LATEST REVIEW STUDIES OF DIFFERENT COMPOSITES AL, Mg-WITH CNT

Waranghuse Somnath[1],Mankar R.L.[2]

1. P.G.Student, MechanicalEngineering, Jaihind C.O.E.Kuran, Pune,India.

2. Assistant Professor, Mechanical Engineering, Jaihind C.O.E.Kuran, Pune,India.

ABSTRACT

In this paper start with definitions and overview of the current status of composite technology, the basic concept and characteristics including properties of composite and typical composite material of interest , and in course use , also study transformation relation for these mechanical properties we conclude with start discussion of micromechanical predictions of elastic properties. Although the underling concept of composite materials go back to antiquing, the technology was essentially developed and most of the progress occurred in the last decades, and this development was accompanied by a proliferation of literature in the form report, conferences, journals and few dozen books. Composite having unique advantages over monolithic material ,such as high strength ,high fatigue life stiffness, low density and adaptability easily. Now days automobile and marine industries are need of better class of materials that need all versatile uses. In this paper different composite of AL, Mg prepared by different process. CNT has perfect physical and chemical properties and mechanics properties study . recent progress in magnesium matrix composite technology is reviewed. The conventional and new processes for the fabrication of magnesium matrix and aluminum matrix composites are summarized. CNT's distribution with composite matrix was traced characterized. The standard specimens fabricated using different process followed by machining. Samples are prepared at different process was then tested their properties like mechanical, physical, chemical. In mechanical tensile, compression test studied. Microstructure was also studied using an optical microscope.

Keyword:- Multiwall Carbon Nanotube(MWCNT),magnesium , Stir casting technique.

1.INTRODUCTION

Now days with the modern development need of developments of advanced engineering materials for various engineering applications goes on increasing. To meet such demands metal matrix composite is one of reliable source. Composite material is one of the reliable solutions for such requirement. In composites, materials are combined in such a way as to enable us to make better use of their parent material while minimizing to some extent the effects of their deficiencies. The simple term 'composites' gives indication of the combinations of two or more material in order to improve the properties. In the past few years, materials development has shifted from monolithic to composite materials for adjusting to the global need for reduced weight, low cost, quality, and high performance in structural materials. Driving force for the utilization of AMCs in areas of aerospace and automotive industries include performance, economic and environmental benefits. A composite material is a material consisting of two or more physically and/or chemically distinct phases. He composite generally has superior characteristics than those of each of the individual components. Usually the reinforcing component is distributed in the continuous or matrix component. When the matrix is a metal, the composite is termed a metal-matrix composite (MMC). In MMCs, the reinforcement usually takes the form of particles, whiskers, short fibers, or continuous fibers. Objectives for Development 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 precondition here is the improvement of the component properties. The development objectives for light metal composite materials are:

• Increase in yield strength and tensile strength at room temperature and above while maintaining the minimum ductility or rather toughness,
• Increase in creep resistance at higher temperatures compared to that of conventional alloys,
• Increase in fatigue strength, especially at higher temperatures,

• Improvement of thermal shock resistance,
• Improvement of corrosion resistance,
• Increase in Young's modulus,
• Reduction of thermal elongation.

In conventional casting processes, liquid metal ispoured into a mould and solidifies as heat is extractedvia the mould walls. The morphology of the growingsolid–liquid interface is typically dendritic. The natural progression of filling followed by solidification often leads to internal structural defects, such as entrained oxide or shrinkage porosity, which combine to yield a casting of relatively poor mechanical properties.

Operation of the stir caster

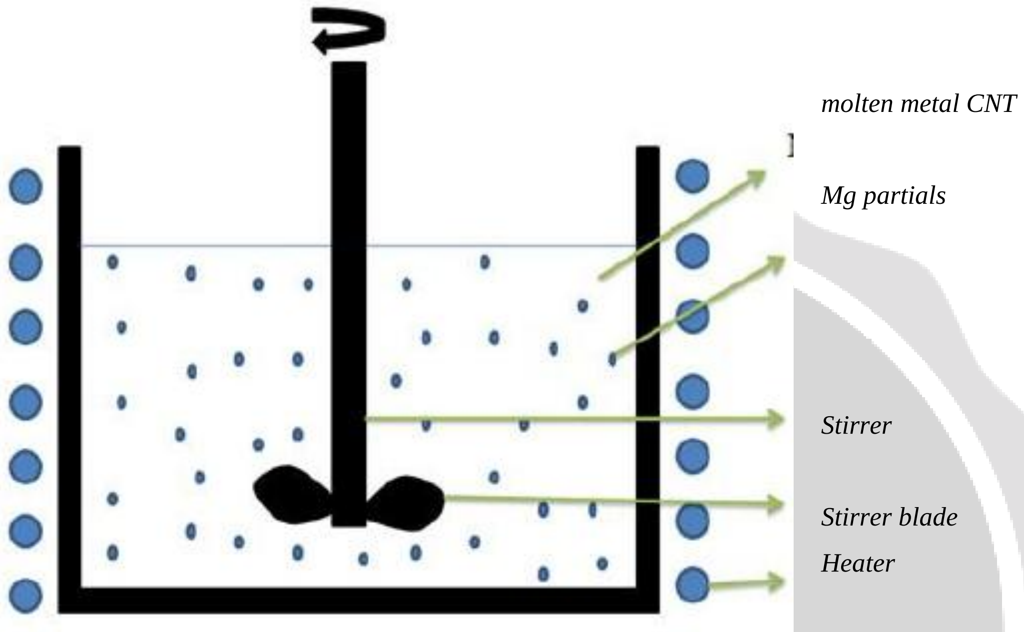


figure 1stir casting process

When setting up the stir caster before an experiment the rotor was first lowered into the crucible, Fig. 1. Its height was accurately adjusted to form a partial seal at the exit such that it was held concentrically during stirring. Only a partial sealing of the outlet was allowed to ensure that torque pick-up from the rotor-crucible interaction was negligible. An external plug attached tothe batch casting trolley provided a full seal at the exit. After the caster set-up, metal melted in an induction furnace was transferred to a resistance holding furnace where it was stabilised at a temperature 20 °C above the liquidus temperature. The melt was then poured into the stir caster furnace which had been preheated to MP °C.

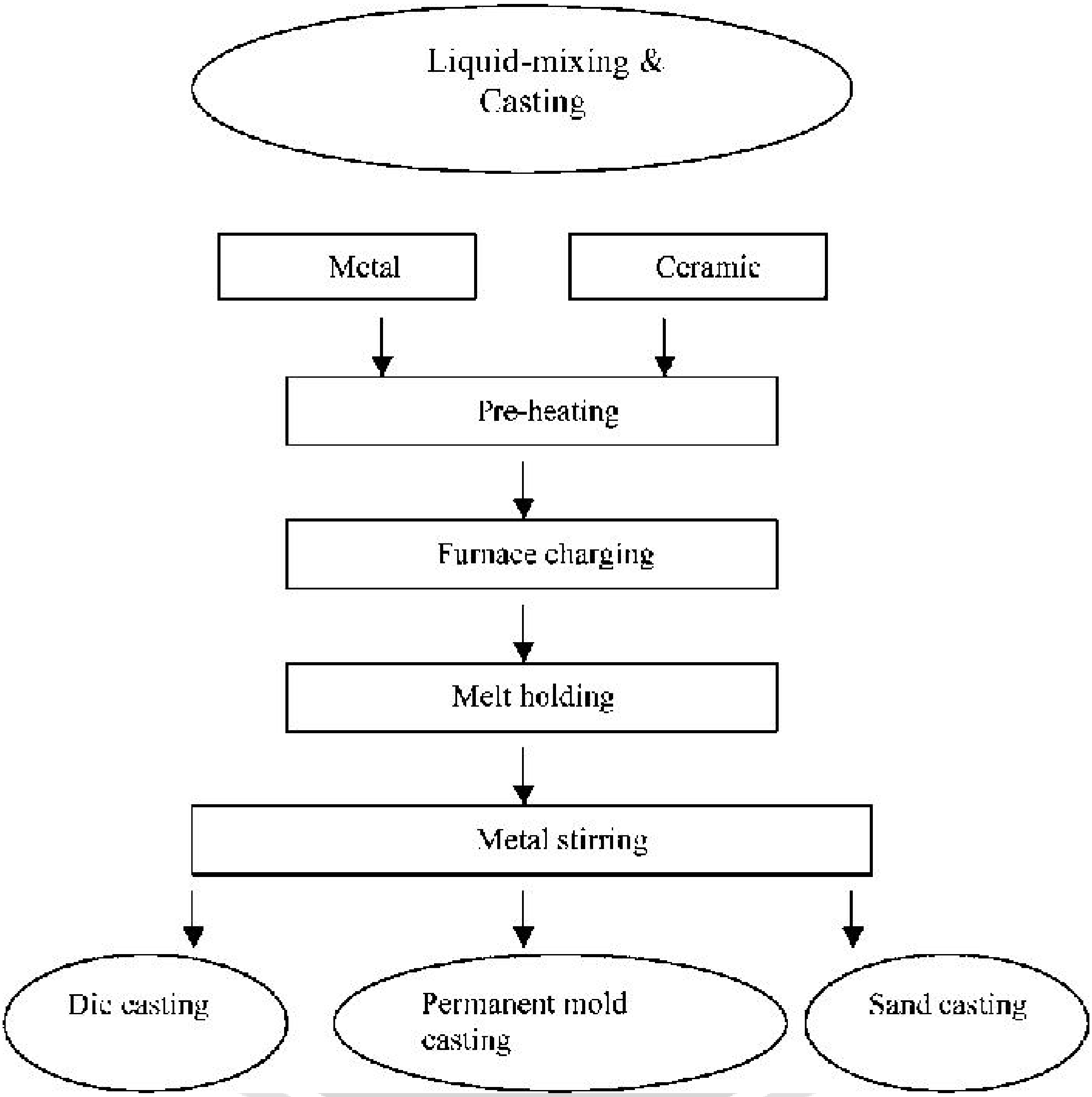


Fig 2.Process of stir casting

Once the temperature of the semi-solid melt (*T*ss) was stabilised, giving the desired *f*s, via the element controllers, rotation of the stirrer was started. After shearing the alloy at the specified shear rate and for the specified length of time, the rotor was raised, the plug on the batch casting trolley was released and the alloy allowed to flow into a cylindrical steel mould. Conventional gravity chill castings, poured from 20 °C above the liquidus, were also made in these moulds, for comparison purposes. The resultant bars were examined radio graphically. Quality indicator wire showed that a resolution of about 0.1 mm could be obtained from the procedure.

2. LITERATURE REVIEW

2.1 CNTs reinforced aluminium matrix composites

Fig.1Aluminum (Al) sample

Aluminium is the most widely used light metal material with good corrosion resistance and process ability. However, the intensity, wear resistance and high temperature properties of general aluminium and alufer are poorer. These properties can be improved when the aluminium matrix combined with carbon nano-tubes.

Weiping Xu et al developed multiple walls carbon nano-tubes reinforced aluminium matrix (MWCNTs/Al) com-posite. In this composite, multi-wall carbon nano-tubes were well-distributed and combined with matrix perfectly. But the multi-wall carbon nano-tubes in boundary zone and shoulder deformation zone were easy to agglomeration. After 5 stirring and friction processing, the average micro hardness of compo-site is 78HV. The results of Kelvin probe test showed that work values of each area are in the error range (±25mV). Hongqiao Qin prepared CNTs/Al composite powder. The quality of composite powder is affected by the dose of carbon nano-tubes, the optimum dose is 10%. Only satisfied the mill-ing time, can CNTs well-distributed in the aluminium matrix-es. But the excess of CNTs may increase the tendency of crack-ing. Junhui Nie et al. developed the W-CNTs/A1 and Founded that the performance of composite material was in-fluenced by the content of W-CNTs. When the content of W-CNTs is 0.75%, the performance is perfect, and the relative density is 99.5%, tensile strength increased by 28.3%, Vickers hardness increased by 11.0%, conductivity increased by 93.9%.

Table 1.AL-Properties

Crustal structure	face-centered cubic
Magnetic ordering	Paramagnetic
Electrical resistivity	2*(20°C) 28.2 nΩ.m*
Thermal conductivity	*237 W.m−1.K−1*
Young's modulus	*70 GPa*
Bulk modulus	*76 GPa*
Mohs hardness	2.75
Vickers hardness	167 MPa
Melting point	933.5 K, 660.3°C, 1220.6 °F
Boiling point	2792 K,2519°C,4566 °F
Liquid density at m.p.	2.375 g.cm−3

2.2 CNTs reinforced copper matrix composite materials

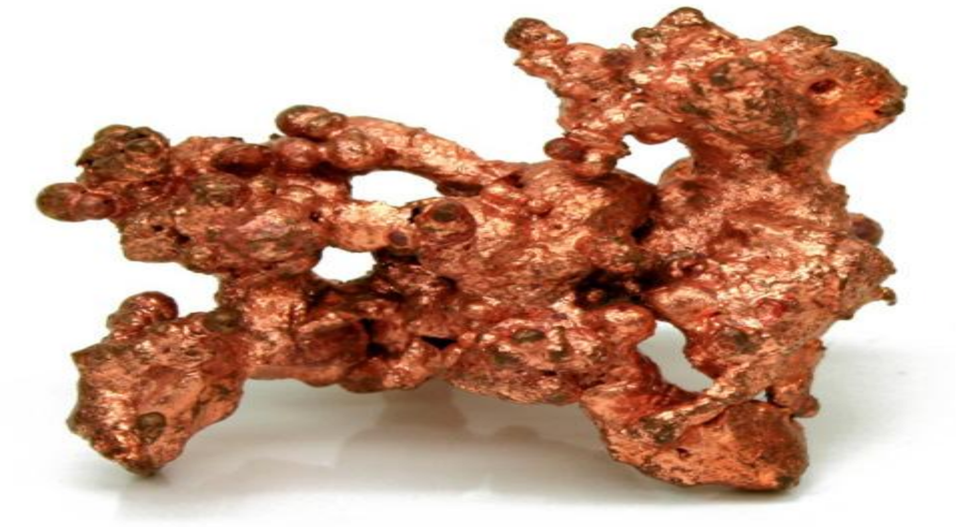


Fig 3 Cu-sample

As the widely needs of high strength and high conductivi-ty copper base materials in the lead frame and point electrodes and heat transfer coil in the fusion device, the study of copper matrix composites was promoted. CNTs have excellent me-chanical and electrical conductivity, it can disperse in copper matrix and strengthened copper. And can prepare CNTs rein-forced copper matrix composite materials with high tempera-ture strength, good conductivity and thermal conductivity.

Yinghui Zhang et al prepare W-20% C/Cu composite materials using CNTs as the strengthening phase. The content of CNT can affect the density and hardness of the composite materials. CNTs can play a role of fine-grain strengthening when it added into 20% W-Cu composite materials. The density and hardness of the material increased with the increase of addition amount of CNTs. Junhui Nie prepares CNTs/Cu composite material, and it has good interface bonding proper-ties. CNTs can improve the tensile strength of the material. Through the observation and study of materials, when the mass fraction of CNTs is 1%, it is combined with copper sub-strate interface good, stress transfer is also good, and tensile strength increased by 59.6%, electrical conductivity increased by 75%. Fei Meng et al using powder metallurgy technol-ogy with rolling annealing prepared CNTs dispersion strengthened copper matrix composites materials. The research showed that rolling technology can greatly improve the mate-rial density, the density is 78.7%before rolling, and the density reached 98.9% after rolling. The result also showed that there are large amounts of pore in materials, and rolling promoted the densification. At the same time, rolling technology also has a great effect on the hardness of material, and the brinell hardness increased from 49.2 to 96.4, the main reason is the density of the material increased, what's more, CNTs dispersion strengthened also make the material hardness improve. Because the squeeze and the shear of adjacent copper particles during the process of rolling extrusion, the agglomerated CNTs distributed into the particle clearance, the greater the rolling passes, the more force clusters CNTs, the tensile de-formation more fully, and its distribution is more uniform.

Table 2.Cu Properties

Crustal structure	face-centered cubic
Magnetic ordering	Diamagnetic
Electrical resistivity	20°C) 16.78 nΩ.m
Thermal conductivity	401 W.m−1.K−1
Young's modulus	110–128 GPa
Bulk modulus	140GPa
Mohs hardness	3.00
Vickers hardness	369 MPa
Melting point	1357.8 K, 1084.6°C, 1984.3 °F

Boiling point	2835 K, 2562°C, 4643 °F
Liquid density at m.p.	8.02 g.cm−3

2.3CNT-Iron (Fe) Composites

Fig. 4 Fe Sample

Iron is a chemical element with the symbol Fe and atomic number 26. It is a metal in the first transition series. It is the most common element (by mass) forming the planet Earth as a whole, forming much of Earth's outer and inner core. It is the fourth most common element in the Earth's crust. Iron metal has been used since ancient times, though copper alloys, which have lower melting temperatures, were used first in history. Pure iron is soft (softer than aluminium), but is unobtainable by smelting. The material is significantly hardened and strengthened by impurities from the smelting process, such as carbon. A certain proportion of carbon (between 0.002% and 2.1%) produces steel, which may be up to 1000 times harder than pure iron. Crude iron metal is produced in blast furnaces, where ore is reduced by coke to pig iron, which has a high carbon content. Further refinement with oxygen reduces the carbon content to the correct proportion to make steel. Steels and low carbon iron alloys with other metals (alloy steels) are by far the most common metals in industrial use, due to their great range of desirable properties and the abundance of iron. A sample of Iron is shown in Figure and its properties are presented in Table

Table 2.Fe- Properties

Crustal structure	body-centered cubic
Magnetic ordering	Ferromagnetic
Electrical resistivity	(20 °C) 96.1 nΩ.m
Thermal conductivity	80.4 W.m−1.K−1
Young's modulus	211 GPa
Bulk modulus	170 GPa
Mohs hardness	4.00
Vickers hardness	608 MPa
Melting point	1811 K, 1538 °C, 2800 °F
Boiling point	3134 K, 2862 °C, 5182 °F
Liquid density at m.p.	6.98 g.cm−3

2.4 CNTs reinforced magnesium matrix composites

Fig.5 Mg Sample

Developing lightweight and high strength carbon nano-tubes reinforced magnesium matrix composites through rein-forcing magnesium and magnesium alloys by CNTs have be-come a hot research field. The conventional method for developing CNTs reinforced magnesium matrix composites is stir-ring casting. Since the chemical activity of Mg is high, it can react with manyelements easily. When use stirring casting method, the harm from magnesium melt to CNTs is slight. Qiuyu Huang et al. studied the corrosion of CNTs/Mg in sodium chloride solution. When CNTs was added, compact net structure will be formed on the corrosion interface, it can prevent the invasion of Cl- and protect the alloy. The degree of corrosion is most slight and corrosion rate is lowest when the content of CNTs is 1.5%, the corrosion resistance increased by 9.79 times. The main compositions of corrosion product are Mg (OH) 2, MgO and CNTs, and this can be tested by the analysis of the surface and structure of mineral. CNTs can thinning grain size and increasing the corrosion resistance. Weixue Li et al analyzed the stress of each components of CNTs reinforced magnesium matrix composites when being loaded. The main strengthening mechanism is stress transfer-ring. The more the layer number is, the more sparse the dis-persing is, and this go against the raise of yield strength. Only within the specially appointed scope of CNTs length, can the yield strength rise.

Zhao Ping prepares the CNTs particu-late reinforced magnesium matrix amorphous composite ma-terial. Observing through transmission electron microscope found that carbon nanotubes particles combined with matrix perfectly, and XRD characterization also proved that the amorphous structure was not big changed. Compression test prove that the maximum compression strength and the fracture displacement were improved. The large area agglomeration of CNTs was not found. CNTs formed a lot of toughening nest structure in the matrix. But the change of macro plastic toughness material is not obvious. Zhou guohua [7] et al. pre-pared CNTs reinforced AZ31 magnesium matrix composites, and the effect of carbon nanotubes on corrosion resistant properties of magnesium alloys was tested. Doing the static salt water immersion test in 3.5% NaCl solution (mass fraction, the same below). Tests showed that the corrosion resistance improved obviously after adding CNTs. When the addition amount is 1.5% (mass fraction), the average corrosion rate dropped to 1.1069 mg/(m2·s).

Table 2.Mg- Properties

Crustal structure	Hexagonal closed packed
Magnetic ordering	Paramagnetic
Electrical resistivity	(20°C) 43.9 nΩ.m
Thermal conductivity	156 W.m−1.K−1
Young's modulus	45 GPa
Bulk modulus	45GPa
Mohs hardness	2.5
Vickers hardness	608 MPa
Melting point	923 K,650°C,1202 °F
Boiling point	1363 K,1091°C,1994 °F
Liquid density at m.p.	1.584 g.cm−3

3 THE PROBLEMS EXISTING

3.1 The well-distributed of CNTs in the matrix

The key step during the preparation of CNTs reinforced metal matrix composites is the well-distributed of CNTs in the matrixes. But it is easy to agglomerate since the high specific area and specific surface area of CNTs. When the agglomeration happens in the grain boundaries, the grain boundary strength will decrease greatly. The frequently used method to solve this problem is ultrasonic dispersion and mechanical milling of CNTs in the liquid phase, but the agglomeration will happen inevitably during the subsequent processing. Fur-the more, acid calcination and strong oxidation methods can add –OH and –COOH and other active groups on the sides and open ends of CNTs, and improve the dispersing of CNTs, but this also can't receive the theoretical calculated value.

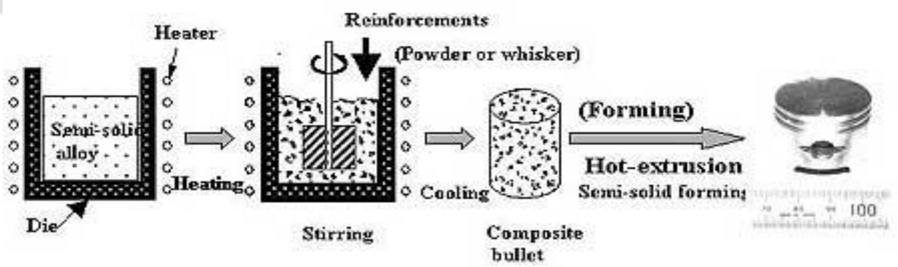
3.2 The compatibility of CNTs and matrix

Since the slight surface of CNTs, the wettability of the boundaries between wild phase and metal matrix is poor. Now, a majority of researches are adding CNTs without sur-face treatment to metal matrix directly, and the combine of CNTs and matrix is slight. To solve this trouble, surface treat-ment can be adopted. The usually method is coating metal matrix on the surface of CNTs. Coating Cu、Ni、Ag、Co、Mg on the surface of CNTs have been reported. After surface treatment, the boundaries of CNTs and matrix become strong-er and the dispersing of CNTs was promoted. Therefore, the surface treatment of CNTs during the development of CNTs reinforced metal matrix composite is necessary.

3.3 The orientation of CNTs in metal matrix

Now, the study of microcosmic structure of CNTs/metal composite only considering the relation between the content of CNTs and the performance of composite, rather than the mutual cooperation of CNTs and metal matrix, and neglecting the influence from the structures of CNTs and metal matrix. CNTs has the draw ratio which much bigger than whisker, but the size of caliber is much smaller than fiber. So the reinforce mechanism of CNTs is different from whisker and fiber. The possible reinforce mechanisms of CNTs are dispersion strengthening and bridging strengthening, but the related re-inforce models haven't set up.

4.METHODOLOGY



Experimental Method identified for the thesis work:
Step 1: Preparation of sand mould
Green sand or Molding sand as it is popularly known is used with binding material to form the cope and the drag or the cores of the mold
Step 2: Preparation of Specimen of various compositions
The alloying element CNT is mixed proportionately by weight in the ratio of different percentage. The percentage of alloying element to be used is determined by literature review and history for development of this work
Step 3: Machining of specimen for test.
The material needs to be sized as a square section with a notch as specified by the relevant IS standard (for Charpy/ Izod Impact test later)
Step 4: Checking Hardness over `Hardness testing
MachineBrinell Hardness Test to be carried out over `Llyod' testing machine
Step 5: Checking Impact Strength using `Charpy
Impact testing machine' Test for Impact Strength is carried out using the setup specified for Izod Impact Test
Step 6: Analysis and graphs

As per DOE/ Optimization to be conducted using Taguchi Method/ MinitabVarious Experiments are planned to be conducted on MMC samples by varying weight fraction of CNT(5%, 10%, 15%, 20 %, and so on) and size of CNT-Mgparticles to analyze the casting performance characteristics of CNT/Mg-MMCs.

Hardness

The Brinell hardness test shall be carried out over Brinell hardness tester. Six samples of CNT/Mg- MMC's for different sizes and weight fraction of Mgparticles shall be prepared. After test and hardness value on dial, the Brinell hardness values with reference to scale HRB shall be taken for all samples and shown by graphs.

Impact Strength

Impact Test to be carried out over Charpy Impact Testing Machine and results to be recorded. According to size and weight fraction of CNT particles Four Specimens CNT/Mg-MMC's of Square/roundcross-sectionof size with single V-notches are planned.

Microstructure

Metallographic samples are normally sectioned from the cylindrical cast bars. A 0.5 % HF solution is used to etch the samples wherever required. To see the difference in distribution of Mg particles in the CNT matrix, microstructure of samples are developed on Inverted type Metallurgical Microscope and weight fraction (5%, 10%, 15%, 20 %,) of CNT-Mg particles. Opticalmicrographs shows the distribution of CNT particles within the matrix.

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BIOGRAPHIES

1. 

Mr. WARANGHUSE SOMNATH L.

M.E. (Design Engineering)-appear

Mechanical Engineering,

Jaihind C.O.E.Kuran, Pune,India.

2. 

MANKAR R. L.

Assistant Professor,

Mechanical Engineering,

Jaihind C.O.E.Kuran, Pune,India.