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Metal Casting- A Review Work

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ABSTRACT
This paper deals about the trends of Al/Al alloys based metal casting . It reviews the historical events of metal matrix composites (MMCs), produced in casting industries. After a brief introduction on properties of metal matrix composites. Processing and the developments of the metal matrix composites have been discussed at length. On the basis of above said subject, the future research needs in metal matrix composites on the basis of applications of the casting in industry was discussed.
Keywords - Metal Casting, Composites, Metal matrix Composites**.**

I. INTRODUCTION

Due to the wide choice of materials, today's engineers are posed with a big challenge for the right selection of a material and the right selection of a manufacturing process for an application. There are more than 50,000 materials available to engineers for the design and manufacturing of products for various applications. It is difficult to study all of these materials individually;
Therefore, a broad classification is necessary for simplification and characterization [1-2].

II. TYPES OF MATERIALS

Materials, depending on their major characteristics (e.g., stiffness, strength, density, and melting temperature), can be broadly divided into four main categories: (1) metals, (2) plastics, (3)ceramics, and (4) composites.

III. ALUMINUM/ AL ALLOYS

Aluminum (Al) had been at the center of a variety of engineering applications since long. It was first of all produced in the laboratory long back in 1825 by reducing aluminum chloride; however, its wide acceptance as an engineering material did not occur till World War II.
Aluminum is the most abundant metal in nature around 8% by weight in the earth's crust. The ore from which most aluminum is presently extracted is BAUXITE (Hydrate Aluminum Oxide). About 25% of the total aluminum produced in World is used for Containing and Packaging, about 20% of it is used in architectural applications and about 10% of Al produced is used for electrical conductors. The remainder i.e. 45% is used for durable goods in industry, consumer products, vehicles, and airspace applications[11, 12]. Aluminum is capable of mixing with other metals in liquid state, but solid solubility of alloying elements is typically only up to a few percent. In some cases inter-metallic compounds are formed and become a part in the structure of the aluminum alloy. No element is completely soluble in aluminum in the solid state. The percentage of alloy elements in useful aluminum alloys does not exceed about 15%. A number of other elements in aluminum will also be added because of their roles in fabrication and
strengthening. The alloy-designation for Al is based on four digits corresponding to the principal alloying elements. The most important alloying elements in aluminum alloy systems are copper (2xxx), manganese (3xxx), silicon (4xxx),magnesium (5xxx) and zinc (7xxx)[11, 13]. A number of other elements and compounds may also be added to Al for special purposes to have a new class of materials called Metal Matrix Composites (MMCs), which are most important because of their roles in fabric-ability, electrical conductivity, thermal conductivity and strengthening.

IV. SOME FEATURES OF COMPOSITES

Composites have been routinely designed and manufactured for applications in which high performance and light weight are needed[13-16].They offer several advantages over traditional engineering materials are discussed as:
- Composite materials provide capabilities for part integration. Several metallic components can be replaced by a single composite component.
- Composite structures provide in-service monitoring or online process monitoring with the help of embedded sensors. This feature is used to monitor fatigue damage in aircraft structures or can be utilized to monitor the resin flow in an RTM (resin transfer molding) process. Materials with embedded sensors are known as "smart" materials.
- Composite materials have a high specific stiffness (stiffness-to-density ratio). Composites offer the

stiffness of steel at one fifth the weight and equal the stiffness of aluminum at one half the weights

- The specific strength (strength-to-density ratio) of a composite material is very high. Due to this, airplanes and automobiles move faster and with better fuel efficiency.
- The fatigue strength (endurance limit) is much higher for composite materials. Steel and aluminum alloys exhibit good fatigue strength up to about 50% of their static strength
- Composite materials offer high corrosion resistance. Iron and aluminum/ aluminum alloys corrode in the presence of water and air and require special coatings.

V. TERMINOLOGY IN COMPOSITES

Some of the more prominent terms used with composite materials are defined below. A more detailed list can be found in Tsai, as well as in the Glossary.

Lamina: A lamina is a at (or sometimes curved) arrangement of unidirectional (or woven) fibers suspended in a matrix material. A lamina is generally assumed to be orthotropic, and its thickness depends on the material from V which it is made.

Reinforcements: Reinforcements are used to make the composite structure or component
stronger. The most commonly used reinforcements are boron, glass, graphite (often referred to as simply carbon), and Kevlar, but there are other types of reinforcements such as alumina, aluminum, silicon carbide, silicon nitride, and titanium.

Matrix: The matrix is the binder material that supports, separates, and protects the fibers. It provides a path by which load is both transferred to the fibers and redistributed among the fibers in the event of fiber breakage.

V. METAL MATRIX COMPOSITES

Metal matrix composites are materials with metals as the base and distinct, typically ceramic phases added to improve the properties. Although it is desired that these phases remain distinct and separate, reactions do occur between them. If this is the case, it affects the processing and final properties of the composites, regardless of which type of reinforcement is used. The Metal Matrix Composites (MMCs), in general, consist of continuous or discontinuous fibers, whiskers or particulate dispersed in a metallic alloy matrix. The reinforcements provide the composite with the properties not achievable in monolithic alloys. Continuous fiber composites have been especially restrained, finding use only in high value parts in the aerospace field. This is due to the difficulty in processing of the materials, forcing manufacturers to offer
them at high cost.

VI. HOW MMCS DIFFER FROM OTHER MATERIALS

MMCs differ from other composite materials in several ways. Some of these general distinctions are as follows:

- The matrix phase of an MMCs is either a pure or alloy metal as opposed to a polymer or ceramic.
- MMCs evidence higher ductility and toughness than ceramics or CMCs, although they have lower ductility and toughness than their respective unreinforced metal matrix alloys.
- The role of the reinforcement in MMCs is to increase strength and modulus as is the case with PMCs. Reinforcement in CMCs is generally to provide improved damage tolerance.
- MMCs have a temperature capability generally higher than polymers and PMCs but less than ceramics and CMCs.
- Low to moderately reinforced MMCs are formable by processes normally associated with unreinforced metals.

VI. FABRICATION METHODS

Deformation processing-It can also be used to deform the composite material. In MMCs mechanical processing (swaging, extrusion, drawing, or rolling) of a ductile two-phase material causes the two phases to code form,
causing one of the phases to elongate and become fibrous in nature within the other
phase.

Powder Metallurgy: This process involves the mixing of two powders in the desired volume ratio followed by compaction. The compacts are then sintered to get the composite. The advantages in this process
include the latitude in controlling the volume ratio of the constituents.

Diffusion bonding- It is a common solid-state processing technique for joining similar or dissimilar metals. Inter diffusion of atoms between clean metallic surfaces, in contact at an elevated temperature, leads to bonding.

In Situ Processes: In these techniques, the reinforcement phase is formed in situ. The composite material is produced in one step from an appropriate starting alloy, thus avoiding the difficulties inherent in combining the separate components as done in a typical composite processing.

Liquid-State Processes-Liquid Infiltration
In the infiltration technique, liquid metal is infiltrated through the narrow crevices between the fibers or particulate reinforcements which are arranged in a perform, fixed in space, unlike the stir mixing and casting process where the reinforcements are free to oat or settle in the melt due to density differences.

Squeeze casting or pressure infiltration. It involves forcing a liquid metal into a fibrous or particulate perform. Pressure is applied until solidification is complete.

Spray-Forming of Particulate MMCs

Another process for making particle-reinforced MMCs involves the use of modified spray forming techniques that have been used to produce monolithic alloys for some time. One particular example of this, a co-spray process, uses a spray gun to atomize a molten aluminum
alloy matrix, into which heated silicon carbide particles are injected.

VII. PROPERTIES OF METAL MATRIX COMPOSITES

Some of the important properties of MMCs are:

- High longitudinal and transverse strengths at normal and elevated temperatures.
- High toughness and impact properties.
- High surface durability and low sensitivity to surface flaws.
- Near-zero coefficients of thermal expansion.
- High electrical and thermal conductivities.

VIII. APPLICATION OF METAL MATRIX COMPOSITES

There are many reasons for the growth in composite applications, but the primary impetus is that
the products fabricated by composites are stronger and lighter. Today, it is difficult to find any industry that does not utilize the benefits of composite materials. Some of the major industries are using MMCs are[12][11][14]:

The Aerospace industry

The aerospace industry was among the first to realize the benefits of composite materials. Airplanes, rockets, and missiles all y higher, faster, and farther with the help of composites.

The Automotive Industry

Composite materials have been considered the "material of choice" in some applications of the automotive industry by delivering high-quality surface finish, styling details, and processing options.

The Electrical Industry

Some of the important metal matrix composite components are applied and used as insulation materials for electrical construction, supports for circuit breakers and printed circuits, armors, boxes and covers, antennas, radomes, tops of television covers, cable tracks, wind mills, housing cells etc.

The Sporting Goods Industry

Sports and recreation equipment suppliers are becoming major users of composite
materials.

Marine Industry

Composite materials are used in a variety of marine applications such as passenger ferries, power boats, buoys, fabricate hovercrafts, rescue crafts, patrol boats, trawlers, landing gears, anti-mine ships, racing boats and canoes.

Consumer Goods

Composite materials are used for a wide variety of consumer good appli- cations, such as sewing machines, doors, bathtubs, tables, chairs, computers, printers, etc.

Other Industrial Applications

The use of composite materials in various industrial applications is growing. Composites are being used in making industrial rollers and shafts for the printing industry and industrial drive shafts for cooling-tower applications.

IX. FUTURISTIC PROMISES OF METAL MATRIX COMPOSITES

Use of MMCs has recovered and in the long term will continue expand, as a result of technological advancements, both in the area of new methods for producing MCs, as well as in evaluating MMCs various applications. Though a large number of highly specialized and sophisticated aluminum alloys have been developed in an ongoing effort over the past decades,
still there remains urgent need for the development of new or improved Al/Al alloys composites. Aluminum alloys reinforced with very high volume fractions of ceramic particulate or fibers are evincing much interest for structural applications that require high specific modulus, low thermal expansion coefficient and wear resistance.

X. CONCLUSION

As per there properties, they have significant scientific, technological and commercial importance. During the last decade, because of their improved prop-erties, MMCs are being used extensively for high performance applications such as in aircraft engines and more recently in the automotive industries. MMCs are materials that are attractive for a large range of engineering applications. They are a family of new advanced materials, which are attracting considerable industrial interest and investment worldwide.

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