Experimental Investigation And Mechanical Properties Al6061 Reinforced With Copper Particles

Parasa Yugandhar Babu[1], Phani Kumar Jogi[2], P Ravindra Babu[3], K Ramakanth[4]
[1] Dept of Mechanical Engineering
[2, 3, 4] Faculty, Dept of Mechanical Engineering
[1, 2, 3, 4] Gudlavalleru Engineering College, Seshadari Rao Knowledge Village, Gudlavalleru: 521 356, A.P, INDIA.

Abstract- *in this paper reveal an aluminum alloy Al 6061-copper particulate metal matrix composites was prepared with three different volume fractions of reinforcement 75 µm (2%, 4% and 6%) using stir casting route. The particles distribution and mechanical, physical properties are observed and the hardness, compression and density are to be explained mechanical and physical properties. Finally it was observed from the results that the hardness, density and compression strength increased with increase in wt % of reinforcement.*

Keywords- Aluminium-6061, copper particles, Stir casting Process, Mechanical properties.

I. INTRODUCTION

"Design" concerns Innovation and Renovation in all areas of scientific issues. As an Engineer the main aspect to fulfil is, minimizing of cost, maximizing the span of life and reliable for work. If it is satisfy these things the design has value, if not regulates these aspects the design is failed. While coming to the main stream of research, composites has specific importance in today's environment. Before designing of any component selection of material plays vital role. Convectional material gives less benefit than the composite materials. These composite materials are dividing into different matrix composites according to the area of application. The main purposes of these composites are improving the properties of the materials which lead to high performance and acceptable quality of material. MMC'S have some good properties like high strength, specific modulus, damping capacity, stiffness, good wear resistance and weight saving. Aluminium metal matrix composites acquires most interest because of having some effective properties comparative to the other alloys. While seeing according to the strength, stiffness and tribological property it has significant improvement by addition of reinforcements.The choice of reinforcement among the wide range of materials available in outside is a big task. Selection of material should be adaptable to manufacturing process for their applications.

There are different process techniques which are used in manufacturing process. Among those I adapted Stir Casting technique cause of some features like easy to install, high efficiency etc. Most of the industries are using this process for manufacturing the composite materials.

Mixing of reinforcement in liquid base mental is not an easy task to accomplish, by stir casting it made easy and regulating the casting defects also.

II. MATERIAL AND METHOD

2.1 Matrix material and reinforcement:

For present research Aluminum- 6061 in the form cylinder of ϕ80 mm was selected as matrix material with copper as reinforcement. The chemical composition of Al-6061 was tabulated in Table1

Table 1 Chemical Composition of Al-6061.

Constituent	Si	Fe	Cu	Mn	Mg	Cr	Zn	Ti	Al
%	0.65	0.7	0.25	0.15	0.9	0.07	0.25	0.15	Reminder

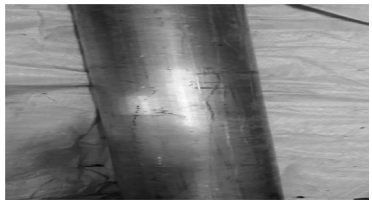

Figure 1: Al 6061 bar

figure 2: copper powder

In these composites the Al 6061alloy properties low weight and high strength material and having the density of this alloy is 2.7 gr/c.c. in terms of reinforcement the copper

powder have high refractive index and density of the material is 8.96 gr/c.c.

2.2 Fabrication of composites:

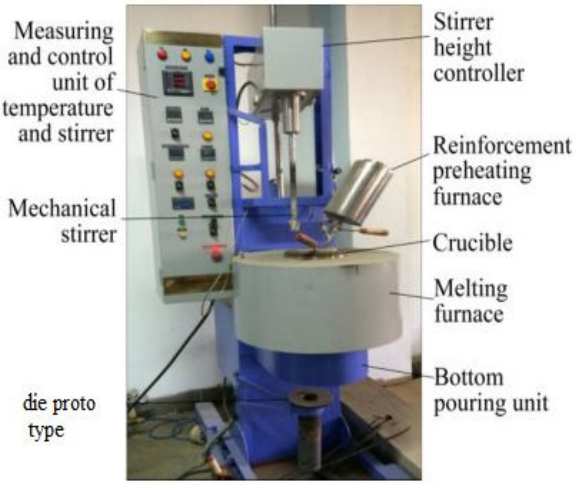

Figure 3: bottom pouring stir casting machine

Perfect mixing of two or more metals into single composite is a great task to do effectively. Past few decades researchers done a great job on it, and finally find the solution i.e.; none other than STIR CASTING. Stir Casting is employed in every industry due to their easy of adoption and installation. In Stir casting, base metal is melted above the melting point and after complete melting of metal, we have to add the reinforcement material slowly into the molten metal. Before we adding the reinforcement in the machine we sholud pre-heat it below melting temperature to remove the wettability in it. Allow the Stirrer to rotate after adding the reinforcement, to mix both base metal and reinforced metal into a Metal Matrix Composite.

III. EXPERIMENTAL DETAILS

3.1 compression test:

The samples are prepared for compression testing as per ASTM standards. The compression tests are conducted on universal strength testing machine. The results of compression test are shown below table 2

Figure 4: universal testing machine

3.2 Density Tastings:

Density is defined as, mass of a substance per unit volume. Mathematically it is donated as mass divided by volume. Theoretical density of aluminum 6061 is 2.7 g/cm^3. It is useful to check the Density of various liquids and material weighting up to 99.99gm measure of this by following three methods:

1) *In Water:* Solid sample testing in water
2) *In Liquid:* Solid sample testing in another liquid

Figure 5: density tester

3) *Of Liquid:* Liquid sample testing with known solid sample micro controller based unit.

3.3 Brinell hardness test:

Hardness test is carried out on the composite samples using Brinell hardness testing apparatus with 10 mm diameter and load of 187.5 kg. The loading time is 30 secs. Three readings are taken for each specimen and mean value is considered.

Figure 5: hardness tester

IV. RESULT AND DISCUSSION

4.1 mechanical and physical properties:

Table 2: properties of test materials

Type	Hardness (B.H.N)	Compression strength (N/mm^2)	Density (gr/c.c)
Al6061	91.587	483.1	2.68
Al6061+2% Cu	105.001	496.22	2.73
Al6061+4% Cu	118.62	625.44	2.76
Al6061+6% Cu	86.53	686.35	2.94

4.2 Density:

Table 2 clears, the density of the composites increased with increase in the content of copper, this is because of the presence of high density Cu in a fraction of composition.

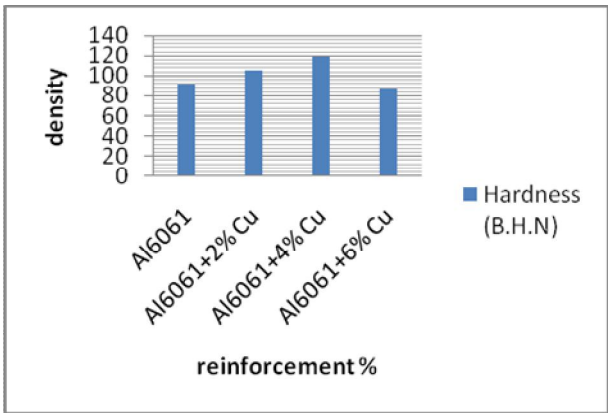

Figure 7: density comparison

4.3 Compression strength:

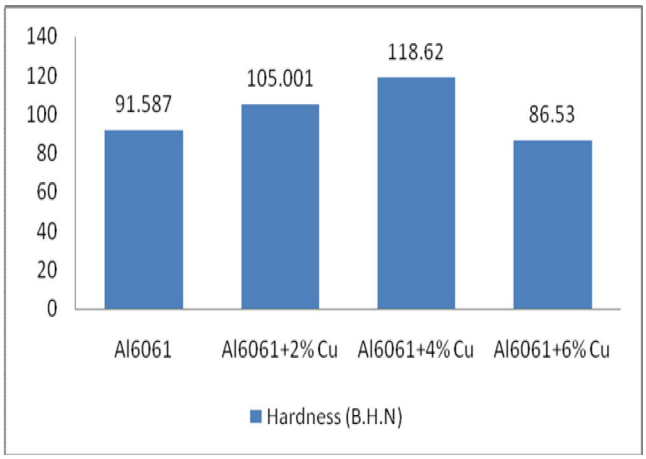

Figure 8: compression strength comparison

Figure clearly shows the variation of the compressive strength of the composites with increase in the reinforcement concentration in them. The Compressive strength values of AMCs with varying wt. % of Cu reinforcements. From the table we can see that the Compressive strength value of Al+3%Cu is greater as compared to remaining one.

4.4 hardness:

Below chart shows, the relation between Hardness and wt. % of reinforcements of fabricated composites. From the Hardness results, it is observed that the Hardness of AMCs is greater than unreinforced Al. Increasing of Hardness in AMCs can be attributed due to the bonding between reinforcements and the base mental.

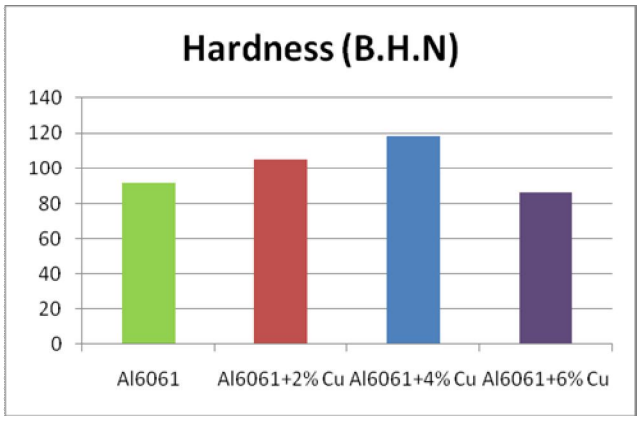

Figure 9: hardness difference

V. CONCLUSION

A. Compressive strength was increased by increasing of weight percentage of the reinforcements. The compressive strength of Al-6061 is 483N/mm^2. The maximum compressive strength attained at 6% of the fabricated composites i.e.686.65 N/mm^2

B. Density of the fabricated specimen increasing with an increase weight percentage of reinforcement. The maximum density observed at 6% i.e. 2.94 g/cm^3.

C. Hardness of the pure Al-6061 is 91 BHN. The hardness was increased by varying of weight percentages of the reinforcements and that is noticed at 6% having 86.56 BHN.

REFERENCES

[1] M.k surappa, "Deformation mechanisms and texture evolution of in-situ magnesium matrix composites containing polymer derived SiCNO dispersoids during hot compression" , 2018,material sciences and engineering, vol. 720, pp 49-59

[2] Velugula Mani Kumar and Chinta Neelima Dev "Evaluation of mechanical characteristics for Aluminum-copper Metal matrix Composite" ,2014, Research Journal of Engineering Sciences, Vol. 3(3), pp 1-5.

[3] N. Radhik, ·R. Karthik,·S. Gowtham,,S. Ramkumar "Synthesis of Cu-10Sn/SiC Metal Matrix Composites and Experimental Investigation of its Adhesive Wear Behaviour", 2017, Springer Nature, vol.11, pp 345-354.

[4] Siddabathula Madhusudan, Mohammed Moulana Mohiuddin Sarcar, Narsipalli Bhargava Rama Mohan Rao. "Mechanical properties of Aluminum-Copper(p) composite metallic materials", 2016, Journal of Applied Research and Technology, pp 1-7.

[5] C. E. da Costa, Vicente Amigo Borras, "Properties of AA6061 Aluminum Alloy Reinforced with Different Intermetallics and Ceramics Particles", 2006, Materials Science Forum, Vols. 530-531, pp. 255-260

[6] Devinder Yadav,Manish Kumar ,"Mechanical Properties Evaluation Based On Nickel Reinforced Aluminium Metal Matrix Composites", 2009,Indian Jornals Of Pure And Applied Physics ,pp 134-152.

[7] Manoj Kumar.Pal,Simranjeet Singh Sardhar,Rohan Kalia,Arka Ghosh,"Identification Of Optimum Composition And Mechanical Properties Of Al-Ni Metal Matrix Composite",2015,Scientific Research Publishing, pp 326-334.

[8] Dr.C N Chandrappa "on fabrication of Al-SiC composites by stir casting by varying the weight percentages of reinforcement"2015, Scientific Research Publishing, pp 326-334.

[9] V.Rama KoteswaraRao,J.Rangaray,Chowdary,A.Balaji,D.Sai Krishna B.P.RBhavabhvti,G.Sreevattsava,K.Abhiram,"A Review On Properties Of Aluminium Based Metal Matrix Composites Via Stir Casting,2016,International Journal Of Scientific And Engineering Research ,Vol 7, pp 742-749.