current scenario in the development of materials that have excellent strength to weight ratio suitable for automobile applications where fuel economy with improved engine performance is becoming more critical situation. In real time performance demands for many modern engineering systems require materials with broad spectrum of properties to execute, which are quite difficult to meet using monolithic material systems. Metal matrix composites (MMCs) have been noted to offer such required needful property combinations required in a wide range of engineering applications. Some of these property combinations include: high specific strength as required, low coefficient thermal expansion as needed and high thermal resistance, good damping capacities, superior wear resistance, high specific stiffness and satisfactory levels of corrosion resistance as well. Aluminum hybrid matrix composites have become better substitutes for the conventional aluminum alloys and other once so-called materials because of their characters like improved strength to weight ratio that means low density, energy saving nothing but fuel or power saving, and better wear resistance. Reinforced aluminum hybrid matrix, a composite for the use of the automotive industry, aeronautics and other structural applications, has been increased because of the physical and mechanical properties it possesses with improved performances. Aluminum based hybrid matrix composites with a variety of particulate reinforcements and some kind of additives such as Al2O3, TiC, Ti2B, SIC, TiN, Si3N4, Fly ash, graphite, and industrial waste byproduct have been conceived and developed for various potential applications.

LITERATURE SURVEY

Processing and Characterization of Hybrid Metal Matrix Composites [1] J. Mater. Environ. Sci., 2018, Volume 9, Issue 7, based on his paper reports a review on the structural and mechanical behavior of aluminum hybrid metal matrix composite. Aluminum matrix composites (AMC) are modern and advanced metal matrix composites (MMC) that can meet the recent increasing demands of various automotive industries and structural applications. The physical, structural, thermal and mechanical properties of aluminum matrix composites have made them useful in fields of aerospace, marines,

automotive etc. It is necessary to select the right combination of compounds or minerals or additives to reinforce with the metal as it will directly affect the properties of metal matrix composite thus formed. Selection of different constituents will affect the properties of MMC differently and the composition of constituents can also be varied to observe the changing properties of MMCs. This paper describes the various processing techniques and the various research and development activities taking place in the field of hybrid metal matrix composites

MATERIAL AND METHODS

ALUMINUM ALLOY 2014,

SILICON CARBIDE, FLY ASH

2014 aluminum alloy is an aluminum alloy, with copper as the primary alloying element. It is strong, with strength comparable to many steels or metals and has good fatigue and creep strength and average mach inability. It has lower resistance to corrosion than many other aluminum alloys listed, but has significantly better corrosion resistance more than the 2000 alloys present. Its relatively high cost limits its use. 2014 aluminum alloy's composition roughly includes 0.0–0.25% zinc, 0.4–1.20% magnesium, 3.9–5.0% copper, and less than a half percent of silicon, iron, manganese, titanium, chromium, and other metals. It is produced in many tempers, some of which are 2014-0, 2014- T6, 2014-T651.The first 2014 was developed in secret by a Japanese company, Sumitomo Metal, in 1943. 7075 was eventually used for airframe production in the Imperial Japanese Navy. Silicon carbide (SiC)

Silicon carbide (SiC) which is one kind of a semiconductor containing silicon and carbon. It can be occurred in nature as the extremely rare mineral moissanite. Synthetic SiC nano particles have been mass-produced since 1893 for use as an abrasive kind. Grains of silicon carbide can be bonded together by sintering to form very hard ceramics that are widely used in applications requiring high endurance, such as car brakes, car clutches and ceramic plates in bulletproof vests in automobiles industries. Electronic applications of silicon carbide such as light-emitting diodes (LEDs) and detectors in early radios were first demonstrated around 1907 in electrical applications. SiC is used in semiconductor electronics devices that operate at high temperatures or high voltages, or both instances. Large single crystals of silicon carbide can be grown by the Lely method and they can be cut into gems known as synthetic moissanite.

SiC chemical composition:

SiC is composed of tetrahedra of carbon and silicon atoms with strong bonding nature in crystal lattice.

Fly Ash which is well known in thermal power plant as it is a combustion exhaust particle. When coal is burnt in thermal plant for power generation the resultant for coal burning is flue ash that is fly ash. The fly ash containing oxides of silicon and aluminum as well as some potassium, titanium sulfure percentages are included. It is heavily available in nature and we can use of it for structural application like cement making and now as reinforcement.

Sand casting

There are many kinds of manufacturing methods and Out of all fabrication processes Sand casting is the best and fastest root to get a new fabrication product. In the sand-casting process, first mould has to prepare with the help of pattern and then poring the molten metal in the mold to get casted product. Before preparing the mould we should have some knowledge regarding properties of mould.

Molds made of sand are relatively cheap and easy, and sufficiently refractory even for steel foundry, cast iron foundry use. In addition to the sand, a suitable bonding agent usually clay or wood powder or any additives are mixed or occurs with the sand. The mixture is moistened, typically with water that too 6 to 8 percent only, but sometimes with other

substances, to develop the strength and plasticity of the clay and to make the aggregate suitable for molding. The sand is typically contained in a system of frames or mold boxes known as a flask and there are three types of flasks are there, first one is called cope which is in the top. Second one is called as drag which in placed in the bottom place.

ELECTRO MAGNETIC STIR CASTING:

Electromagnetic stir casting is the best alternate for sand casting as it is a speed and early process for melting the material. Here is one crucible is placed in electric furnace to melt the metal. One stirrer is placed upon the stir casting apparatus to stir the molten metal when reinforcements are added to mix homogeneously. Along with these arrangements ultra-sonic rod is introduced during the blend to produce bonding between the aluminum and nano particles.

Tests Conducted

Tensile Test

Tensile testing, also known as tension testing is a fundamental materials science test in which a sample is prepared as per the ASME standards is subjected to a controlled tension until failure. The pure Ductile materials will show some large elongation which can be observed, the results from the test are commonly used to select a material for an application, for quality control, and to predict how a material will react under normal forces. Properties that are directly measured via a tensile test are ultimate tensile strength, maximum elongation and reduction in area with the help of a system or manual calculations. From these measurements the following properties can also be determined: Young's modulus, Poisson's ratio, yield strength, and strain- hardening characteristics which are more important in automotive industry.

Hardness Test

Hardness is a mechanical property of a material, not a fundamental physical property. It is defined as the resistance force to indentation on the physical shape, and it is determined by measuring the permanent depth of the indentation. More simply put, when using a fixed force on the object and a given indenter, the smaller the indentation, the harder the material. Indentation hardness value is obtained by measuring the depth or the area of the indentation using one of over 12 different properties.

Impact Test

The impact test, also known as the Charpy V-notch test, is a standardized high strain-rate test which determines the amount of energy absorbed by a material during fracture and sudden impact load applied. This absorbed energy is a measure of a given material's notch toughness and acts as a tool to study temperature-dependent ductile- brittle transition rate. It is widely applied in industrial applications, since it is easy to prepare and conduct and results can be obtained quickly and cheaply with the machine apparatus. A disadvantage is that some results are only comparative with other.

OBJECTIVE

The present study involves the development of hybrid metal matrix composite reinforced with particulate SIC, Fly ash and Al 2014 by electromagnetic stir casting method. Weight fraction of SIC 2% and fly ash variation % is reinforced with base Aluminum Alloy 2014 matrix. The fabricated aluminum alloy was solution treated and then precipitation treated for T-6 condition. Casted composite and heat treated composite machined carefully to prepare specimens for micro hardness and tensile strength as per the ASTM standards.

EXPERIMENTAL INVESTIGATION

1. Aluminum alloy 2014
2. Aluminum alloy 2014 + SiC 2%
3. Aluminum alloy 2014 + SiC 2 % + fly ash 5%
4. Aluminum alloy 2014 + SiC 2 % + fly ash 10%

5. Aluminum alloy 2014 + SiC 2 % + fly ash 12%

6. Aluminum alloy 2014 + SiC 2 % + fly ash 15%

AA 2014 hybrid metal matrix is fabricated by Electromagnetic stir casting method. It is an attractive and economical casting technique which allows conventional metal processing route.

AA 2014 melted above 850 ºC in a crucible and the reinforcements were preheated up to same temperature for proper mixing and oxidation removal. Preheated SiC and fly ash were mixed in the metal slurry manually at 850 ºC. The molten metal poured in preheated moulds and allowed to cool. Casted metal matrix was machined to remove cluster formation on the surface and then cut into required dimension by using fan-saw cutting machine.

Fig 1:AA 2014, Fly Ash, SiC, Mg

Fig 2: Stir Casting arrangement

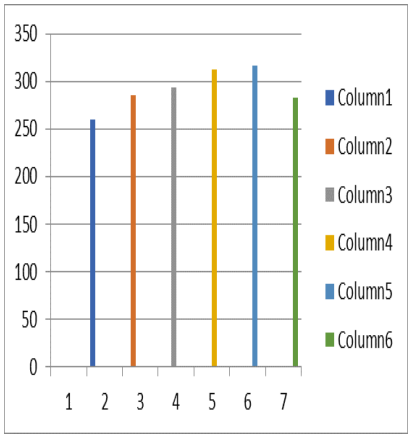
After Stir casting process of AA 2014 and fly ash, SiC, the molten metal is poured in the die and let it to be solidification for some time and then take these blocks to cut dumbbell shaped work pieces.

Fig 3: Work pieces before and after tensile tests

Fig 4: UTM machine

SAMPLE	UTS
1	335
2	343
3	356
4	362
5	372
6	341

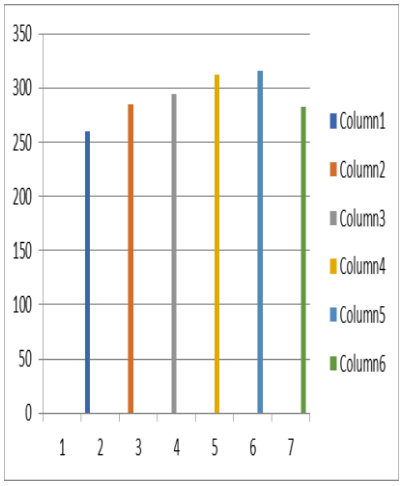
Table 1: UTS values



Graph 1: UTS graph

SAMPLE	Y. S
1	260
2	285
3	294
4	312
5	316
6	283

Table 2: Yield strength



Graph 2: Y.S graphs

CONCLUSIONS:

The conclusions drawn from the present investigation are as per the following:

- The result affirmed that mix framed AA2014 with Magnesium/Fly-Ash and SiC strengthened composites is plainly better than base AA2014 in the correlation of elasticity, strength and effect quality.
- It is discovered that prolongation will in general decline with expanding particles wt% which affirms that 4% magnesium and variety of Fly-Ash and SiC expansion builds weakness.
- It appears from this investigation that UTS and Yield Strength tend beginnings to increments with increment in weight level of magnesium and variety of fly debris.
- Strength can be observed from 12% of fly ash and 2% of SiC blends with pure AA2014 increasing.
- It can be seen from the SEM pictures and EDS examination that the particles are all around dispersed in the base amalgam and agglomeration of the particles are extraordinarily diminished, and the dissolve pool is all around shielded from the barometrical conditions.

REFERENCES:

1. S.Bandyopadhay, T.Das , and P.R.Munroe ,Metal Matrix Composites - the sunshine Yet
2. Stronger Metals for Tomorrow, A Treaise On Cast materials, p-17-38.
3. Composite Materials: Engineering and style By F.L.Matthews And R.D.Rawlings, Chapman and Hall Publication.
4. Estimation of Cavitation Pressure to Disperse Carbonnano Tubes in Aluminum Metal Matrix Nano Composite. By,Suneel D.,Nageswar Rao D, Satyanarayana .Ch,Pawan Kumar Jain.
5. Ultrasonic Cavitation Assisted Fabrication and Charecterization Of A356 Metal Matrix Nano Composite Reinforced With ash, B4c, Cnts.
6. Estimation of Cavitation Pressure to Disperse Carbon Nano Tubes in Aluminum Metal Matrix Nano Composites.
7. Fabrication and Study of The Mechanical Properties of AA2024 Alloy Reinforced with B4c Nano Particles Using Ultrasonic Cavitation Method.