

Tensile and Hardens Testing of Aluminium Alloy Composites Reinforced with Alumina Nanoparticles

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ABSTRACT: Metal Matrix Composites (MMCs) are known for higher strength, toughness and superior Mechanical and Tribological Properties. They can withstand elevated temperatures in corrosive environment. Most metals and alloys could be used as matrices and they require reinforcement materials which need to be stable over a range of temperatures and also non-reactive. However, the choices for low temperature applications are not many. Only light metals, with their low density prove to be advantageous. Aluminum, Titanium and Magnesium are the popular matrix metals. Tensile and hardness test were carried out on aluminum metal matrix composites to study the influence of addition of Al₂O₃ Nano particles in Al7075 matrix material with addition of rare earth material Cerium and to understand their mechanical properties. Aluminum alloy together with its composites were prepared by stir casting method with suitable die measuring diameter of 25mm and 225mm length. Tensile test specimen was prepared as per ASTM standards. Standard ASTM procedure was followed to conduct hardness and tensile test. Further micro structural studies on the composites were obtained and analyzed.

KEYWORDS: Metal matrix composites, Stir- casting, Reinforcement, ASTM standards, tensile test, hardness test.

I. INRODUCTION

The toughest job for the designer is to find the right material for structures and machine components. Many researchers are working in this direction to find new materials and to develop methodologies to characterize them to use in new design situations..Steels are widely used in structures and machine components. Different grades of steels are available from high strength steels to medium strength steels. Now a day's aluminium alloys are replacing steels wherever possible, because it is comparatively lighter in weight and resistant to corrosion. Alloys of Al-Zn-Mg-Cu series are extensively used in aerospace industry [1]. The yield strength of pure aluminium is 7 to 11 MPa, while its alloys range from 200 to 600 MPa [2]. Aluminium, having one third the density and stiffness of steel is ductile, easy to machine, cast, draw and extrude. Corrosion resistance is excellent due to a thin layer of aluminium oxide formed when exposed to air, preventing oxidation

Metal marix composites (MMCs) have better performance advntages compared to pure metals and alloys since they posses the best properties such as ductility and toughness of the matrix and high modulus and strength of the reinforcements[3-5]. MMCs are the attractive choice of materials for several applications such as aerospace, automaotive , sporting and military applications [6-7].The aluminum alloys were processed in different ways, adding different alloying elements, subjected to different heat treatment processes to improve its mechanical and fractur1.4 Rare earth element (Cerium)

1.1 Cerium: It is the most abundant rare earth metal found in many minerals like allanite, monazite, bastnasite, cerite and samarskite. Monazite and bastnasite are the two important sources of cerium. Fig. shows that cerium is an iron grey lustrous metal. It is malleable and oxidizes very readily at room temperature, especially in moist air. It is the most

reactive rare earth metal reacting rapidly by both alkali and acid solutions except europium. The pure metal ignites if scratched with a sharp instrument.



Fig 1.1 Image of Cerium metal

II. PROCESSING TECHNIQUES

Among the variety of manufacturing processes available for discontinuous Metal matrix Composites, Stir casting is generally accepted as particularly promising route, currently practiced commercially. Its advantages lie in its simplicity, flexibility and applicability to large quantity production. It is also attractive because, in principle, it allows a conventional Metal processing route to be used and hence minimizes the final cost of product. This liquid metallurgy technique is the most economical of all the available routes for Metal matrix Composites production and allows very large size components to be fabricated. According to Skibo et al the cost of preparing composites material using casting method is about one third to half that of competitive methods and for high volume production, its projected that cost will fall to one tenth.



Fig 2.1. Casted Aluminium Alloy

III. EXPERIMENTATION

Al 7075 alloys reinforced with Alumina Nanoparticles were cast using liquid metallurgy route in the form of cylindrical bars of length 225mm and diameter 25mm

Table 3.1: Chemical composition of Al7075

Element	Si	Cu	Mg	Ni	Fe	Mn	Ti	Cr	Al
Weight %	12.77	0.94	0.96	1.06	0.20	0.01	0.20	0.02	Bal

TABLE-3.2 : Designation of Composites

Sl.No	Alloy/composite	Designation
1	As Cast	M
2	As Cast+2 wt% Al ₂ O ₃	M1
3	As Cast + 4wt% Al ₂ O ₃	M2
4	As Cast + 6wt% Al ₂ O ₃	M3

IV. TESTING

4.1 Microstructure

Micro structural studies on the hot forged square cross-section bar were conducted using Optical microscope with an object lens range 100x,300x,500x and 1000x fitted with camera interfaced with a computer for image capture and analysis. The samples were surface ground with 220 grit at 250 rpm, 320 grit at 350 rpm, 400 grit at 450 rpm and 600 grit at 550 rpm of emery paper at speed respectively. Then polished with 5 m diamond paste. The samples were washed with distilled water and dried with warm flowing air. These samples were then etched with solution of 10g of Sodium hydroxide with 90ml of water. They were then washed with distilled water and dried with warm flowing air before microstructure viewing.

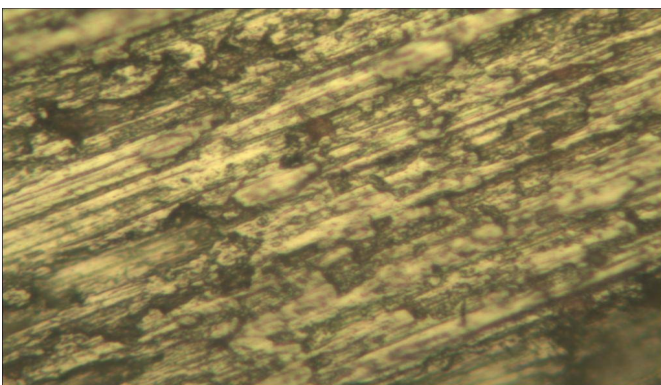


Fig 4.1 M2 Sample before etching

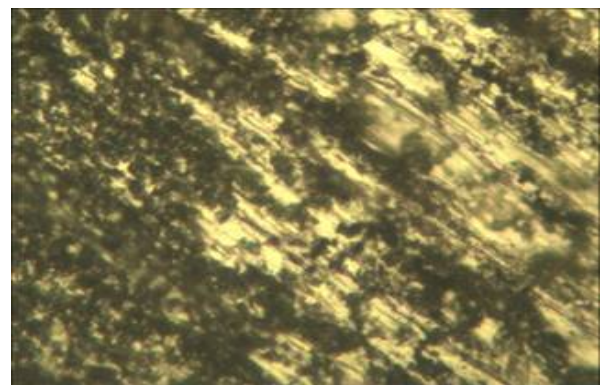


Fig4.2 M2 Sample after etching

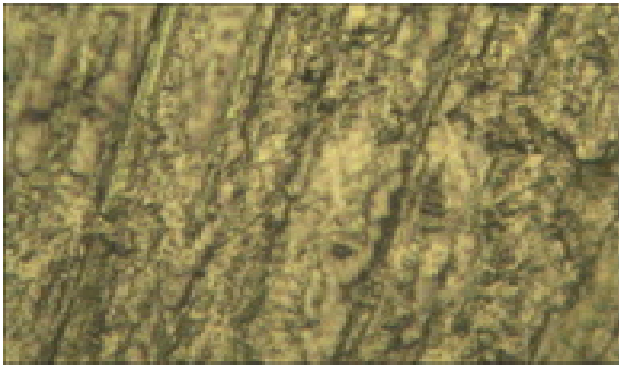


Fig 4.3 M3 Sample before etching

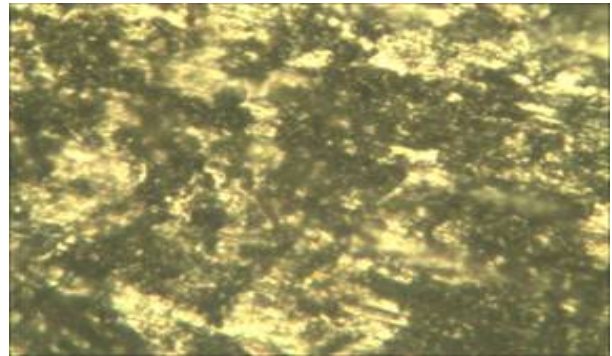


Fig 4.4 M 3 samples after etching

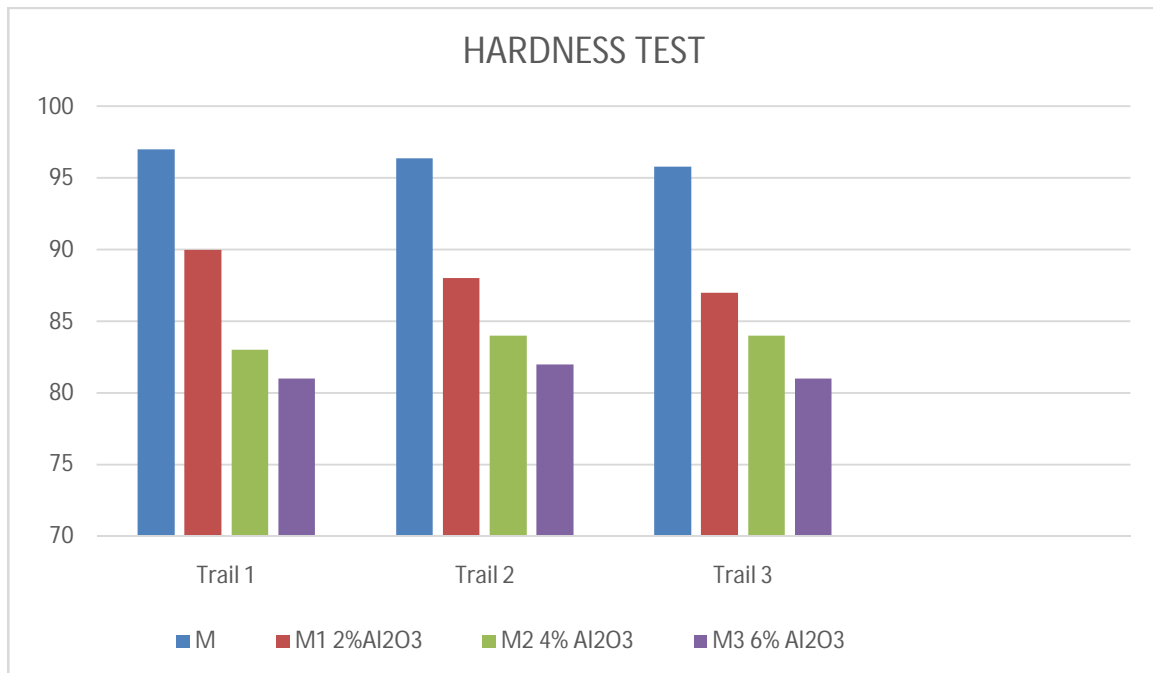
4.2. Hardness test: The hardness tests were conducted as per ASTM E10 norms using Brinell hardness tester. Tests were performed at randomly selected points on the surface by maintaining sufficient spacing between indentations and distance from the edge of the specimen.



Fig 4.5 Hardness test equipment

Table 4.1

Trail no	M	M1 2% Al ₂ O ₃	M2 4% Al ₂ O ₃	M3 6% Al ₂ O ₃
1	97	90	83 HRB	81 HRB
2	96.4	88	84 HRB	82 HRB
3	95.8	87	84 HRB	81 HRB



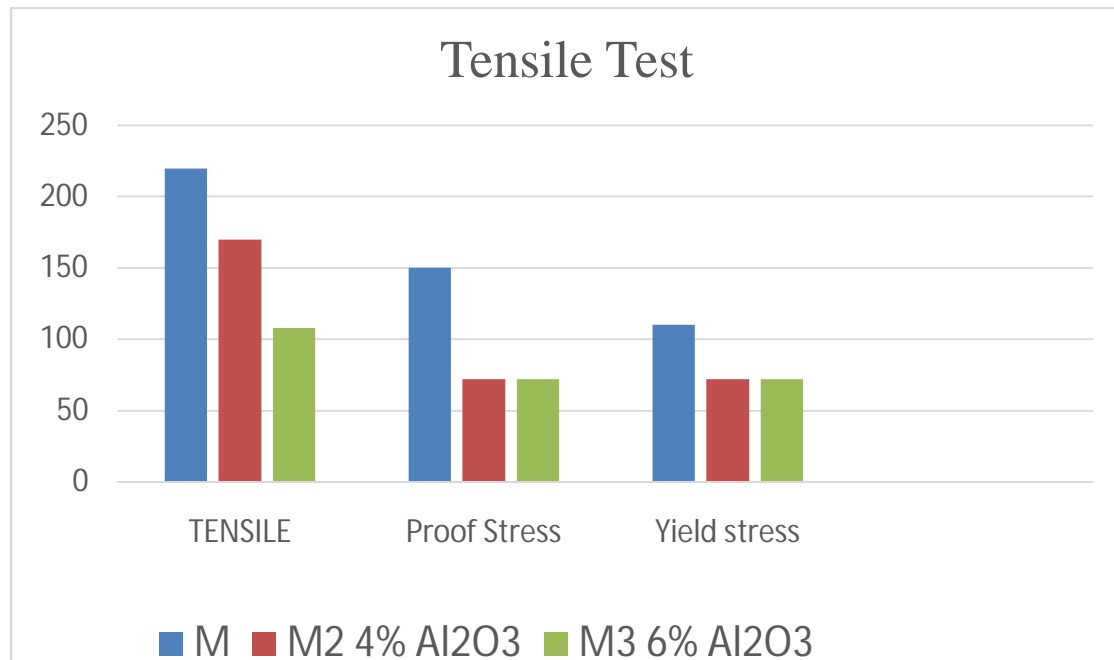
4.3: Tension test



Fig 4.6 Universal testing machine

Table 4.2

Properties	M1	M2	M3
Tensile Strength (MPa)	110-152	70	108
Proof Stress 0.20% (MPa)	65-110	72	72
Yield Stress (Mpa)	69	72	72



V. CONCLUSIONS

The authors experienced a new problem when they made an attempt to mix Alumina into Aluminium melt, Alumina could not get mixed well due to poor wetting properties of Alumina as well difference in their densities. Due to complexity associated with the interfacial reaction between Alumina and metal matrices, much of the progress could not be achieved. Lack of a suitable synthesis technique is one of the major challenges in achieving dispersion of Alumina in MMCs

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