ISSN No:-2456-2165

Investigation of Egg Shell and Alumina Reinforced with Magnesium Matrix Composite

L.Subash[1] U.Natarajan,[2]
[1,] PG Scholar, Manufacturing Engineering, ACGCET, Karaikudi, Tamilnadu, india.
[2]Associate Professor, Department of Mechanical Engineering, ACGCET, Karaikudi, Tamilnadu, India.

Abstract:- In Aerospace and Automotive industries, the demand for lighter materials is increasing drastically. The main advantage of Magnesium Metal Matrix Composites over Aluminum Metal Matrix Composites and there is an additional (15-20%) weight saving. Magnesium reinforced with carbonized, uncarbonized Egg shell and alumina have significant advantage over conventional materials. Generally, these reinforcements are used to improve the hardness and tensile strength of metal matrix composites and also improve the corrosion resistance of materials. In this present work, we have performed two specimen of Magnesium with reinforcement, 4% of Alumina and 6% carbonized and uncarbonized Egg shell using casting assisted by stir casting method. The specimens were subjected to Mechanical tests such as Micro Vickers Hardness test, compression test, tensile test and impact test. In addition, the corrosion study of these uncarbonized and carbonized reinforcement was carried out and analyzed. This composite technique employed to replace the existing aluminum alloys used in the automobile and aerospace industry without compromising on its properties.

Keywords:- *Magnesium (Mg), Alumina (Al_2O_3), Uncarbonized Egg shell (UES), Carbonized Egg shell (CES), Egg Shell Powder (ESP)*

I. INTRODUCTION

The ever-increasing fuel price has led to a renewed urgency to address the issue of weight reduction in the aerospace and automotive sectors. Since the early 1960, there's demand for new and improved engineering materials with advancement of modern technology concentration in the areas of automotive, aerospace industries had forced a rapid development of metal matrix composites as some MMCs like Al-MMCs and Mg-MMCs were significantly lighter than metals and alloys. In Automotive and Aerospace industries, the demand for lighter materials is increasing exponentially. The main advantage of Magnesium Metal Matrix Composites (Mg-MMCs) over Aluminium Metal Matrix Composites (Al-MMCs) is that, there is an additional 15-20% weight saving without having to compromise on properties [1]. An important factor which is to be considered in producing MMCs is cost of production. The costs involved should be as economical as possible. Also, casting technique is used for the manufacture of complex parts. Hence, stir casting a simple and cost effective technique is used in this study, followed by squeezing, under the pressure from a hydraulic ram in an enclosed die. This is done to minimise casting defects like blow holes and porosity. Though the costs involved in production of Magnesium metal matrix composites are relatively higher when compared to that of aluminium metal matrix composites, the benefits accrued more than compensates the costs involved. The main parameters involved in stir casting method are stirring speed, Holding time, Stirring time and Size of reinforcement particles [2]. A stir casting method with a melt holding and stirring at a temperature of 680◦C can be successfully utilised to synthesise reinforced magnesium based metal matrix composites with minimum porosity. The uniform distribution of SiC particulates and good SiC–matrix interface bonding indicates the suitability of present processing technique [3]. The purpose of fabricating metal matrix composites is to decorate the mechanical properties like hardness, tensile strength, ductility etc. and also to reduce their wear rate. MMCs produced by including reinforcement material in the metal. The desire of reinforcement material is very important according to its field of application. The reinforcement of Eggshell has poultry is an influential sector in Agriculture in India and has an average growth rate of 6% in egg manufacturing in step with annum. The hen population of India is 489 million that produces 47 billion eggs per year and ranks third highest among egg producing countries in the world.

Fig1:- Waste eggshell producing soil pollution [4].

Thus egg shell may be utilized as a biodegradable waste as a low cost material for reinforcement within the matrix and can be utilized as a low cost reinforcement in the matrix for composites [4]. Egg shells are biodegradable so it may be utilized as a low cost reinforcement in the matrix for composites.

About 95% of the dry Eggshell is calcium carbonate weighting 5.5geams. Eggshell contains around .3% phosphorus and .3% magnesium and signs of sodium, potassium, zinc, manganese, iron and copper [5]. To study that impact of uncarbonized Eggshell Weight percentage

ISSN No:-2456-2165

on mechanical properties of composite material developed by Electromagnetic stir casting technique. The mechanical properties are tensile modulus, flexural hardness and stiffness have been extensively progressed [6]. The mechanical properties, tribological properties and microstructure of Al6061-SiC and Al7075-Al2O3. Weight percentage of reinforcement material vary from 2%-6% and research proven that tensile strength and hardness of the composite material increases with increase in the weight percentage. Wear rate of Al6061-SiC is better than Al7075-Al2O3 composite [7]. Magnesium alloys are this type of lightweight metallic alloys currently being investigated, due to its low density, 1.74 g/ cm^3, and high mechanical stiffness. The mechanical benefits of magnesium, however, are contrasted by a high corrosion rate as compared to aluminium or steel. Because of magnesium's electrochemical potential, as illustrated in the galvanic collection, it corrodes easily in the presence of seawater. The high corrosion of magnesium has relegated the alloy to use in areas unexposed to the environment, consisting of car seats and digital boxes [8].The corrosion behaviour of Mg, AZ31 and AZ91 has been evaluated in 3.5% NaCl solution using weight reduction, Electrochemical polarization and impedance measurement. Carrion rate derived from the weight losses demonstrated the occurrence of steeply fast corrosion reaction on AZ91 alloy after three hours of immersion, indicating the start of galvanic corrosion [9]. A chassis serves as the basic foundation which gives strength to the body and on which all the parts of a machine rest. An example of a chassis is the base structure of a car. That mass or weight reduction is an important issue in automotive industry. Chassis is a prominent structure for a body, which takes the loads during serious accidents, costly recalls; chassis too has a great impact on product image. Accidents, costly recalls; chassis too If any failure occurs in chassis it will leads to collapse of whole vehicle system which cannot be replaced easily. The chassis structure must safely support the weight of the vehicle components and transmit loads that result from longitudinal, lateral and vertical accelerations that are experienced in racing environment without failure [10].

II. PREPARATION OF EGG SHELL PARTICLES

Uncarbonized Egg shell: The Egg shell (Fig.1) were collected from local households; they had been then washed with demineralized water to eliminate any foreign objects and the skinny outer membrane

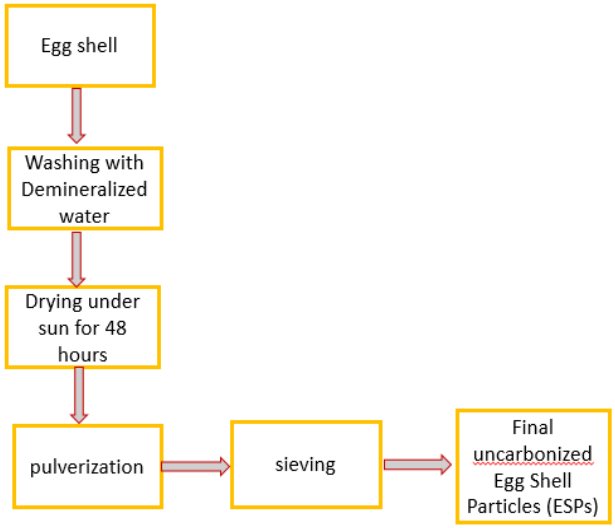

Fig 2:- Preparation of Egg Shell Particles.

The Egg shell had been then sun dried for duration of 48 hours in dry condition. The dried Egg shell were then pulverized to attain fine powder (fig.2) with the help of a grain miller at 400 rpm. The obtained powder was passed through sieves of required size so as to attain particles with uniform size distribution.

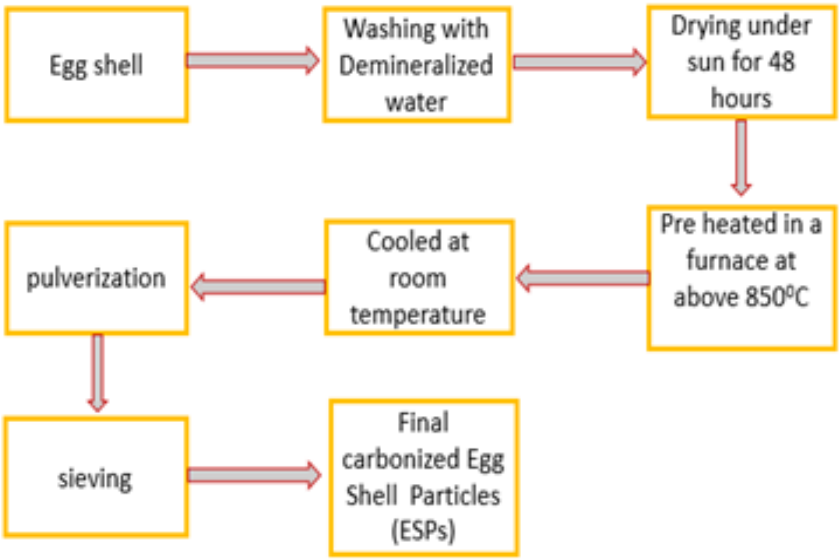

Fig 3:- Uncarbonized Egg shell Powde

ISSN No:-2456-2165

Corbonized Egg shell: The Egg shells had been collected from local areas.And then Egg shells Had been then washed with water to remove any impurities; such as dust and Egg liquid.

Fig 4:- Preparation of Egg Shell Particles.

The thin outer membrane. The Egg shells had been then solar dried for period of 48 hours.To obtain carbonized Egg shell powders,the Eggshell were first kept in the furnace(fig 5) preheated to a temperature of 1000 ℃ for a period of 60 minutes (fig 6) and then transformed to powder usage of the Egg shell powder were then pulverized to obtain fine powder with the help of a grain miller at 400 rpm after cooling to room temperature. The obtained powder was passed through sieves of required size so as to obtain particles with uniform size distribution.

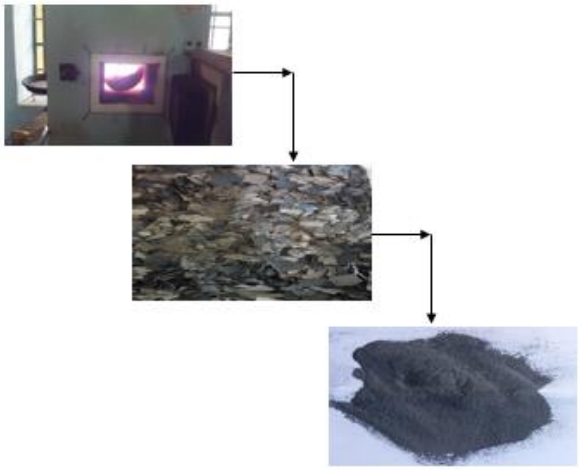

Fig 5:- Process carbonized Egg Shell Powder

III. PREPARATION OF CASTING

Magnesium matrix composites are the two compositions reinforced. They are (mg- Al_2O_3-uncarbonized egg shell), reinforcement of 10 vol.% alumina(29g) and uncarbonized egg shell(44g) second composition (mg-al2o3-carbonized eggshell), reinforcement of 10vol.%alumina(29g) &8vol.% carbonized egg shell(44g), were produced by the stir casting process. The size of the reinforcement particles are of 25-50 μm for alumina and 70 μm for Egg shell.

The main operation was done on stir casting machine with vacuum casting. The machine consists of crucible and furnace the crucible is placed on the top end of the machine. The reinforcement (alumina and eggshell) particles are put in the crucible.

Fig 6:- Stir casting machine.

ISSN No:-2456-2165

The main purpose of putting the reinforcement particles reaches up to temperature of 200℃. A valve is placed at the bottom of the crucible which preheating the valve at bottom is closed. Simultaneously furnace which is at the mid of the machine is also preheated to a temperature of 800℃. This temperature is maintained for a period of 2hrs. After preheating of furnace, Mg ingot of 760g placed in the furnace. The melting temp of Mg ingot is 750℃ and the Mg starts to melt in 1/2hr. A stirrer is placed on the top is made to move down by the use of hydraulic press and it starts to rotate by means of servomotor. The stirrer enters the furnace from top to bottom and starts to stir the melted Mg. The reinforce preheating crucible value which is placed at the end of crucible is opened and the preheated particles come out through a hole of 5mm into the furnace.

The composition of the product have Magnesium as a matrix material and its reinforcements is alumina and Un carbonized eggshell. A flat shaped specimen is acquired without any impurities.

Fig 7:- Samble1 (Mg+ Al_2O_3+UES)

The second composition of the product have the Magnesium as a matrix material and its reinforcements is the alumina and carbonized eggshell. Same as like the first specimen, second specimen is also acquired without any impurities.

Fig 8:- Samble2 (Mg+ Al_2O_3+CES)

IV. MECHANICAL TESTING

➢ *Tensile Test*

The Tensile test is a destructive test process that provides information about the Tensile strength, % of Elongation, yield stress and toughness etc. In this work, the tensile properties of the developed composites were obtained using 25 kN servo-hydraulic UTM. The ASTM E8 standards dimensions for conducting tensile test.

The tensile take a look at specimen before and after fracture are proven in Fig.11, 12 below. Results decreased that tensile strength of the Mg-alumina matrix by 107.32 MPa in the case of uncarbonized egg shell and 84.54 MPa in the case of carbonized particles *(Fig.9).*

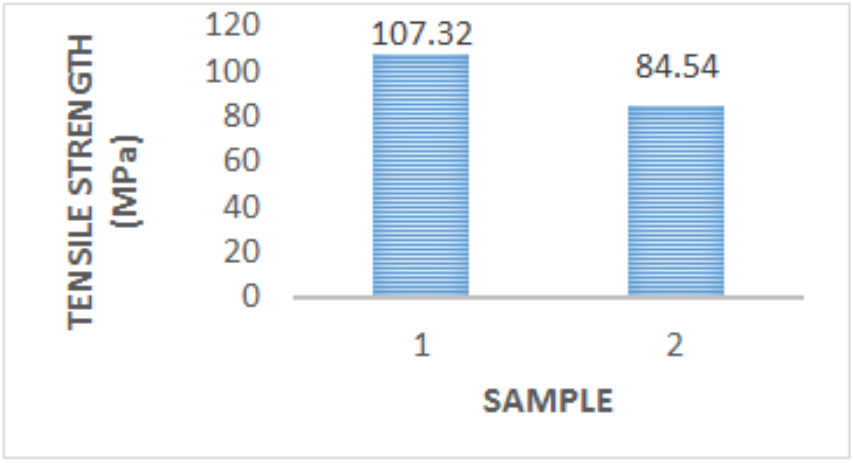

Fig 9:- Comparison of Ultimate Tensile Strength of Two composites

There changed into a decrease within the % Elongation values after the addition of CESs to the Mg-Al_2O_3, Eggshell matrix.

ISSN No:-2456-2165

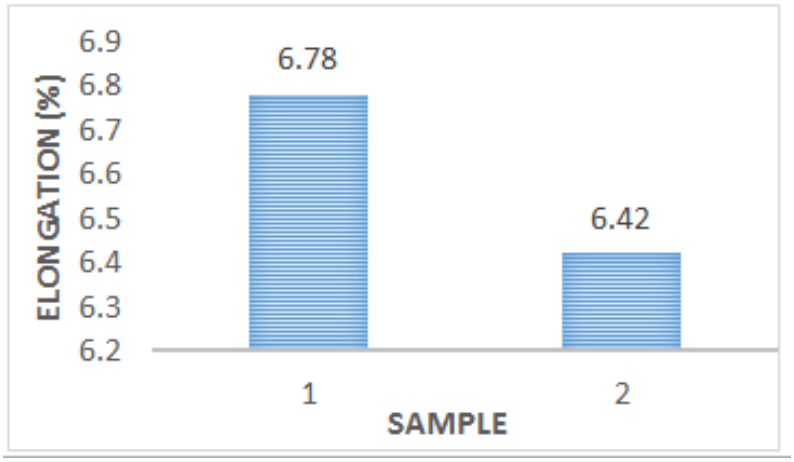

Fig 10:- Comparison of Elongation of Two composites.

This the Mg-Al_2O_3, un carbonized Egg shell is 6.78% Elongate and Mg-Al_2O_3,carbonized Egg shell is 6.42% Elongate.

The yield stress values after the addition of CEPs to the Mg-Al_2O_3, Egg shell matrix. This the Mg-Al_2O_3, un carbonized Egg shell is 87.27MPa yield stress and Mg-Al_2O_3, carbonized Egg shell is 73.56 MPa yield stress.

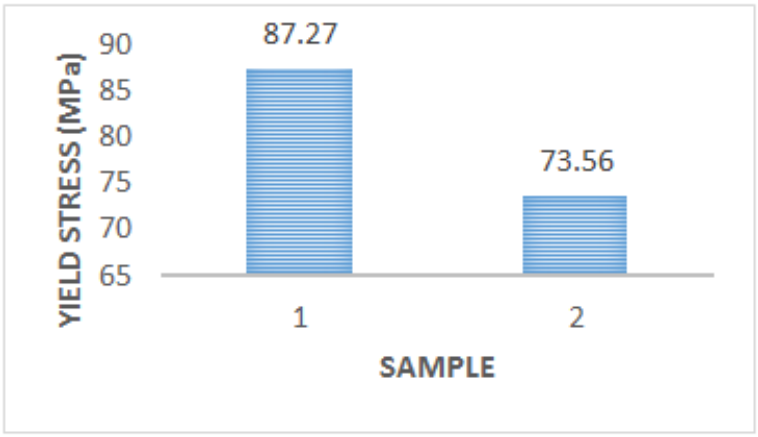

Fig 11:- Comparison of Yield stress of two composites.

Fig 12:- Before the Tensile test.

Fig 13:- After the Tensile test.

ISSN No:-2456-2165

➢ *Compression Test*

The compressive strength of Mg- Al_2O_3, Carbonized Egg shell composite and Mg- Al_2O_3, Un carbonized Egg shell composite increased by 1.113% respectively. Magnesium matrix around reinforcement powder flow away in the direction perpendicular to the applied load that reduces load transfer ability of the matrix and leads to material failure.

The compression take a look at specimen before and after fracture are show in (fig 14 and 15).

Fig 14:- Before the Compression test.

Fig 15:- After the Compression test.

Results decreased that Compressive strength of the Mg-alumina matrix by 122.13 KN in the case of un carbonized Egg shell and 109.74 KNin the case of carbonized Egg shell.(fig.*16).*

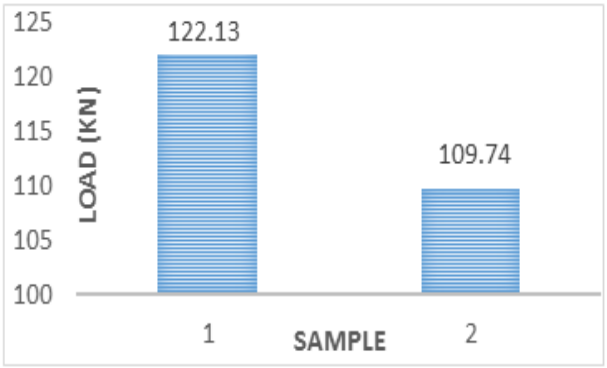

Fig 16:- Comparison of Compression Strength of Two composites.

➢ *Hardness Test*

The project we are using micro Vickers hardness test. In this method intender has the material of diamond intender. And intender has the shape of pyramid with a square base and an angle of 136°. The intender penetrate the work piece by 10 to 15 seconds. In our project we are making two different composition of material. First sample casted.

By base metal of magnesium and reinforcement of alumina and Un carbonized Egg shell.

LOCATION	HV 0.5Kg
1	38
2	36
3	37

Table 1:- Vickers hardness test result sample 1

The other sample prepared by base metal of magnesium and reinforcements of are alumina and Carbonized Egg Shell.

LOCATION	HV 0.5Kg
1	41
2	38
3	40

Table 2:- Vickers hardness test result sample 2

➢ *Impact Test*

Impact testing is of enormous importance. A collision between to objects an often result in damage to one or both of them. The damage might be scratch, crack, Fracture or break. In the magnesium matrix composite specimens were analyse the strength of impact by izod Impact test machine. Impact testing is resisting about impact. This is often called a material's toughness. In impact test principles of first we have to prepare v notch in the specimen. And then impact strength to be calculated.

SAMPLE	IMPACT VALUES IN (J)
1	6
2	4

Table 3:- Izod impact test value

ISSN No:-2456-2165

V. DENSITY TEST

The Project we are using two type of reinforcement one is Carbonized Egg shell and another one is Un carbonized Egg shell. This eggshell powder was Density analysed by weight loss method.

- *Un Carbonized Egg shell= 1.55 g/cm^3*
- *Carbonized Egg shell = 1.47 g/cm^3*

VI. CONCLUSION

In this project experimental study, stir casting machine were used in the magnesium matrix composite and significant conclusions on performance were drawn as given below.

- Successful making of Carbonized Eggshells and Un carbonized Egg shell Reinforcement.
- Addition of 6wt% of Un carbonized Egg shell particales as reinforcement in Magnesium matrix improves the Hardness,Tensile strength ,yield strength and compressive of the matrix material compared with carbonized Egg shell reinforcement in magnesium matrix.
- As per results 6wt% of carbonized eggshell was improving the hardness and corrosion rate. Compared with Un carbonized Egg shell reinforcement in magnesium matrix composite.

REFERENCES

[1]. S.Rohit, A.RazalRose, B.Rakshat (2017) Development of Magnesium Composite Material by the method of Stir Casting for applications in Automotive and Aerospace. *Industries,International Conference on Precision,meso,micro and nano Eengineering (COPEN10)*, pp429-432.

[2]. N.Ramanaiah.(2016) Intermetallic- reinforced boron caebide (B_4C) composites produced through stir casting processing,*International Journal CMAIJ,*Vol no:*1(2),*pp*58-66.*

[3]. Palash Poddar, V.C. Srivastava, P.K. De, K.L. Sahoo.(2007), Processing and mechanical properties of SiC reinforced cast magnesium matrix composites by stir casting process, *Materials Science and Engineering* A 460–461 , 357–364.

[4]. Razia Malik,Seema, Nitin Kumar et al, (2017)Fabrication and Mechanical Testing of Egg Shell Particles Reinforced Al-Si Composites, *International Journal of Mathematical,Engineering and Management Sciences,* Vol no 2(1), pp 53–62,

[5]. vikas verma, nishant, mandeep gill, et al,(2018), Effects of waste eggshells and silicon carbide addition in the synthesis of aluminium alloy 6061 hybrid green metal matrix composite, *International Research Journal of Engineering and Technology (IRJET),*Vol no:05(06),pp 1413-1419.

[6]. Shashi Prakash,Nagendra Kumar,Manish.(2019) Effect of Uncarbonized Egg shell Weight Percentage on mechanical properties of composite material developed by Electromagnetic Stir casting Technique, *International Information and Engineering Technology Association.*Vol no:*27,* pp*101-107.*

[7]. Vikrant Rana1, Amit Singla and Amit Chauhan.(2016) Study on Mechanical Properties and Microstructure of Aluminium Alloy 63401 Reinforced with Alumina Powder.*Indian Journal of Science and Technology*,Vol no: 9(36), pp1-10.

[8]. D.Thirumalaikumarasamy,K. Shanmugam, V. Balasubramanian (2014) Comparison of the corrosion behaviour of AZ31B magnesium alloy under immersion test and potentiodynamic polarization test in NaCl solution. *Journal of Magnesium and Alloys*, Vol no: (2), pp36-49.

[9]. vijayan, s. n., sendhilkumar,s., kiran babu,k.m. (2015), design and analysis of automotive chassis considering cross –section and material., *international journal of current research.,Vol no:*7(05),pp 15697-15701,.

[10]. Himanshu Hiraman Rathod, Sanjay Kumar, Vinit Goel .,(2018). A Review on Analysis and Design of Vehicle Chassis and its Materials, *International Journal of Scientific & Engineering Research.*,Vol no: 9 (3)., pp 45-47.

[11]. K. Soorya Prakash, P. Balasundar, S. Nagaraja, P.M. Gopal , V. Kavimani.(2016). Mechanical and wear behaviour of Mg–SiC–Gr hybrid composites, *Journal of Magnesium and Alloys.*,Vol no:(4)., pp197–206.

[12]. www.sciencedirect.com

[13]. www.ieee.org