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FABRICATION OF NOVEL ALUMINIUM AND ITS APPLICATION

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ABSTRACT

Failure occurs in compounds after elongated exposure due to micro cracks. Therefore maintenance of such locations is not practically possible at remote areas in the effort to increase the reliability and endurance of compounds, these Self healing compounds are manufactured to automatically fix small crevices and cracks if there will be any to make sure failure doesn't happen and increase the life of structures. Thereby making maintenance task simplified and efficient. This industry report targets to summarise the recent developments in the area of self healing compounds. Firstly, techniques of characterisation and fabrication have been studied as much as possible for self-healing microcapsules and self-healing carbon fibre laminates that contains graphene/ hexa-methoxy-methyl-melamine (HMMM), rejuvenator, supramolecular elastomer, and hybrid shells. This report also lasers the numerical approach in order to explore recoveries in self-healing compounds and also to study the enhancements in mechanical properties of these new compounds. Then, the applications of shape memory polymer and alloy in CNTs reinforced self healing compounds are also worked upon. Compound material with sheets of carbon nano tubes (CNS) is worked upon as self healing material as it is able to maintain its temperature to that of living species. Therefore this application will be based on smart self healing compounds, compiling this industry report.

Keywords: *Fabrication, Novel Aluminium, Hexa-Methoxy-Methyl-Melamine (HMMM), Rejuvenator.*

Introduction

Self healing compounds are able to restore their structural integrity after a failure, very similar to that of self-healing abilities in living species. In these compounds, the long duration exposure process ends up with small cracks and micro crevices which results in a failure. Therefore the maintenance is required to re-enhance the strength and endurance of these compounds. However, self healing characteristics in composites may not do the self healing of the worn out material until its not triggered from the outside. On this basis, self healing compounds are classified in two main groups

- autonomic (without external intervention);
- non autonomic (with external intervention).
  - After encapsulated healing units into polymer matrix are embodied, during designing of self healing compounds, the release of healing units and other concerned factors is a matter of delicate handling. Process of micro-encapsulation is concerned regarding to the enclosure of particles that are micron sized, which then isolates and confirms these from the external surroundings. In theory it is confirmed that the micro-encapsulated healing units are used by polyester matrix to complete self-healing process.
  - For the process, the dicyclopentadiene (DCPD) is associated with the Grubb's enzymes which are then released in the resin of epoxy, thereby metathesis polymerisation (ROMP) is started along with a cross-linked tough polycyclopendiene is thereafter creates material which actually heals the wear and tear. In this way considerable improvement in terms of failure can be restored as compared to the original specimen.

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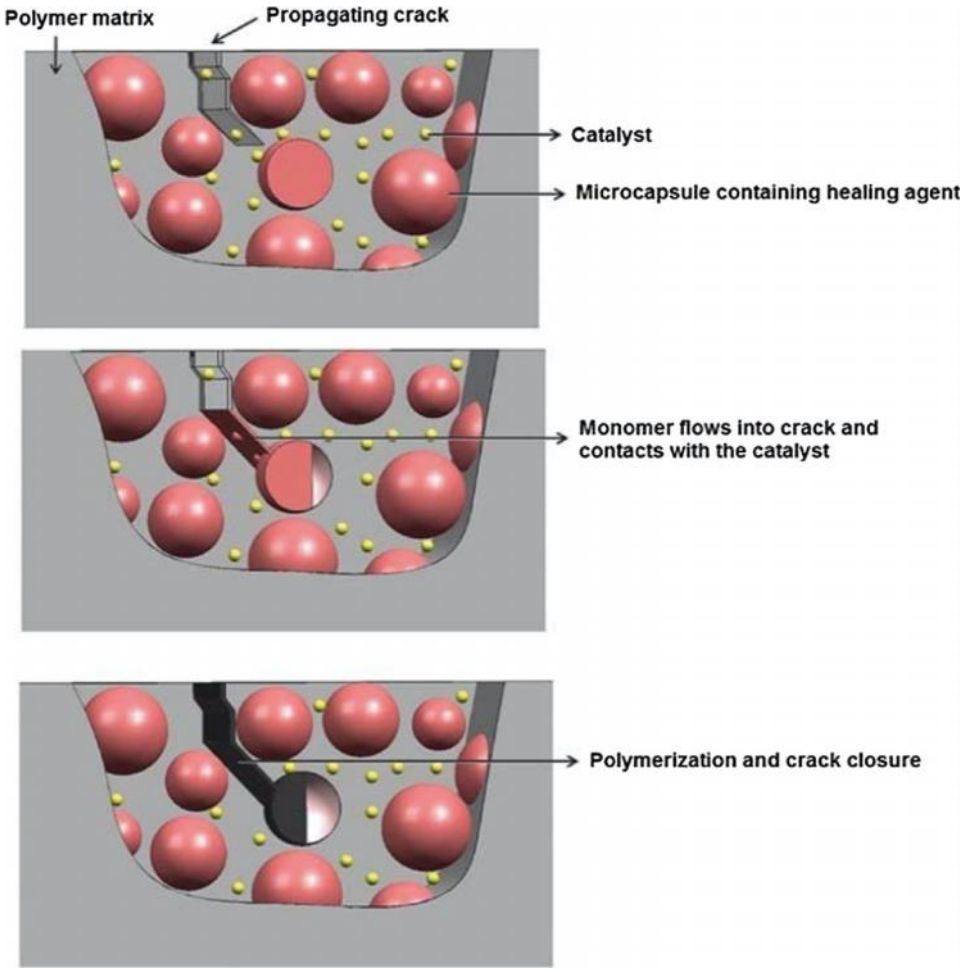


Figure 1: Self Healing Compound with Microcapsules

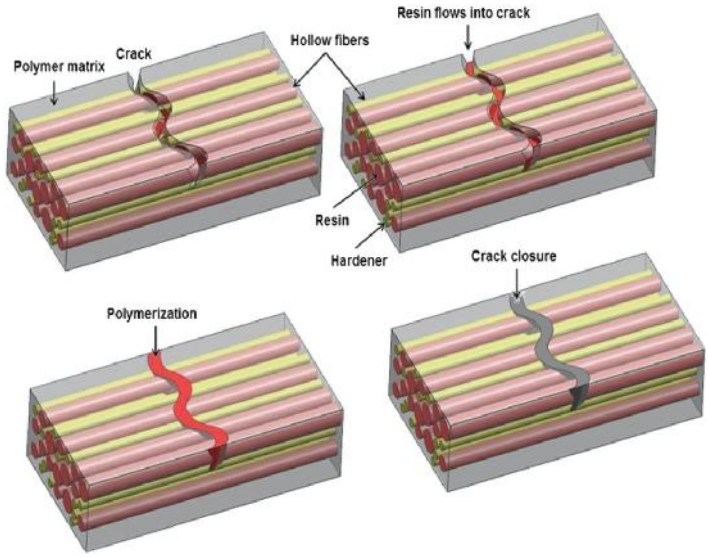


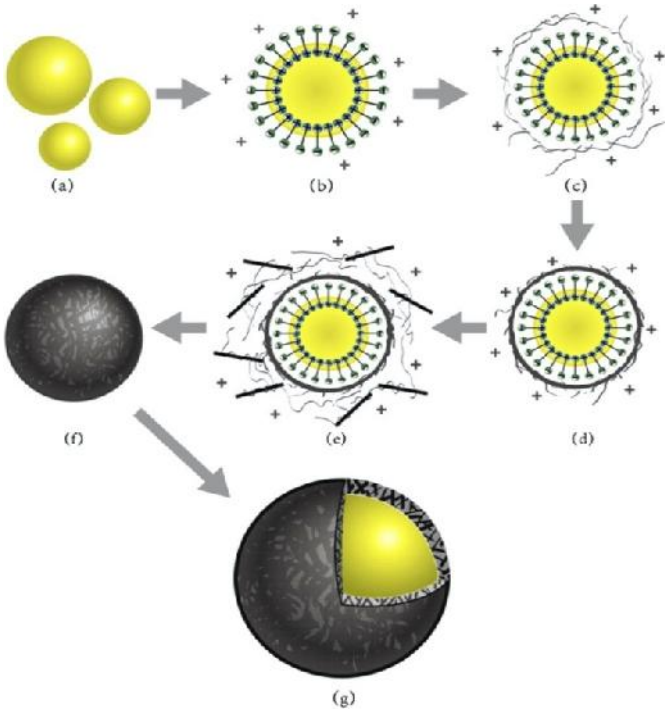
Figure 2: Self Healing Compound with Epoxy Resin

Fabrication

Compounds are manufactured by various methods such as:

- powder metallurgy
- stir casting
- combo casting
- mechanical alloying
- liquid metal infiltration
- spray decomposition

Major experimentation that associates with Aluminium compounds is the method of uniform dispersion of reinforced particles within the created alloy. Techniques that are used all have their individual benefits and limitations coefficient on the measurement parameters. The primary two types of fabrication process are stir casting and powder metallurgy.



Stir Casting Method

Manufacturing aluminium composites uses stir casting as the most common way of manufacturing. This way the reinforced particles like carbides eg: SiC, B_4C, oxides eg: Al_2O_3 and borides eg: TiB_4 under the ATP are reinforced in the molten matrix of aluminium supported by mechanical stirrer. In such techniques of fabrication of composites, the wet-ability of reinforced particles in the melt is a big step in casting process. vortex (twister) process is created and is relatively successful to accomplish the casting properly. Stir process can be utilised till 30% volume of reinforced to proper composites. Stir casting is utilised for mass production, cheaper price and material range for processing is a large. The composite fabricated by stir casting provides a more uniform dispersal of the reinforcement that has ben done. The stir casting is affected by factors like stirring speed, stirring time, melting temperature, and by the positioning of blade height along with blade geometry and the temperature of pouring. In contrast to normal casting. Firstly, the reinforcements are kept dried instead of being dipped in metal matrix liquid and secondly, the lean of particles is towards the sink or float depending on their density virtually in the liquid matrix. In comparison to other casting stir casting has major advantages such as, stronger bonding in matrix-particle, control is relatively easier, cheap in cost, simple method and the extensive variety of materials to create composites with the method.

Recent Developments in stir casting method created a method called the double stir casting or two-step. In this process, the matrix material is firstly reached to melting point. The molten material is then cooled to a temperature stated as semi-solid condition. At this point the reinforcements that were preheated are then added & mixed constantly. for the final step slurry is raised to a temperature in liquid-state condition and is thoroughly mixed. The bonding strength of two-step mixing method is usually caused because of its ability to break the deposit of gas around the particles of surface which then otherwise inhibits the moisture between the melt and particles, thus the mixture of the in the semi-solid condition of the particle helps in order to release the gas layer.

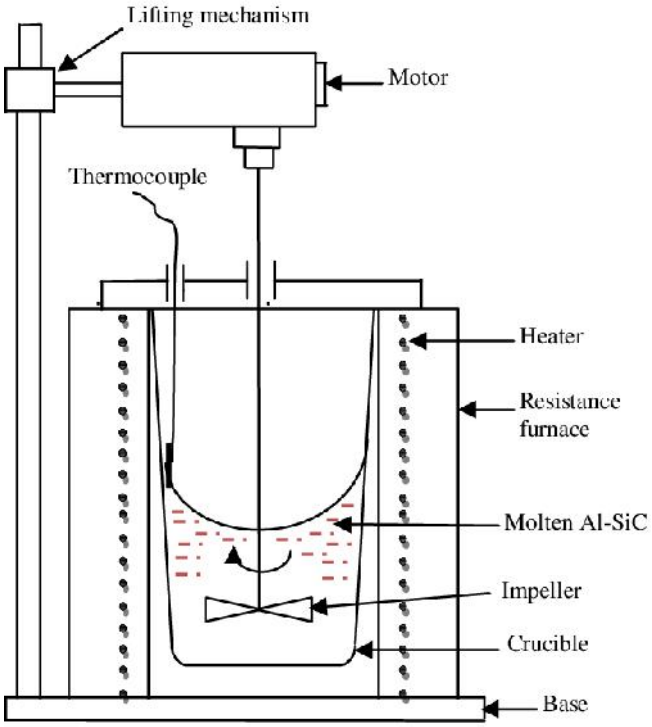


Figure 3: Stir Casting Method

Powder Metallurgy Method

This is one of the most widely used process of manufacturing the composites, the most considerable advantage of powder metallurgy method is the ability to shape the powders straight to its final component form, the method has been widely used in changing the primary methods of casting process because of the usage of less energy, less requirement of raw materials, quality is significantly higher, low basic cost and better at fabricating the complex parts. Because of this it is been used in aerospace , automotive and other delicate manufacturing process. Moreover, the reinforced hard material is disposed off in order to fracture. This fracture happens when particles through the blending process and depends upon the density of phase ratio. The size of such base alloy normally and reinforced units range in size from of 3 to 20 μm and 20 to 40 μm, accordingly along with ratios of phase being less than that 5:1. this process, involves powder combinations amalgamation, that in turn confirms the primary homogeneousness nature of mixtures. mixture is then compacted under the room temperature in isostatic process. Accordingly, the water molecules certainly to be removed from the mix in order to reduce the porousness in course of condensation. At the final condensation stage, hot pressing process of vacuum can be utilised to achieve the required composites. Final product of powder metallurgy is attained by process of extrusion with the ratio of a minimum 20:1. However higher extrusion ratio is necessary to acquire the strong bonding in between the particles & in obtaining a uniform and symmetrical distribution of the reinforced particles. Number of benefits from the powdered metallurgy are such as any type of reinforcements and alloy can be used in the fabrication of MMCs, since it requires low temperatures, the composites having great reinforcement particles can be manufactured by powdered metallurgy process.

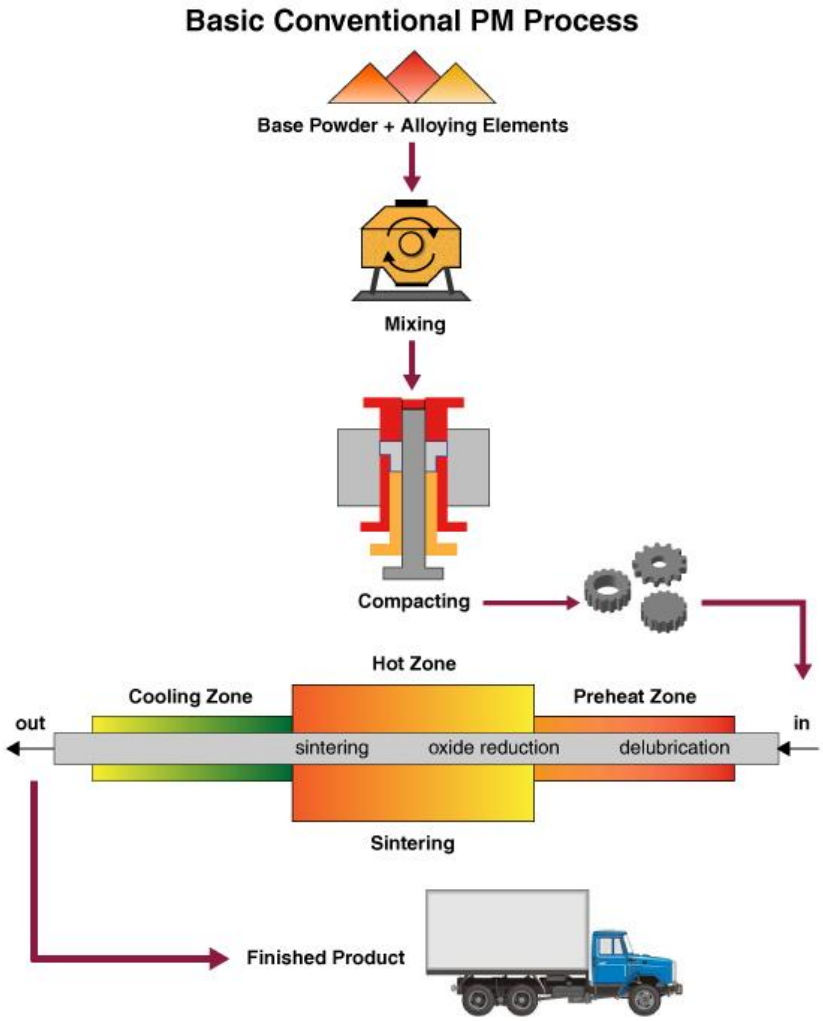


Figure 4: Powder metallurgy method

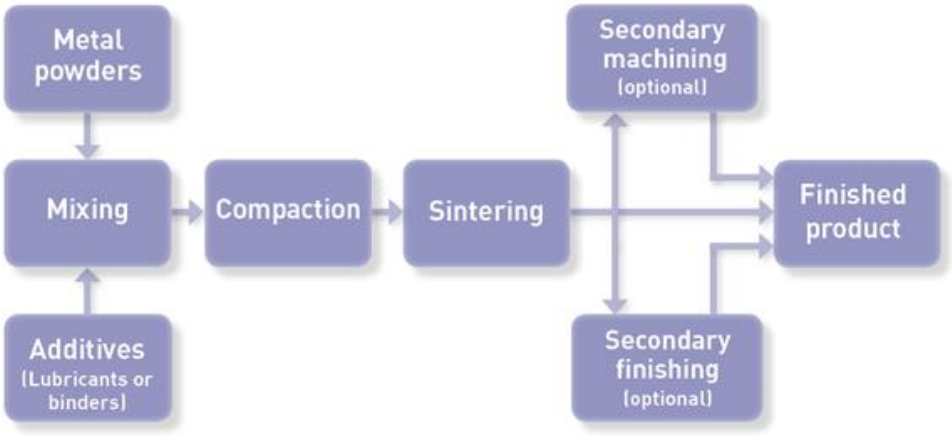


Figure 5: Flow Chart Powder Metallurgy Method

Reinforcement in AMC

- **Silicon Carbide (SiC)**

In the MMC, the process of machinability is quite different from basic customary material because of the reinforced elements. Reason being scratched elements generally will cause high damage on cutting tools. in cutting tool the flank damage was considerably increased with increase in proportion of reinforcement. It's also found that there is more intensification in particle wt. % negatively disturbs the roughness.

Literature Review

Research by: P. B. Pawar and Abhay A. Utpat, SiCp reinforced AMCs were made utilising the process of stir-casting by changing particle wt. % in sections of 2.5, 5, 7.5 and 10. SiCp uniform distribution can be attained when composite is being prepared using the process of powder metallurgy rather than stir casting process however the process of stir casting is more cheap process financially compared to the process of powder metallurgy.

Research by: Lal Krishna S.K et al, Al-SiCp matrix composite are manufactured using the process of stir casting by making the process two step mixing method. on the basis of financial analysis, complete fabrication price and the amount of time consumed are reducible by changing the current material with the composite of Al-SiCp in terms of cutting down the weight saving, the Overall price of production after all machining feature bearing is also reducible up to a whopping 44.95 %.

Research by: Raghavendra N and V S Ramamurthy, silicon carbide is used as the reinforcement at 3% wt. % where Al7075 is taken as the base material. By adding of SiCp in minor amount, the ceramic reduces the friction coefficient, thereby decreasing vibration and noise. Noise reduction in friction causes the entire system to function more elegantly.

Internship Work Observation

Observation 1: Experiment was done in order to relate and produce, mechanical properties of the compound Al6061/SiCp & Al6061/SiCp/Gr which are the hybrid metal matrix composites. Production of composites was done using process of stir casting where volume of reinforcement was changed as terms of 5%, 10% and 15% in wt. for results density of SiCp & SiCp/Gr which are the reinforced composites that have various weight portions were analysed and it was seen that the density of material was increased with the SiCp and was found to be decreased with SiCp/Gr, so these SiCp/Gr hybrid MMCs showed up as a more profitable light weight manufacturing material.

Observation 2: the fatigue lasted for 2.5 wt. % Al/SiC/Gr metal matrixes composites resolute on dissimilar levels are basically associated with the base materials. metal matrix hybrid composite showed in increment in the fatigue resistance when it is side by side analysed to the base material that is LM 25. The fatigue analysis gave a wider scatter.

- **Graphite(Gr)**

The graphite reduces the porousness and increases the intermolecular density of both Al/graphite and Al/TiC/graphite of the MMCs.

Literature Review

Research by: Pardeep Sharma, the most work emphasises basically upon the results attained from graphite particles mixed with Al6082, MMCs is manufactured by method of stir casting. The SEM statistics discovered a non-uniform dispersion of Graphite elements. The main result of the done examination is not in favor to reinforce the Graphite particles to Al6082 matrix as the final result of non-uniform dispersion of Gr particles as observed by the study of microstructure.

Research by: M.Vamsi Krishna, the intermolecular space for the SiC and SiC/Gr reinforced MMCs with a different wt. %, their density ascended when reinforcing with SiC and descended when the reinforcement with SiC/Gr hybrid particles is done, therefore SiC/Gr hybrid MMCs can be seen as a light weight material for manufacturing and production purposes. SiC/Gr hybrid MMCs has proper mechanical behaviour properties

Research by: A. R. K. Swamy, Al6061/graphite reinforce MMCs were manufactured efficiently by the process of liquid metallurgy, that includes reinforced particles up to 4 wt. %. A compromise is necessary at the time of deciding how much wt. % of graphite is to be added I order to improve the mechanical properties of the MMCs by maintaining the hardness it has and its rate of wearing out.

Internship Work Observation

Observation 1: Al6061/Gr MMCs were manufactured by using the method of liquid metallurgy. The mechanical properties of Al6061/Gr composites observed are substantially replaced by the variable wt. % of graphite molecules. It is seen that increment in the wt. % of graphite accumulation in the matrix, resulting in the considerable development in the mechanical properties.

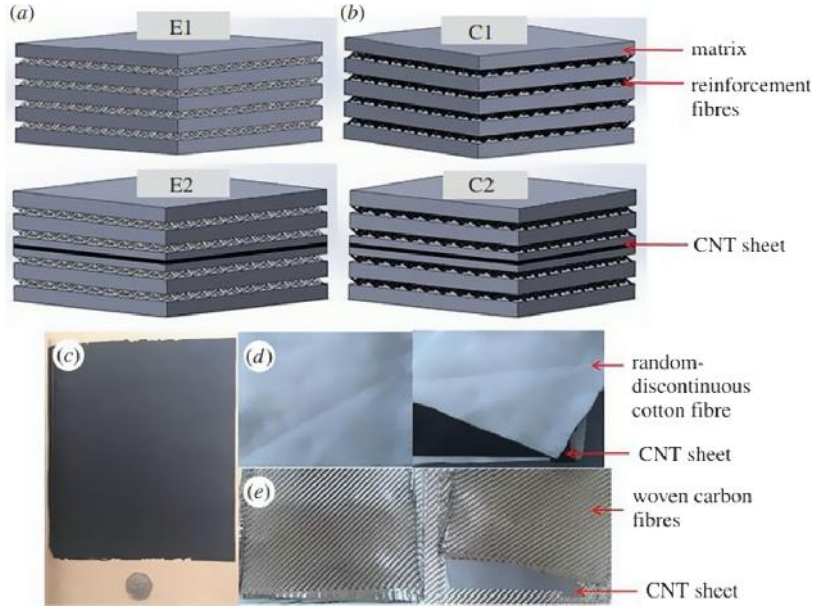
Observation 2: the proper mixing technology in order to attain a uniform dispersion of non coated Graphite particles in a matrix that has been developed.

Functionality Recoveries in Self-Healing Composites

The creeks and cracks are usually repaired using glass of borosilicate and composites we have taken about so far, and is also recognised to possess a higher resistance to the oxidation. thermoplastic dispersed units have been used to heal wider cracks. This process of self healing is known as close-then-heal process due to the wide-open cracks getting repaired and closed after using the shape memory phenomenon of fibres of shape memory polyurethane (SMPU) before the healing. In applications of aerospace the composites are critically examined for their abilities to self heal. Moreover these materials hold strong for fracture and toughness improvement as well. Research done for fatigue along with impact improvement 75% taking regards to load of damage for a microcapsule (consisting of epoxy resin) is repaired. Toughness of fracture improvement is stated to more than just the load improvement of peak damage in order to examine the ability of healing cap. The healing approach of microcapsules for the low-velocity impacts is common and is examined in many researches so far. as progress after a further impact is observed as energy for peak load (86%) & Peak load (53%) investigations are carried out on impacts at high velocity in order to find if a self-healing ionomeric polymer can be taken as an alternative to plies of aluminium (for preventing damage of space structures from debris in space). Attempts to make them practically useable have been successful as damages are healed significantly.

Applications

With the development in technology, now as an alternative to metal alloys the Self-healing polymer composites are being primarily used for the space structures in order to resist damage caused by space debris. the addition of alloy of shape memory (SMA) in self- healing composites of carbon, damage tolerance under repeated impacts is reduced. Thus using SMA wires is a better approach to obtain better resistance on impact to aerospace laminates of GFRP, but it is not always for composites of GFRP. coatings of self healing material have the new applications in the sections of aircraft such as aircraft panels, preventing it from corrosion and minor impacts. By utilising a high-pressure mechanism of moulding, with the combination of a shape memory polymer and the carbon nanotubes (CNTs) with a cross ply (0/90/90/0) carbon fabric, fabrication of self healing GFRP laminates is done. improved fatigue and resistance are the results of the application and thus its is utilised in aerospace materials.



Future Prospects

Self-healing composites are the primary and go to materials of the future in the field of research in innovative product research. Researches are putting their findings to recover mechanical and the basic fundamental properties in materials after repairing the damage using such smart composites. Still, the concept of self-healing composites has some limitations, like a low standing repair mechanism and therefore the stability of repair mechanism is not accurate also, Identification of damages and further healing are main challenges for the self-healing composites.

After examining, it is found that it is not possible to completely ignore laminates of graphine/polymer, which possess self-healing abilities even after many challenges to in their use of practical applications. Since, the improvement in self repairing abilities and mechanical properties, the two separate conditions. Therefore, sustaining the balance in the laminate of graphene/polymer is still a drawback to overcome. Plus it is equally necessary in order to improve the compatibility of both polymer and graphene, after we modify graphene, at the same time retaining the natural characteristics of graphene.

Conclusion

Literature survey report on the Aluminium alloy MMCs material it is concluded that, the aluminium in pure form and diverse variants when added with additional compounds through the method Stir casting process and powdered metallurgy are effectively used in order to manufacture composite of metal matrix with the preferred properties. The stir casting process has major advantages such as flexibility, cost-effective, efficiency, simplicity and the ability for mass production. The composites thus can be properly synthesised the melt by stirring process by utilising 3-stages of mixture techniques with the process of preheating the reinforced particles. It has been seen that the properties (mechanical) of the compounds are greatly affected by the fractions in weight. For increasing the capability of properties of machine, developed composite material, the % of reinforcement is limited to less than 10% and for increasing the strength of developed material, the temperature of ageing is limited to less than 180^0 C. Configuring the mechanical properties of the MMCs materials that are hybrid can be found from the experiments.

References

1. Ghosh Swapan Kumar. Self-healing materials: fundamentals, design strategies, and applications. Weinheim: Wiley-Vch Verlag GmbH & Co. KGaA; 2009. ISBN: 978-3- 527-31829-2.
2. Weiner S, Wagner HD. The material bone: structure-mechanical function relations. Annu Rev Mater Sci 1998;28:271–98.
3. Zhou BL. Self-healing materials: fundamentals, design strategies, and applications. Mater Chem Phys 1996;45:114–9.
4. Lakhvir Singh, Baljinder Ram, Amandeep Singh, Optimization of Process Parameter for Stir Casted Aluminium Metal Matrix Composite Using Taguchi Method, IJRET, 02 (2013).
5. J. Myalski, J. Wieczorek, A. Dolata Grosz, Tribological Properties of Hetero Phase Composites With an Aluminium Matrix, JAMME, 15 (2006) 53-57.
6. J. Lakshmipathy, B. Kulendran, Reciprocating Wear Behaviour of 7075Al/SiC and 6061Al/Al2O3 Composites: A study of Effect of Reinforcement, Stroke and Load, Tribology in Industry, 36 (2014) 117-126.

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