INVENTIVENESS IN MERGING GENETICALLY DISSIMILAR MATERIALS: A REVIEW

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Abstract— ***The scientific advancement is various combinations of material development is driving the research to the forefront, in most of the industries. When metals chemically fail to combine readily with other metal, they easily combine with certain non-metals to provide exceptionally good properties. The main reason is due to strong bonding of metals to non-metals. This research work and study draw upon primarily all our activities to gather designing, and planning sources and our understanding of effectiveness in implementing structurally complementing materials to create a new product of excellent quality, better strength, valuable and profitable, through Merging by combining Genetically dissimilar materials, to obtain unified special product, possessing custom made properties, by applying new techniques for various applications in numerous industries. The aim of this research study and experiments is to find the combination of materials with an aim of getting a better and more desirable product combining different properties as needed.***

Index Terms— MMC, Metal matrix composite, Merging Genetically Dissimilar Materials, Inventiveness, Strengthening Mechanism, Fibre.

I. INTRODUCTION

The metallic components carry free electrons, and remain free to move to another atom. Such free electron features have many profound metallic material properties and consequences. To provide an example, the metallic part of material act like a good conductor of electricity, due to free electron movements around the metal. They classify and group well with polymer and ceramic materials. Additionally, these different materials from an appropriate composite material by means of various combinations [26]. Hence, the composite materials combining required properties of each material can be formed from these organized commonly classified materials, depending on their forces of atomic bonding of individual material.

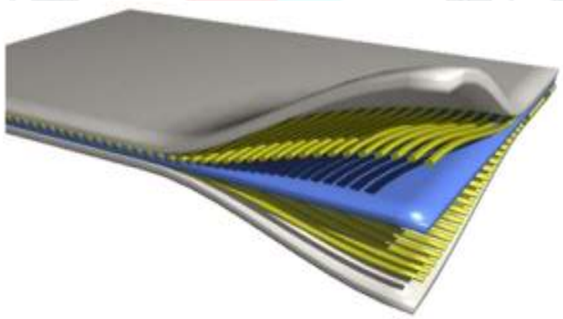

Fig.1 Composite material View

Hybrid Materials technology is another inventive method of Merging Genetically dissimilar materials, as they combine two or more smart materials at the molecular or nano-metric levels, comprising of multiple constituents. For example, one is organic and other inorganic. The organic component imparts functional advantages, while inorganic element offers mechanical advantages. Moreover, many hybrid materials act like anti-oxidizing instrument, and highly fire and corrosion resistant [5].

Composites possess special properties, because they are designed so, and are prepared by the combination and merging of two or more prominent engineering metals/materials; out of which, the main material is the Matrix. It constantly surrounds other phases in a dispersed form. Hence, the composite properties are the functions of constituent phase properties, with respect to their shape, size and the relative amount of the dispersed material phase [27].

In its major regular form, 50 years back, merging Genetically Dissimilar Materials, by the combination of one or several metals with a ceramic, called Cermets. This term was utilized to understand the additional properties generated, more values and purpose created by merging metal and ceramic. Presently, several other metal and non-metal combinations nevertheless exist. For example, tungsten composite heavy alloys, tungsten toughened with copper, copper and niobium, all these composites are used in superconductors, and for other applications [11].

The process makes the resulting product ideal for the application, as it carries features like: (a) The capability to apply the combination of different materials; (b) The capability to develop complicated sizes and shapes; (c) Requirement of less tooling cost; (d) Avoiding the secondary processing of machining operations.

In the conventional manufacturing technology, previously, the standard metal fusion and processing techniques like gravity casting, extrusion, vacuum casting processes were applied to produce billets or ingots, and thereon, to form the final products, they were cast to obtain the finished products [24].

Such casting of materials was developed by silicon carbide particle suspension with melted aluminium. However, the major technical problem was related to the requisite techniques applied to maintain ceramic particle dispersion with metal matrix, to form a perfect mix. Apart from that, the concerned silicon carbide particle contents needed a perfect control to prevent separation. Such problems do not exist in the prevailing inventive technology of merging genetic dissimilar materials.

Certain exclusive composites of the metal matrix system permit industrial designers to develop a unique material holding custom-made properties. For example, when a specified amount of thermal coefficient of expansion is needed for the robust electronic appliance packing, a fusion of metal composites is used [1].

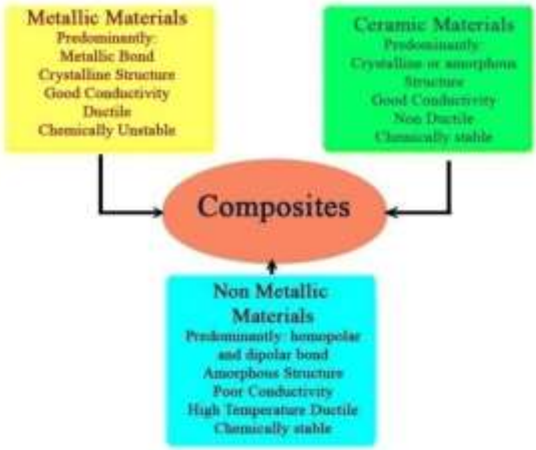

Fig. 2 Composite Materials Group Classification [21].

The objectives to develop composite light weight material are:

1. To improve Tensile and Yield strength at the normal atmospheric temperature and if possible, above certain degrees as needed, while preserving least toughness or ductility;
2. Improve creeps resisting property at elevated temperature in comparison with other standard alloys;
3. Improve fatigue power and strength, at elevated temperatures;
4. Improve resistance to thermal shock;
5. Improving resistance to corrosion;
6. Enhance Young's modulus;
7. Reduction of thermal expansion properties [16].

The properties for specific material functions, are:

1. To increase and maintain high conductivity and strength in conducting materials;
2. Improve creep resistance at lower temperatures;
3. Improve burnout behavior, and switching contacts;
4. Improving wear resistance, and sliding contacts;
5. Increasing spot welding operating time of electrodes by decreasing burn outs;
6. Producing the layer of composite material for use in electronic components;
7. Producing superconductor ductile composites;
8. Producing magnetic materials carrying unique properties.

II. LITERATURE REVIEW

The stirring of MMC casting was actually initiated in 1969, during the time, newly converted alumina particles into the molten state by continuously stirring aluminium alloy in the molten form mixed with ceramic powder [12]. Later, Chawla et al. reported the results by forming a new technique of vortex mixing to prepare ceramic particles dispersing in composites of aluminium matrix [8], which was initially invented by Hashim et al. [13], experimented in the Indian Scientific Institute. Kaufman J. [18] made a modest attempt to study and cultivate aluminium matrix MMC with particulates of silicon carbide, to produce a standard, economical method to form a homogenous ceramic material dispersion. Afterward, Basavarajappa et al. [3] experimented his research with an aim to find Al6063–SiC metal matrix particulate composites using a metallurgical process applying the liquid route, by stirring casting techniques. They varied the reinforcement amount from 0 to 9.5% by weight, dispersed SiC particulates in alloy formation of Al6063. Thereafter, Chawla N. [9] evaluated the porosity measures in the MMC, and observed various difficulties in enhancing material strength, specifically in particles of reinforced MMCs. Later, Jokhiyo M [15] in his investigative studies observed certain striking results when temperature and speed of pouring varied at different stages, and rated Aluminium casting mechanical properties. He observed that, when the speed was between 2.10 cm/seconds and 16.10 cm/seconds, the temperature also varied between 685°C and 755°C [14], in 2011 studied Aluminium and SiC composites, using SiC 0%, 0.15%, 0.2% and 0.25% in his experiments conducted with 0.220 μm particle sizes, specifically using the cast stirring technique. The resulting Al Alloy increased mechanical strength, stress resistance power, hardness, and the overall tensile strength. Thereon, Behera R [4] investigated the hardening, solidification conditions, forging properties of Alloy of Aluminium LM6 with SiC particle composites at three different composite casting steps [19] preferred Aluminium MMC more than standard materials in various applications like automotive, aerospace, and marine due to their light weight and exceptional enhanced properties. In the stirring cast process, the reinforced powder format phases got dispersed in the molten form of magnesium due to mechanical stirring [20].

III. MATRIX MATERIAL PROCESSING AND RESULTS

Materials and products working in an intense environmental condition in space offer opportunities and severe challenges to material scientists. A typical spacecraft hovering near the earth orbit, must exercise extreme caution in dealing with naturally developed harsh environmental phenomena like protoplasm, ionized particle radiation, interaction with atomic oxygen, electromagnetic and thermal radiation, suddenly generated vacuum, and other factors, impact of tiny particles of metals, rocks, micro-meteoroids and man-made debris. The 30 years of Space Station had to undertake178000 rounds of thermal cycles, operating between +130°C and –130°C, while moving around the Earth's shadow, and beyond Mars and Earth missions. They had to pass through 1,500°C temperature zone. Therefore, these spacecraft working under extreme critical space missions demand robust, lightweight material structures to pass through all odd conditions with an intense elemental accuracy and unlimited, predetermined stability while encountering thermal and dynamic intrusions. Only composite materials, having a high stability rating, specific stiffness, low CTE- thermal coefficient of expansion can impart the requisite attributes to create dimensionally strong, lightweight and stable structures. Hence, therefore, organic and metal matrix composites are invented to meet all these space applications [23].

Even after effective MMC development, graphite- magnesium; graphite- aluminum; boron- aluminum, [25], the technology faces considerable hurdles concerning manufacturing convenience, quality control, inspection, and extended cost. It has been proved that MMCs are essentially resistant to micro-cracking stability while resorted to electromagnetic interference, radiation exposure, and thermal cycling. Alongside, discontinuously MMC reinforced material like silicon carbide particulates toughened with aluminum alloys, SiCP/Al, GP/Al like composites are cost effective for aerospace purposes and other commercial applications. Yet, when there are innumerable benefits, and potential for future space programs, many drawbacks hinder the quick developments [23].

IV. MANUFACTURING AND MERGING TECHNIQUES OF GENETICALLY DISSIMILAR MATERIALS

Fibre being highly resistant to many chemicals, and atmospheric conditions, it is reinforced with other materials/metals to form a composite of superior strength and several other needed mechanical properties. That makes a favourable ratio of strength and weight, produced by integrating stiff and strong brittle fibres merging in more ductile and softer matrix. The purpose of the matrix material is to act like a medium to transmit the applied external load and forces to fibre layers. The material matrix conveniently protects fibres from the external forces and loads, because of its designated designed properties.

The composites can be discontinuous or continuous reinforcements. The continuous reinforcements provide the maximum stiffness and strength, while the discontinuous fibre composites help when economics in manufacturing dictate the terms and process [17].

V. RESEARCH WORK ON STRENGTHENING MECHANISMS

The research conducted on Ceramic, Polymer and Metal Matrix based Nanocomposites indicate that they are the best alternatives to overcome all the limitations posed by monolithic, and micro-composites concerning stoichiometry and elemental composition challenges in nano-cluster segment. They permit property combinations, possess design uniqueness, not obtained in conventional composites. Their importance and value was reported way back in 1992, and yet in initial inference stage [7].

The structure of nano-composite matrix materials consists of nano size nanotubes, fibres, whiskers, particles, and such reinforced elements. They possess good strength, much more than the best HSS - High Strength Steel, and an exclusive property to encounter stress, and strain. Its value of Young's modulus is equivalent to that of diamond, exhibit high resilience, can sustain, contraction, large angle bending, and straightening with no damage, much more useful than plastic/metal composites and possesses resistance to fracturing [2].

VI. CONTINUOUS AND DISCONTINUOUS COMPOSITES

Discontinuous FRC - Fibre-Reinforced Composite fabrication uses fibres of short carbon in combination with Pyrolyzed or Pyrolytic Organic Carbon Matrix. The objective is, rather, to obtain discontinuous substrate fibres to enhance fabrication ability in big structures, obtain maximum isotropic materials, improve tensile strengths of inter laminar fusion, and decrease composite porosity. The FRC is a composite material of fibres acting as dispersed or discontinuous phase, matrix acting as a continuous phase, and also, the interface of their inter phase regions [6].

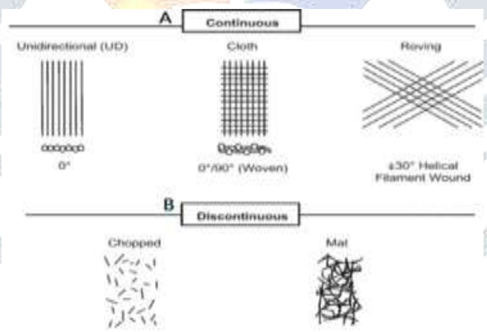

Fig. 3 Typical composite reinforcement types [6]

VII. SYSTEM GUIDELINES TO COMPOSITES

Designers usually convey their decisions concerning the selection of materials for composites. Hence, they need to be more knowledgeable and familiar with the characteristics of different types of materials available, their relevant properties, commercially availability status, and the affordability of the life-cycle of the prevailing discontinuous reinforced various metals. Understanding this, the material specific features and performance need to be identified and integrated thereafter, with an affordable manufacturing techniques and methods, using innovative designs to develop and generate systems, and related subsystems gain tangible and perceptible benefits. But, this should be complimented by adequate, and affordable raw materials, resources, in the entire system, which is difficult to surmount using the new technical, while measuring and encountering cost barriers [23].

VIII. CONCLUSION AND FUTURE ISSUES

MMC inventiveness, research, experimentations are presently in the production application commencement stage. They need to be made, as a priority measure, commercially more attractive, and viable, while developing better materials. Hence, higher and intensive development and research priorities are needed with more attention, to generate cheaper and convenient processes.

Many properties of MMC are difficult to evaluate, if the metals are monolithic. For example, the toughness of the material is difficult to define. The mechanism of conventional fracture tests, using an analytical method for testing metals are derived from assumptions of similar type crack extensions; for example, without altering the metal shape, the crack can lengthen. Whereas, the composite materials are non-homogeneous showing a complicated inner damage pattern. Hence, the conventional applicability of to MMC fracture mechanism becomes debatable, without knowing its accuracy, particularly in fibre-reinforced composite materials.

IX. References

List and number all bibliographical references in 10-point Times, single-spaced, at the end of your paper. When referenced in the text, enclose the citation number in square brackets, for example: [1]. Where appropriate, include the name(s) of editors of referenced books. The template will number citations consecutively within brackets [1]. The sentence punctuation follows the bracket [2]. Refer simply to the reference number, as in "[3]"—do not use "Ref. [3]" or "reference [3]". Do not use reference citations as nouns of a sentence (e.g., not: "as the writer explains in [1]").

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