EXPERIMENTAL INVESTIGATION OF MWCNT –Mg COMPOSITE TO FIND OUT MECHANICAL PROPERTIES BY STIR CASTING

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Abstract

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 Mg –MWCNT prepared by different process. CNT has perfect physical and chemical propertiesand 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. And what happen when proper mixing of MWCNT with Mg their density will increases or not ,the density and hardness measurement show what happen about weight of Nano composite.

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

1.INTRODUCTION

It is need of Automo1bile manufacturer to reduce the weight of vehicles in recent years .The Carbon nanotubes (CNTs) are increasingly attracting scientific and industrial interest by virtue of their outstanding characteristics. Magnesium (Mg) alloys are gaining more recognition as alightest structural material for light-weight applications, due totheir low density and high stiffness-to-weight ratio. As a result, magnesium alloys offer a very high specific strength among conventional engineering alloys. In recent years, ceramic nanoparticles, such as SiC, Al2O3nanoparticle and others, have been used to reinforce differentmetallic materials to form the metal matrix composites. The proposedmechanisms for strengthening metal-matrix composites(MMCs) were thermal expansion mismatch, Orowan looping,Halle etch relation and the shear-lag model. The potential of employing CNTs as reinforcements has, however, been severely limited because of the difficulties associated with dispersion of entangled CNTs during processing and the poor interfacial interactions between CNTs and polymer. To ensure effective reinforcements for polymer composites, proper dispersion and good interfacial bonds between CNTs and polymer matrix have to be guaranteed. Epoxy resin is the most common class of thermosetting resin used in various applications because of their high tensile strength and modulus, low shrinkage in cure, good chemical and corrosion resistance, high adhesion and dimensional stability. Epoxy resins have been widely used in practical applications such as adhesives, construction materials, composites, laminates and coatings owing to their excellent mechanical properties. The introduction of nanomaterials into the metal matrix israther difficult due to the harsh manufacturing conditionsemployed for processing the metal composites. The main challengesfor processing nano-MMCs are: a. reaching homogeneousdispersion of the reinforcing nanomaterials in the metal matrix.the formation of strong interfacial bonding and c. retention of thechemical and structural constancy of the nanomaterials , such ascarbonaceous nanomaterials, in particular preventing its oxidation.The addition of nanoparticles with high aspect ratio can enhancethe mechanical properties of the MMCs without resorting to heavymachining which induce substantial plastic deformation. ThusMMCs can lead also to improved stress corrosion resistance of theMg-alloys. Magnesium Matrix Composites are the class of Metal Matrix composites composed of magnesium as matrix materialthat is reinforced with intermetallic or ceramic fiber, whiskers or particulates like SiC, Al2O3, and CNTs etc. In the pastdecade, Al based MMCs have been the main research focus because of their excellent lightweight applications. In morerecent years, the superior stiffness-to-weight ratio of Mg based composites has made them attractive in weight savingapplications for the aerospace, electronics, automobile and sports equipment industries . The most commonly usedparticulate reinforcement in Mg is micron-size SiC, due to its low cost and easy availability. Addition of micron-sizeSiC particles to Mg will generally lead to enhanced yield strength, modulus, hardness, fatigue and wear resistance,better damping properties and thermal stability.

2.MATERIALS AND EXPERIMENTAL SETUP

MATERIAL-Multiwall carbon nanotube mixed with mg alloy. The properties of MWCNT and magnesium as follows **:**

Table 1: Properties of MWCNT

Properties	Values
Diameter	20-30nm
Length	3-8um
Purity	>98%(MWCNT)
Real Density	1-2g/cm2

Table 2: Properties of magnesium

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

EXPERIMENTAL SETUP

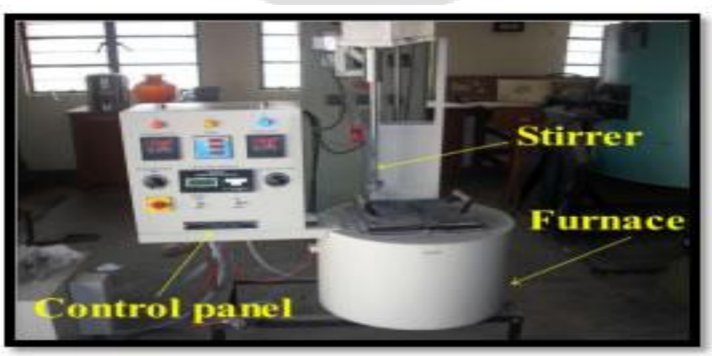


fig.1- stir casting process

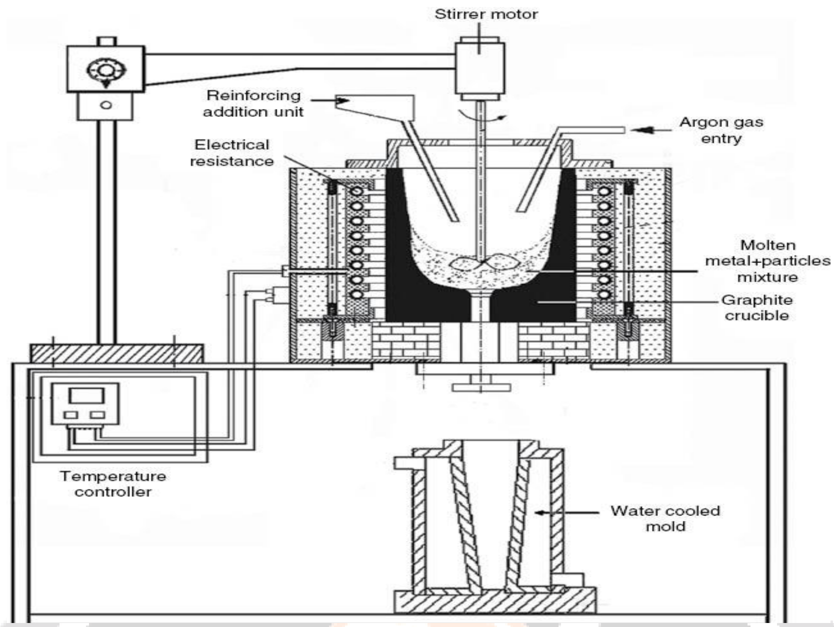
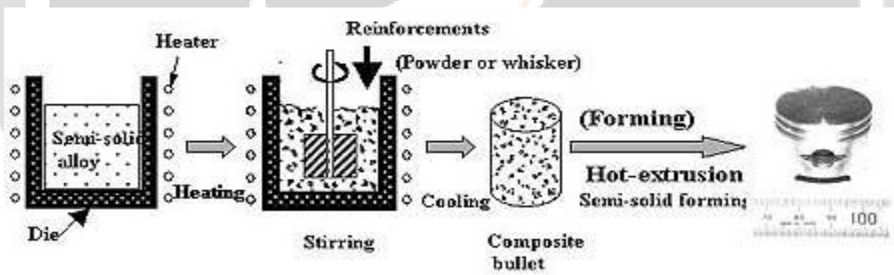


fig.2- stir casting process

3.METHODS:

A. Mg alloy and multiwall carbon nanotube were properly mixed for composition using stir casting process. Stirrer speed was used to mix the MWCNT added for casting process.



B. Preparation of composite The CNT powder was initially purified to remove the impurities like graphite, amorphous carbon etc. by adding concentrated Nitric acid, filtering and washing with de-ionized water followed by drying at some temperature. In stir casting process, MWCNT of different percentages was mixed with Mg alloy for some min at some rpm to get uniform mixing in the crucible. The mixture of a particular weight percentage of MWCNT and Mg alloy was molded shown in fig.1.

Figure 3: Mg Sample

Figure 4: MWCNT Sample

Fig 5:Formation of component

C.Density Measurement

Following fig shows the Experimental setup for density test a) Weight of specimen in air b) Weight of specimen in liquid

Fig 6:Experimental set up for density measurement

The experimental density of the specimen is calculated from equation,

$$\rho e = \frac{Wa * \rho x - Wx * \rho a}{Wa - Wx}$$

Where, ρe = Experimental density of the specimen

ρ_x = Density of the auxiliary liquid.

ρ_a = Density of the air.

Wa = Weight of specimen in air.

W_x = Weight of specimen in the auxiliary liquid.

The theoretical density of the specimen is calculated from equation.

$$\rho_{th} = Vr\, \rho_r + (1\text{-}Vr)\, \rho_m$$

Where, ρ_{th} = Theoretical density (g/cm_3)
Vr = Volume fraction of the reinforcement.

D. Hardness Measurement
Hardness is measured using Vickers hardness tester with a load setting of 10N and dual time of 15sec.
Vickers Hardness of the specimen is calculated by using the following equation:
VHN= (1.8544*P)/ $(d)_2$
Where, VHN = Vickers Hardness Number
P = Load applied in N
d = Indentation diameter in mm

4. Experiment, Results and discussions

4.1 Micro structural: The structure characterization studies were conducted on unreinforced and reinforced samples using scanning electron microscope. The composite samples were metallographically polished prior to examination. Characterization is done in etched conditions. Etching was accomplished using Double etchant reagent. The SEM micrographs of composite and wear debris were obtained using the scanning electron microscope. The images were taken in both secondary electron (SE) and back scattered electron (BSE) mode according to requirement. Microscopic studies to examine the morphology, micro structure were done by a JEOL 6480 LV scanning electron microscope (SEM) equipped with an energy dispersive X-ray (EDX) detector of Oxford data reference system. Micrographs are taken at suitable accelerating voltages for the best possible resolution using the secondary electron imaging.The casting procedure was examined under the optical microscope to determine structure .A section was CNT from the castings. It is first belted grinded followed by polishing with different grade of emery papers. Then washed and polished in clothes and again washed, dried and etched with Double etchant solution and then examined though optical microscope.

Fig .7 Optical Micrograph of MWCNT

4.2 Effect of MWCNT content on Density
It will be found that the theoretical density of Mg-MWCNT composites goes on increases or decreases as % of MWCNT increases. Density measurement results indicate that lighter nan composites have been obtained with the addition of MWCNTs. For Mg-MWCNT composites density increases or decreases d ueto the presence of some impurities like oxygen, nitrogen, etc

4.3 Effect of MWCNT content on Hardness
It will be found that the hardness of Mg-MWCNT composites suddenly increases or decreases as wt. % MWCNT.
The hardness increases with the increase in % of MWCNT content because as the % of MWCNT content increases it distributes throughout the matrix in more uniform way and there is better transfer of load from matrix to reinforcement. If a little MWCNT is added, the hardness of the composite increases because the MWCNTs fill the micro voids of the Mg particles. However, when large amount of MWCNTs are added, the excess MWCNTs that remain after filling the micro voids form conglomerates with the Mg particles. This conglomeration interrupts the casting and causes defects.
The amount of increase in the hardness in the present work will found and hence found significant to affect the ductility of the material compared to that of pure Mg.

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REFERENCES

- 1. Xu Weiping, Xi Lihuan, Xing Li, et al. Studies on Uniformity of MWCNTs/Al Composites by Friction Stir Processing [J]. Journal of Nanchang Hangkong University (Natural Sciences). 2011, 25(4): 19-23
- 2. L.Girisha and Raji George Studied on Properties of Multi Walled Carbon Nanotube Reinforced Aluminum Matrix Composite through Casting Technique, International Journal of Engineering Research & Technology (IJERT), ISSN: 2278-0181, ISSN: 2278-0181
- 3. Zhang Yinghui, Tian Haixia, Zhu Gensong, et al. The density and hardness of W-Cu composite materials affected by nanotubes [J]. Nonferrous Metals Science and Engineering. 2012, 3(3): 33-35
- 4. Tang Qihua, Zhou Xiaohua. Study on the Wearable Performance of Carbon Nanotube/Zinc Alloy Marix Composites[J]. Journal Os Southern Institute of Metallurgy. 2004, 25(5): 14-16.
- 5. Huang Qiuyu, Zeng Xiaoshu, Wu Jicai, et al. Corrosion Behavior of Carbon Nano-tube/Mg-Zn Composite in Sodium Chloride Solution [J]. Hot Working Technology. 2011, (6):100-106.

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