Prediction of Mechanical Properties for Aluminium- Boron Corbide and Fly Ash Hybrid Composites

R. Manivannan and N. Subramanian[2]
[1] PG Student,
Department of Mechanical Engineering,
Dr. Pauls Engineering College,
Villupuram-605109, India,

N. Subramanian[2]
Assistant Professor,
Department of Mechanical Engineering,
Dr. Pauls Engineering College,
Villupuram-605109, India

***Abstract* - Hybrid composite materials have found application in many areas of daily life for quite some time. Materials like aluminium with silicon carbide, boron carbide, fly ash, consisting of carbides and metallic binders, also belong to this group of composite materials. For many researchers the term hybrid composites is often equated with the term light metal matrix composites (mmcs). Substantial progress in the development of hybrid composites has been achieved in recent decades, so that they could be introduced into the most important applications. These innovative materials open up unlimited possibilities for modern material science and development; the characteristics of mmcs can be designed into the material, custom-made, dependent on the application. The advantages of the composite materials are only realized when there is a reasonable cost performance relationship in the component production. The reinforcement of metals can have many different objectives. The reinforcement of light metals opens up the possibility of application of these materials in areas where weight reduction has first priority.**

The development objectives for hybrid composite materials are:

- **Increase in yield strength and tensile strength at room temperature and maintaining the minimum ductility or rather toughness,**
- **Increase in creep resistance at higher temperatures,**
- **Increase in fatigue strength, especially at higher temperatures**
- **Increase in young's modulus.**

The objectives of this project are fabricate hybrid composites with the base metal as LM 25 Aluminum alloy reinforced with a different percentage of Volume of boron carbide particulates and fly ash (5% to 15%) by stir casting manufacturing method. The Specimen for prepared as per the requirements of testing. The mechanical properties like tensile strength, yield strength, material toughness and hardness will be analysed and these results will compare with the conventional materials and existing composite material. Suggest the suitable volume proportioned in hybrid composite.

INTRODUCTION

In the recent advancement of engineering design and manufacturing technology also requirement of our day today applications, the composite materials are play a vital role. The Fiber glass, developed in the late 1940s, was the first modern composite and is still the most common. It makes up about 65 per cent of all the composites produced today and is used for boat hulls, surfboards, sporting goods, swimming pool linings, building panels and car bodies. A piece of wood is a composite, with long fibers of cellulose (a very complex form of starch) held together by a much weaker substance called lignin. Cellulose is also found in cotton and linen, but it is the binding power of the lignin that makes a piece of timber much stronger than a bundle of cotton fibers. In engineering materials, composites are formed by coatings, internal adhesives and laminating. An important metal composite is clad metals. Thermostatic controls are made by roll-bonding a high expansion alloy such as copper to a low expansion alloy like steel. When the composite is heated it will deflect to open electrical contacts. Plywood is also a common composite. Since wood is weaker in its transverse direction than its long direction, the alternating grain in plywood over comes the transverse deficiency.

Humans have been using composite materials for thousands of years. The greatest advantage of composite materials is strength and stiffness combined with lightness. In Modern aviation, both military and civil would be much less efficient without composites. In fact, the demands made by that industry for materials that are both light weight and strong has been the main force driving the development of composites. The airframes of some smaller aircraft are made entirely from composites, as are the wing, tail and body panels of large commercial aircraft. Composites can be molded into complex shapes. Another advantage of composite materials is that they provide design flexibility. Over recent decades many new composites have been developed, some with very valuable properties. There are varieties of composites that can be manufactured according to the requirements of desired properties for a particular application.

The Composites also a one type of engineering materials provides almost unlimited potential for higher strength, stiffness and corrosion resistance over pure material systems of metals, ceramics and polymers. This will probably be “the steels” of the next century.

The Composite materials are formed by combining two or more materials that have quite different properties. The different materials work together to give the composite unique properties, but within the composite the materials can be differentiated since they do not dissolve or blend into each other. Composites are made up of two materials namely matrix and reinforcement. The matrix or binder surrounds and binds together a cluster of fibers or fragments of the stronger material (reinforcement). In Metal Matrix Composites (MMCs), ceramics or metals in form of fibers, whiskers or particles used to reinforce in a metal matrix.

The objectives of this project are:

- To fabricate Metal matrix composites with the base metal as Aluminum reinforced with a different percentage of Volume of boron carbide particulates (5% to 15%) by a suitable manufacturing method.
- Specimen to be prepared for mechanical testing.
- Determining the mechanical properties like tensile strength, yield strength, material toughness and hardness will be tested.
- Compare the properties with the conventional material and existing composite material.
- Suggest the suitable volume proportioned metal matrix material and Develop the light weight metal matrix composite.

FABICATION METHOD

- STIR CASTING

The stir casting technique was used to fabricate the composite specimen as it ensures a more uniform distribution of the reinforcing particles. This method is most economical to fabricate composites with discontinuous fibers or particulates. In this process, matrix alloy (LM25) was first superheated above its melting temperature and then temperature is lowered gradually below the liquids temperature to keep the matrix alloy in the semisolid state. At this temperature, the preheated B_4C particles and fly ash of 5-15% (by weight) and graphite particle of average size of 10 µm and 200 µm respectively were introduced into the slurry and mixed using a graphite stirrer. The composite slurry temperature was increased to fully liquid state and automatic stirring was continued to about five minutes at an average stirring speed of 300-350 rpm under protected organ gas. The B_4C particles help in distributing the graphite particles uniformly throughout the matrix alloy.

HYBRID COMPOSITES

Reference to hybrid composites most frequently relates to the kinds of fibre-reinforced materials, usually resin-based, in which two types of fibres and ceramics are incorporated into a single matrix. The concept is a simple extension of the composites principle of combining two or more materials so as to optimize their value to the engineer, permitting the exploitation of their better qualities while lessening the effects of their less desirable properties. As such, the definition is much more restrictive than the reality. Any combination of dissimilar materials could in fact be thought of as a hybrid. A classic example is the type of structural material in which a metal or paper honeycomb or a rigid plastic foam is bonded to thin skins of some high-performance FRPs, the skins carrying the high surface tensile and compressive loads and the core providing lightweight (and cheap) structural stability. The combination of sheets of aluminium alloy with laminates of fiber-reinforced resin, as in the commercial product ARALL (aramid-reinforced aluminium, Davis, 1985) is a related variety of layered hybrid and the mixing of fibrous and particulate fillers in a single resin or metal matrix produces another species of hybrid composite. In this research, overview is given on the current state of art on aluminium matrix composites with regard to processing, microstructure, properties and applications of AMCs. This research is predominantly concerned with discontinuous fibre reinforcement metal matrix composites, in which Aluminium alloy used as a matrix material and silicon carbide, titanium oxide used as reinforcement materials. Properties of AMCs can be tailored by varying the nature of constituents and their volume fraction. The major advantages of AMCs are as follows:

- Greater strength and Hardness
- Improved stiffness
- Reduced density(weight)
- Creep resistance
- Controlled thermal expansion coefficient
- Improved abrasion and wear resistance
- Improved damping capabilities.

REFERENCES Text

[1] Walter D. pilkey 1997 “peterson's stress concentration factors”, 2nd edition. Wiley Interscience
[2] Vikram Singh and R.C Prasad, 2004 “Tensile and Fracture Behavior of 6061 $AlSic_p$ Metal Matrix Composite”, International symposium of research on materials science and engineering
[3] A.Shakesheff, 1996, "Elevated Temperature Performance of Particulate Reinforced Aluminum Alloys," Materials Science Forum, Vol. 217-222, pp. 1133-1138
[4] Vidya Sagar Avadutala, 2005, “Dynamic Analysis of Cracks in Composite Materials” Wiley Interscience
[5] P. Rohatgi, 1991, "Cast Aluminum Matrix Composites for Automotive Applications," Journal of Metals.
[6] Dr.A.V.Phan, ANSYS Tutorials -2D Fracture analysis
[7] ANSYS Documentation
[8] M.Ramachandran”Material science-Poland, Vol24,No21,2006.
[9] Introduction to Fracture Mechanics, Dr.Prashant kumar.
[10] Mechnical Metallurgy, George Dieter