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SYNTHESIS AND MECHANICAL PROPERTIES OF ALUMINIUM METAL MATRIX COMPOSITES

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Abstract:-

This paper is aimed to process properties of the conventional hardness and microstructure of Al-Sic nano composites with graphene flakes. It is planned to use various combinations with weight percentage of grapheme and Sic and to produce the Aluminum matrix composites by Compression Process. The first nano powered material is 100% pure Aluminum (Al). The other composition is Aluminum Al (70%),Silicon Carbide Sic (30%)The mixtures are to be mixed with nano Aluminum (70%) by weight percentages of adding nano Sic (25%), Graphene nano particles (GNP)(5%) followed by a Compression process to make a rigid form. Graphene and Sic nano particles predominantly are homogeneously distributed on the grain boundaries of Al matrix and Sic nano particles are distributed between GNP. Lot of work has been carried on synthesis of Al–Sic-Graphene composites for various engineering applications. Graphene has endowed with excellent physical and mechanical properties such as Tensile strength, elastic modulus and thermal conductivity and has got attention in the field of electronics, automobile industries, aerospace projects and other engineering applications. The prepared compacts must undergo microstructure evaluation by Metallurgical microscope and also find the Conventional hardness.
Key words:- Metallurgical microscope, hardness, Powder metallurgy, graphene.

1. Introduction:

Present study is focused on the fabrication of aluminum 6061 based metal matrix composites, reinforced with silicon carbide and $Al_2O_3$by stir casting technique. The percentage of one reinforcement particulate is kept constant and varying other and vice versa, namely types I and type II composites. The various mechanical tests like tensile strength test, hardness test, wear test and Impact strength performed on the samples obtained by stir casting technique for comparison purpose. The result indicated that the developed method is quite successful and there is an increase in the value of tensile strength, hardness value and Impact strength of newly developed composite having (Sic + Al_2O_3) particulates in comparison to the Aluminum.

It has been known that nano particles and its compounds have strong inhibitory and microbial activities for bacteria, virus, and fungi. In today's world due to the outbreak of infectious diseases caused by different pathogenic bacteria and development of antibiotic resistance the pharmaceutical companies and the researchers are searching for new antimicrobial agent. The synthesis, characterization and application of biologically synthesized nano particles have now become an important factor of nanotechnology. Nano particles are manufactured worldwide in large quantities for use in a wide range of application. The green synthesis of metal and semi conductor nano particles in an expanding research area due to the potential applications for the development of novel technologies. More recent advancement in researches on metal nano particles.

A nano particle has lot of scope for health care products such as burn dressings, antimicrobial applications, medical devices and scaffolds. Various type of method used to synthesis of nano particles with including chemical reduction, photochemical reactions, electrochemical techniques and green chemistry route. In this paper we repot highlighted about the various plants, fungi, bacteria and actinomycetes used in this process, synthesizing methodology; nano particles shape, size and their application as antimicrobials in elaborate manner. We also highlighted the basic mechanism by which nano particles interact with microbes and future recommendations.

The definition of nano composites has broadened significantly to encompass a large variety of systems such as one-dimensional, two-dimensional, three-dimensional and amorphous materials, made of distinctly dissimilar components and mixed at the nanometer scale. This research presents a detailed definition of nano composites, its origin, classification, properties, benefits, as well as its future. With the proper choice of computerizing chemistries, the nanometer-sized clay platelets interact with polymers in unique ways. The paper

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shows that the application possibilities for packaging include food and non-food films and rigid containers. In the engineering plastics arena, a host of automotive and industrial components can be considered, making use of lightweight, impact, scratch-resistant and higher heat distortion performance characteristics. In plastics the advantages of nano composites over conventional ones don't stop at strength. The high heat resistance and low flammability of some nano composites also make them good choices to use as insulators and wire coverings.

2. Experimental

2.1. Materials

2.1.1 Aluminum 6061:

The aluminum powder used in our project has a purity of 90%. The particle size is 90% i.e., 12.8 am and is flaky in shape. In this stearic acid ($C_{18}H_{36}O_2$ or CH_3 $(CH_2)_{16}COOH$) and methanol (CH_3OH) with purity of 99.99% are used as process control agent to avoid cold welding. The balls are maintained in the ratio of 1:10 i.e., 1 gram of powder is Equal to the 10 grams of the balls weight. By milling 15 hours of powder with an interval gap of every 15 minutes the nano particles are obtained. The obtained nano powders are characterized by the Particle size analyzer.

Fig.2.1: - 6061 Aluminum nano powder

2.1.2 **Silicon** carbide (Sic):

Silicon carbide (Sic) powder used for this study was procured from laboratory, Hyd with an initial particle size of 10 µm. The reduction in particle size of Sic from micron level to the nano level was carried out using a high-energy planetary ball mill in a stainless-steel chamber using tungsten carbide and Stainless-steel balls of 6gm, 16gm, and 32gm respectively. The total duration of milling was 20 hours. The rotation speed of the planet carrier was 200 rpm. The ball mill was loaded with ball to powder weight ratio (BPR) of 1:10. Toluene was used as the medium with an anionic surface-active agent to avoid agglomeration. The milled sample powder was taken out at a regular interval of every 2½ hours of milling and dried with mechanical drier. Then these nano powders are characterized for the nano form.

Fig 2.2: Silicon carbide (Sic) **nano powder**

2.1.3 Graphene:

Graphene is known as an atomic layer of graphite, which is also the essential unit for fullerenes and CNTs. It is a two-dimensional (2D) crystal that is stable under ambient conditions. Single sheets of graphene are expected to have tensile modulus and eventual strength values like those of single wall carbon nano tubes (SWCNTs) and have a vast electrical conductivity.

Fig2.3: Graphene (GNP) **nano powder**

Wet milling process was performed using a planetary ball mill , Hardened steel vial (500 cc), Hardened steel balls (5 mm in diameter). Graphite powders within the range of 15 µm were milled at which the weight of the milled graphite powders was 10 g, and the weight of the milling balls was 200 g,

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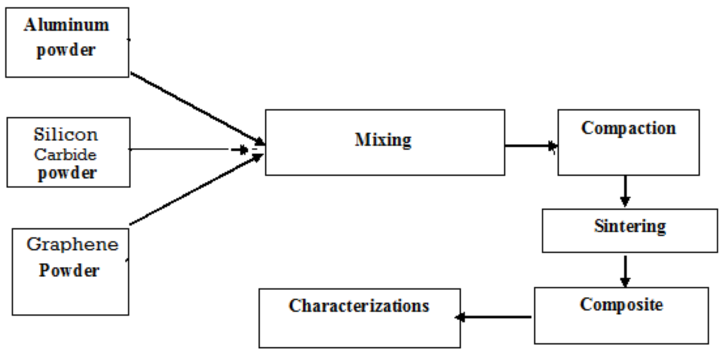
3. Preparation of composites:

Powder metallurgy is the process of blending fine powdered materials, pressing them into a desired shape or form (compacting), and then heating the compressed material in a controlled atmosphere to bond the material (sintering).The with weight percentage of grapheme and Sic and to produce the Aluminum matrix composites by Compression Process. The first nano powered material is 100% pure Aluminum (Al). The other composition is Aluminum Al (70%),Silicon Carbide Sic (30%)The mixtures are to be mixed with nano Aluminum (70%) by weight percentages of adding nano Sic (25%), Graphene nano particles (GNP) (5%) followed by a Compression process to make a rigid form. After compacting the Pellets are under sintering in muffle furnace to from a composite material, after this process the properties are checked.



Powder Metallurgy Process

Flow chart 3.1: Powder Metallurgy Process

The composition of Aluminum, Silicon Carbide and Graphene are shown in the following table:-

Materials	Aluminum	Silicon Carbide	Graphene	Total Grams i.e. Used in Pellets
1	200 grms(100%)	0 grms	0 grms	200 grms
2	140 grms(70%)	60 grms(30%)	0 grms	200 grms
3	140 grms(70%)	50 grms(25%)	10 grms(5%)	200 grms
Total grms	480 grms	110 grms	10 grms	

Table 3.1:- Composition of Nano Powders

Fig.3.1:- Die Set for composites

4. Experimental testing

4.1 Operational Procedure:-

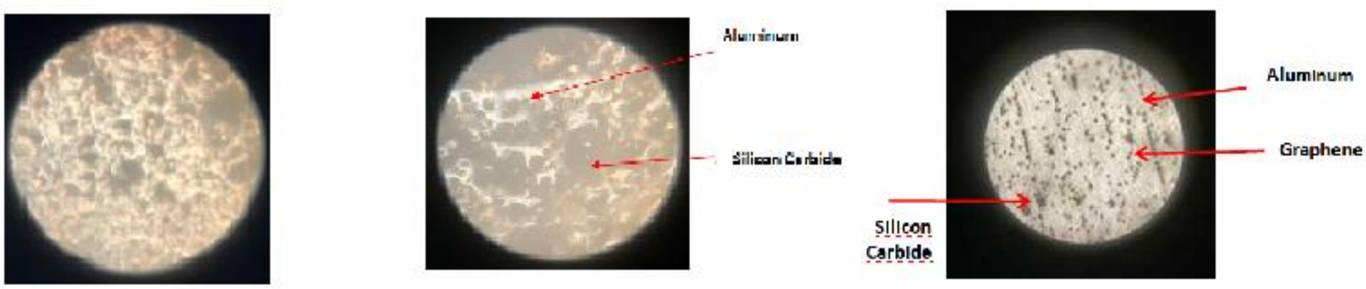
1. Compaction process of mixing alloy powder in die cavity is shown in fig: 3.1
2. This compaction process is carried out with the help of Universal Testing Machine.

3. The compaction is carried out UTM with compaction load of 175 KN. The compaction is carryout under gradually applied load with 2-minute relaxation time.
4. The whole compaction process carried out with the help of Universal Testing Machine.
5. Green compact obtained then sintered at 650^0C for 1 hour by using a conventional Muffle furnace.
6. Due to sintering the weak mechanical bonds of green compact are converted into strong metallic bonds.
7. Compaction pressure has great influence on the number of pores and their size and porosity decreases because the surface contact area between particles increases

Fig.4.1:-Universal Testing Machine and Pellets Under Heating in Muffel Furnace

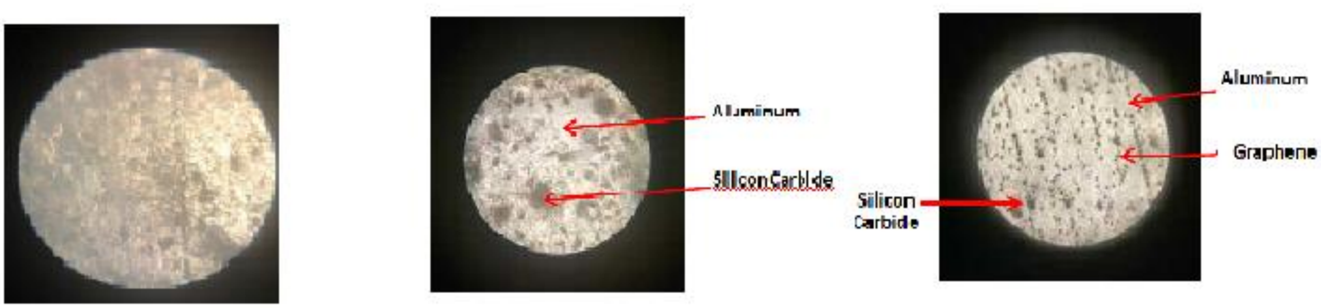
5. Results and discussion

5.1. Microstructures: Under 10X metallurgical microscope the samples are given below: -



Al (100%) **Composition of Al+SiC (70+30)** **CompositionofAl+SiC+Gnp(70+25+5)**

Fig 5.1:- Microstructure of composites under air cooling



Al (100%) **Composition of Al+SiC (70+30)** **CompositionofAl+SiC+Gnp(70+25+5)**

Fig 5.2:- Microstructure of composites under water cooling

5.2. Hardness

5.2.1 Observation during Rockwell Hardness test under Air Cooling

samples	Trial 1	Trial 2	Trial 3	average
Al	47	48	49	48
Al+SiC	51	50	52	51
Al+SiC+Gnp	53	52	54	53

Table 5.1:-Rockwell hardness test of pellets under air cooling

5.2.2 Observation during Rockwell Hardness test under water cooling

Samples	Trial 1	Trial 2	Trial 3	average
Al	48	49	50	49
Al+SiC	57	53	55	55
Al+SiC+Gnp	60	61	62	61

Table 5.2:- Rockwell hardness test of pellets under water cooling

6. Conclusion

Addition of SiC and Graphene individually at different percentages to aluminum matrix composite results in the following.

- The addition of SiC, Graphene particulates into the matrix significantly increases the yield strength, the hardness & decreases elongation (ductility) of the composites.
- Increasing weight percentage of SiC increases their strengthening effect but SiC & Graphene is the most effective strengthening particulates, for higher strength, hardness & grain size reduction.
- As it is also noted that Addition of these composites to the aluminum results in the increase of hardness number for a material which reduces the weight of the material and possess high thermal and electrical conductivity of the material.
- By this project we conclude that the RHN number for the sample 3 in water cooling has high value than air cooling so that the hardness number for the sample 3 is more i.e., Al – SiC – Graphene (70% - 25% - 5%).

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