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SYNTHESIS AND ANALYSIS OF ALUMINIUM METAL MATRIX COMPOSITE

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ABSTRACT
It is worth to mention that the aluminium based composite materials are finding its prominent use in industries. This research work proposes with selection of better materials for automobile industries, the conventional aluminium alloy product at present suitable for specific operating condition and aluminium composite materials on the other hand include wide range of operating condition. For the proposed research work different composition of aluminium materials are used with various reinforcement material different specimens is fabricated using vortex method and various properties of aluminium composite materials are studied using various tests like chemical composition, microstructure, tensile stress, hardness test as per ASTM standard. Finally the properties of fabricated aluminium composite materials are optimized.

Keywords:
Aluminium 6061, Reinforcement Materials (Red Mud, Fly Ash, Sic)

INTRODUCTION
6061 is a precipitation hardening aluminium alloy containing magnesium and silicon as its majoralloyingelements.Originallycalled"Alloy61S,"itwasdeveloped in 1935. It has good mechanical properties and exhibits good weldability. It is one of the most common alloys of aluminium for general purpose use. It is commonly available in pre-tempered grades suchas6061-O(annealed)andtemperedgradessuchas6061-T6 (solution zed and artificially aged) and 6061-T651(solution zed, stress- relieved stretch Edan artificially aged). The mechanical properties of 6061depend greatly on the temper, or heat treatment, of thematerial.Young'sModulusis10×10^6psi(69GPa)regardless of temper.

6061-O
Annealed 6061 (6061-O temper) has maximum tensile strength no more than 18,000 psi (125 MPa), and maximum yield strength no more than 8,000 psi (55 MPa). The material has elongation (stretch before ultimate failure) of 25–30%.

6061-T4
T4 temper 6061 has an ultimate tensile strength of at least 30,000 psi (207 MPa) and yield strength of at least 16,000 psi (110 MPa). It has elongation of 16%.

6061-T6
T6 temper 6061 has an ultimate tensile strength of at least 42,000 psi (300 MPa) and yield strength of at least 35,000 psi (241 MPa). More typical values are 45,000 psi (310 MPa) and 40,000 psi (275 MPa), respectively. In thicknesses of 0.250 inch (6.35 mm) or less, it has elongation of 8% or more; in thicker sections, it has elongation of 10%. T651 temper has similar mechanical properties. The typical value for thermal conductivity for 6061-T6 at 80°C is around 152 W/m K. A material data sheet defines the fatigue limit under cyclic load as 14,000 psi (100 MPa) for 500,000,000 completely reversed cycles using a standard RR Moore test machine and specimen. Note that aluminium does not exhibit a well-defined "knee" on its S-n graph, so there is some debate as to how many cycles equates to "infinite life". Also note the actual value of fatigue limit for an application can be dramatically affected by the conventional de-rating factors of loading, gradient, and surface finish.6061 is highly weldable, for example using gas welding (TIG) or metal inert gas welding properties near the weld are those of 6061-O, a loss of strength of around 80%. The material can be re-heat-treated to restore -T4 or -T6 temper for the whole piece. After welding, the material can naturally age and

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restore some of its strength as well. Nevertheless, the Alcoa Structural Handbook recommends the design strength of the material adjacent to the weld to be taken as 11,000 psi without proper heat treatment after the weld. Typical filler material is 4043 or 5356.

EXPERIMENTAL

A. Materials

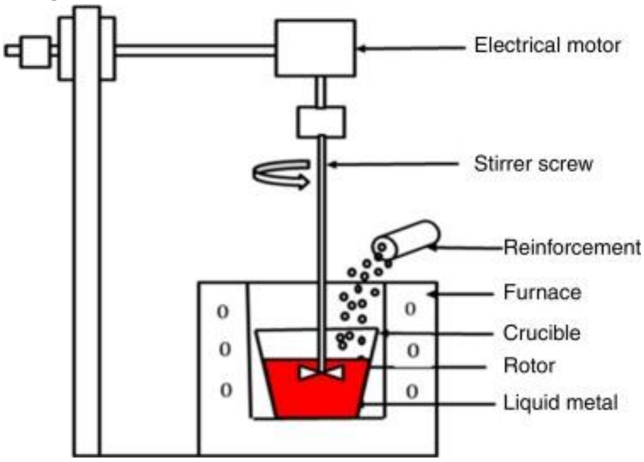
6061 is a precipitation hardening aluminium alloy, containing magnesium and silicon as its major alloying elements. It has good mechanical properties and exhibits good weldability. It is one of the most common alloys of aluminium for general purpose use. It is commonly available in pre-tempered grades such as, 6061-O (solution zed), 6061-T6 (solution zed and artificially aged), 6061-T651 .

B. Reinforcement

The reinforcement material is embedded into the matrix. The reinforcement does not always serve a purely structural task (reinforcing the compound), but is also used to change physical properties such as wear resistance friction coefficient, or thermal conductivity. The reinforcement can be either continuous, or discontinuous. Discontinuous MMCs can be isotropic, and can be worked with standard metalworking techniques, such as extrusion, forging or rolling. In addition, they may be machined using conventional techniques, but commonly would need the use of polycrystalline diamond tooling (PCD).Continuous reinforcement uses monofilament wires or fibres such as carbon fibre or silicon carbide. Because the fibers are embedded into the matrix in a certain direction, the result is an anisotropic structure in which the alignment of the material affects its strength. One of the first MMCs used boron filament as reinforcement. Discontinuous reinforcement uses "whiskers", short fibers, or particles. The most common reinforcing materials in this category are alumina and silicon carbide.[1]The TiO2 Sio2coating was deposited using a home-developed TH system (Ref 23). The system mainly constituted of a Hot chamber, an accelerating gas feeding unit, a particle-accelerating nozzle, a two- dimensional worktable, and a control unit. The acceleration of TiO2 particles was performed by high-pressure He gas. The coating thickness was about 15 lm. Spray parameters are given in Table 1.

Stir casting process

Stir Casting is a liquid state method of composite materials fabrication, in which a dispersed phase (ceramic particles, short fibers) is mixed with a molten matrix metal by means of mechanical stirring. Stir Casting is the simplest and the most cost effective method of liquid state fabrication. The liquid composite material is then cast by conventional casting methods and may also be processed by conventional forming technologies



Stir Casting is characterized by the following features:

- Content of dispersed phase is limited (usually not more than 30 vol.%).
- Distribution of dispersed phase throughout the matrix is not perfectly homogeneous:

1. There are local clouds (clusters) of the dispersed particles (fibers);

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2. There may be gravity segregation of the dispersed phase due to a difference in the densities of the dispersed and matrix phase.

- The technology is relatively simple and low cost.
- Distribution of dispersed phase may be improved if the matrix is in semi-solid condition.
- The method using stirring metal composite materials in semi-solid state is called Rheocasting.
- High viscosity of the semi-solid matrix material enables better mixing of the dispersed phase.
- Chemical Composition of Aluminium 6061

Table I Chemical composition of Al6061 alloy

Element	Cr	Cu	Fe	Mg	Mn	Si	Ti	Zn	Al
wt.%	0.003	0.24	0.16	0.89	0.48	0.63	0.014	0.007	97.57

The alloy composition of 6061 is:

- Silicon minimum 0.4%, maximum 0.8% by weight
- Iron no minimum, maximum 0.7%
- Copper minimum 0.15%, maximum 0.40%
- Manganese no minimum, maximum 0.15%
- Magnesium minimum 0.8%, maximum 1.2%
- Chromium minimum 0.04%, maximum 0.35%
- Zinc no minimum, maximum 0.25%
- Titanium no minimum, maximum 0.15%
- Other elements no more than 0.05% each, 0.15% total
- Remainder Aluminum

RESULTS AND DISCUSSION

Microstructure of Aluminum 6061and Reinforcement Materials.

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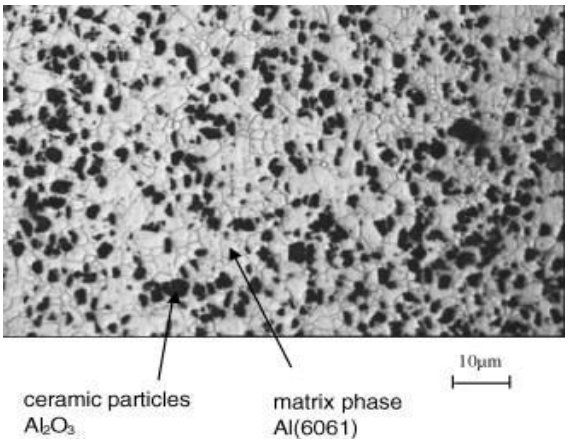
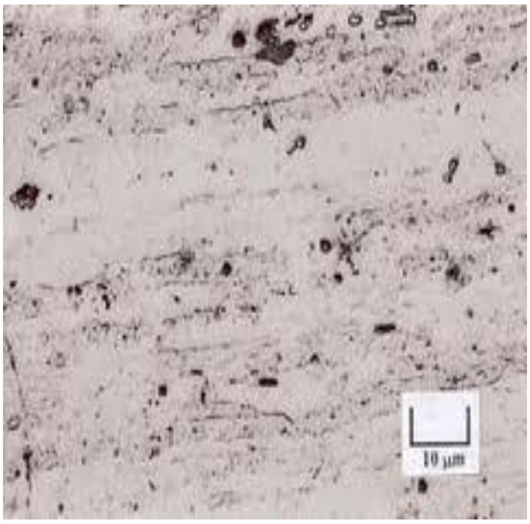


- The strengthening mechanisms of the composites are different with different kind of reinforcing agent morphology such as fibres, particulate or dispersed type of reinforcing elements.
- Dispersion Strengthening Mechanism of Strengthened Composite



Strengthening Mechanism of Particulate Composite

In the particulate reinforced composite the size of the particulate is more than 1 μm, so it strengthens the composite in two ways. First one is the particulate carry the load along with the matrix materials and another way is by formation of incoherent interface between the particles and the matrix. So a larger number of dislocations are generated at the interface, thus material get s strengthened. The degree of strengthening depends on the amount of particulate (volume fraction), distribution, size and shape of the particulate etc.

Micro structural Observation:

Microstructure was visualized with the help of microscope .for the specimen preparation, first of all specimen were cut down into small cuboids shapes after that the different samples , were grinded on different grit size papers 100, 220 ,400, 600 and 1000. The specimens were visualized on different magnifications (50x and 100 x) to show the presence of reinforcement and its distribution on the metal matrix.Different elements /compounds which were present in the specimen optical micrography. This improvement in the anti frictionalbehavior of the two alloys can be mainly attributed to the excellent lubricating property of TiO2 coated specimen. The coefficient of friction of both Al LM25

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alloy and its composites decreases with increased loads. At a maximum load of 20 N in the present work, the decrease in the coefficient of friction of the coated material.

In the dispersion strengthened composite the second phase reinforcing agents are finely dispersed in the soft ductile matrix. The strong particles restrict the motion of dislocations and strengthen the matrix. Here the main reinforcing philosophy is by the strengthening of the matrix by the dislocation loop formation around the dispersed particles. Thus the further movement of dislocations around the particles is difficult. Degree of strengthening depend upon the several factors like volume % of dispersed phase, degree of dispersion, size and shape of the dispersed phase, inter particle spacing etc. In this kind of composite the load is mainly carried out by the matrix materials. The coefficient of friction of applied load 20 N shown in Fig 6(c) the Al LM25 coated material decreases with increased sliding distance, reaching minimum at a sliding distance of 471 m. Beyond this sliding distance, an increase in the coefficient of friction of the studied Al LM25 un coated is further increase sliding distance.

CONCLUSION

From the study it is concluded that we can use fly ash for the production of composites and can turn industrial waste into industrial wealth. This can also solve the problem of storage and disposal of fly ash. Reinforcement material upto 15% by weight can be successfully added to Al by stir casting route to produce composites. The hardness of Al-Reinforcement material composites has increased with increase in addition of fly ash. Both the frictional force sand the wear rates has decreased significantly with the incorporation of Reinforcement material in Al melt. Strengthening of composite is due to dispersion strengthening, particle reinforcement and solid solution strengthening.

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