INVESTIGATION ON MICROSTRUCTURAL PROPERTIES OF AL6061 WITH TiB2 ADDITION

Dr. RAVINAIK BANOTH
Professor in Mechanical Engg dept,
St martin's Engineering College,
Dhulapally Road Secundrabad-500100,
drravinaikme@smec.ac.in,

Mr. B T NAIK
Associate Professor
Mechanical Engg Dept St.Martin's Engg College Dhulapally Secunderabad TS 500100
btnaik96@gmail.com

ABSTRACT:

Aluminum alloys are most predominant for various applications of aerospace and light weight material structures. the basic applications fulfilled with the Aluminum alloys but mechanical properties depend on the structure stability of addition other materials in partial replacement with alloy materials present paper focused on the microstructure formation of TiB2 Addition to Aluminium 6061 alloy to attain better mechanical properties an addition of 5,10,15% TiB2 particles to Aluminium alloy in stir casting method. The casted product poured in the mould sized 15cm x 4 cm x 3 cm to check the solidification microstructures analysed up to 500X for better identification of cast flow and particle mix up at a stirrer speed of 3000 rpm.

Key words: MMC's' stir casting micro structure

1.0 Introduction:

Aluminum is one of the most common elements on earth. In our modern world, it is an important material after steel. Aluminium makes structures too large to use if they are made of other materials such as steel. A precipitate hardening alloy is aluminum alloy. Magnesium and silicone are the major alloying elements, having good mechanical properties and good soldering ability. For general purpose, aluminum alloys are one of the most common. The density of aluminum is less than steel and has also good mechanical properties to be corrosive. There is extensive use of aluminum and alloys. The thermal conductivity of Aluminum 6061, for example, is low, and consequently it is poorly worn. It strengthens the wear resistance and the young module values to overcome this ceramic material.

Progress has switched from metals to composites over the last years. Metal Matrix Composites (MMCs) have the main advantage of its customized properties, which meet the specified special applications qualifications. Thanks to their special properties, the Aluminum mixture is usually employed in aircraft and automobiles. In view of scientific and technological aspects, their excellent mechanical properties and their low cost of production make them an outstanding candidate for a number of applications. MMC's features are primarily influenced by the matrix metal and reinforcement material. There have been research over the last decade in the manufacture of MMCs with different strengthening proportions to achieve the properties required.

2.0 Literature review:

Goutham Karthik [1] This investigation scrutinizes the micro structural and mechanical properties graphite particles reinforced Al6061 aluminum based composites fabricated through stir casting technique. The composites were fabricated by reinforcing 4, 8 and 12% of graphite particles into molten aluminium by stirring at 300rpm.

Suresh S Selvaganesan M [2] This paper focused on the production of Al TiB2 metal matrix composites by the stir-casting process and produced a total of five separate percentage samples of TiB2-0%, 3%, 6%, 9% and 12% in aluminum . In order to prepare the test specimens for tensil and hardness tests according to ASTM requirements the casts composites Al6061– TiB2 have been carefully handled.

Lawrance, Suresh Prabhu [3] Due to its high hardness, strength, resistance to wear, steepness, and unique modulus, some researchers are attracted by aluminum matrix components. The presence of coarse strengthening particulate matter and its irregular distribution and micro-structural heterogeneity have a negative effect on the mechanical characteristics of aluminum alloys.

3.0 Experimental Procedure for Stir Casting:

Here there is the experimental procedure for stir casting. About 2.5kg capacity of crucible can be carried in the electric furnace. 1000 ºC is the maximum operating temperature. The present furnace rate is 230V AC, 50Hz single step. The Al6061 was produced with a forming machine of approximately 2.25 kg. All the metal scraps are pumped into the stove until they reach half a fluid shape of about 600 oC and heated to a temperature. The alloy is mixed by hand to ensure consistency. The refurbished powder is then applied to the oven, heated at 500 oC. Aluminum matrix is heated until it is completely molten, while argon gas is simultaneously pumped into the furnace. There by stirring process is done using the stirrer having an 150rpm. The composite materials at 800 ºC reaches complete liquid state (aluminum melting point is 700 ºC). Hence the complete matrix component is poured in the permanent molds.

Stir Casting:

Al6061alloy-TiB2 composite is prepared by casting stir technique in the present investigation. The different amounts of tin, including 5%, 10%, 15% of volumes and casts are tried and finished. Al6061 alloy is melted in the furnace at 7200C temperature, then slowly pours in powdered form(1 nm) at an optimum speed of 3000 rpm for a 5-10 minute period, then the melt is released via Nitrogen Gass. The molten metal is finally put into the metal mold of the palm. In order to avoid the molten metal being stuck on the surface of the mould, it is covered with crack material. The cast samples are then heat-treated and hot-extruded. In order to monitor the solidification structures analyzed to 500X, a cast product flow mixture with an agitator speed of 3000 to 500x was used in the mold size 15 cm x 4 cm x 3 cm. Argon is persistently blown into the crush to defend against the atmosphere while the cycle is taking place. The stir casting setup is shown in the Fig.3. Solidified Al6061/TiB2 composite is shown in the Fig.

Figure: Stir Casting Setup


Figure: Solidified Al6061/TiB2 Composite

Preparation of Micro Hardness Test Specimen:

The hardness test in the size 15 cm x 4 cm x 3 cm (l x b x t) is made, as illustrated in the figure. The micro strength of Al alloy and composites samples in asphalted condition were determined by the use of the Digital Micro strength Test. Difficulty testing. This prevents excessive gas content resulting from the agitation of melts, resulting in inappropriate porosity in the casting component. In order to prevent the molten metal from contaminating the rod and rod was covered by liquid alumina. The mixture was gushed into the other mold after stirring to get the desired shape. Three castings with different weight percentages (5, 10 and 15 per cent) have been produced of, TiB2.

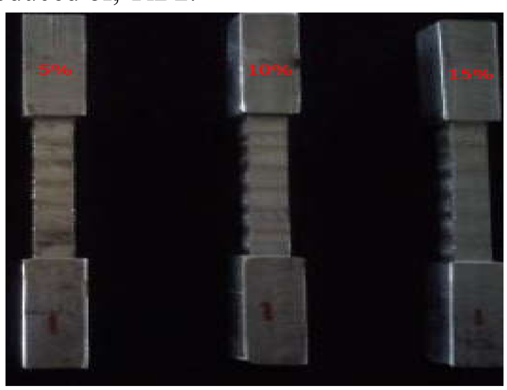


Figure: Test Specimens

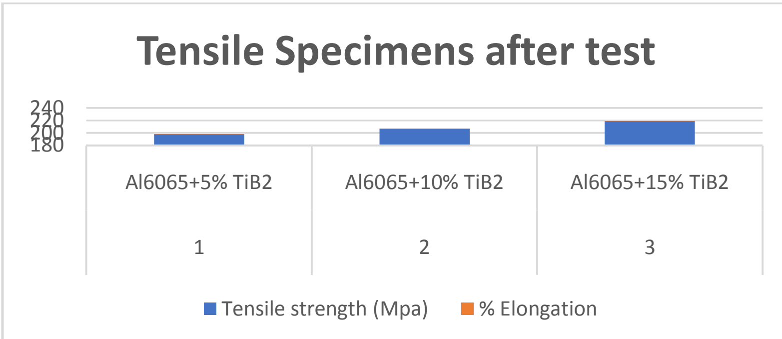
4.0 RESULT AND DISCUSSION

The ultimate tensile strength (UTS) was estimated using a computerized universal testing machine

Figure: Tensile Specimens after test

Table: Tensile Specimens results

S.no	Sample name	Tensile strength (Mpa)	% Elongation
1	Al6065+5% TiB2	198	7.6%
2	Al6065+10%TiB2	207	5.1%
3	Al6065+15% TiB2	219	3.8%



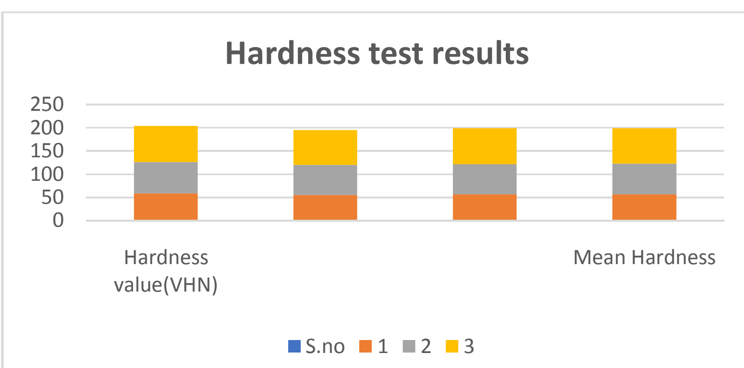
Graph: Tensile Specimens after test

Hardness Test:

Al / TiB2 composites hardness values are listed in the table. The addition of TiB2 will display a substantial improvement in the hardness of the alloy matrix. A measurement of hardness showed a higher hardness value which shows that particles in the matrix improve overall hardness. The aluminum is a soft material that helps to the hardness of the composites thanks to the strengthened particle, particularly ceramic material. The existence of TiB2 more rigid and tough results in increased restrictions of plastic matrix deformation in the toughness test, while that composite hardness may be due to TiB2's relatively high hardness.

Figure: Hardness test results

S.no	Sample name	Hardness value(VHN)			Mean Hardness
		Trial 1	Trial 2	Trial 3	
1	Al6065+5% TiB2	58	55	56.5	56.5
2	Al6065+10% TiB2	68	65	64.7	65.9
3	Al6065+15% TiB2	78	75	78	77



Graph: Hardness test results

The addition of 10% TiB2 leads to a 40MPa increase in comparison with pure aluminium. The strength of TiB2 increases dramatically to 220MPa when the particles of TiB2 exceed 10% of the composite. As shown in the table, the AMCs' elongation decreases if the percentage of TiB2 particles is increased. As the weights of TiB2 particles are increased, the grain refinement and reduction of the ductile matrix material decrease the ductility of AMCs.

SEM Results:

The results of the SEM analysis are represented in the Figure shows the optical micro structure of Al6061 and 5% of TiB2 alloy, the microstructure of the sample indicates that the homogeneity of Al grain was observed. Figure shows the SEM image of Al6061 and 5% of TiB2 particles. Figure shows the microstructure of Al6061 and 10% of TiB2 and Figure shows the micro structure of Al6061 and 15% of TiB2 particles. You can see from the chart that the cluster particle increases, which lead to an increase in temperature. Although the particles clustering has been increased with an increase in processing temperature, the tendency to form particles clusters was higher in higher holding time than in low holding time. The growth of porosity is not restricted by low viscosity liquid.

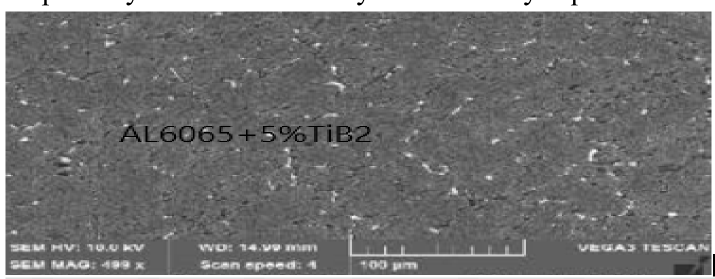


Figure: Micro structure of Al6061 and 5% of TiB2

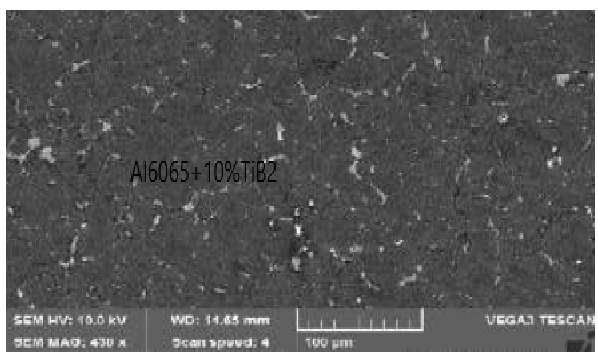


Figure: Micro structure of Al6061 and 10% of TiB2

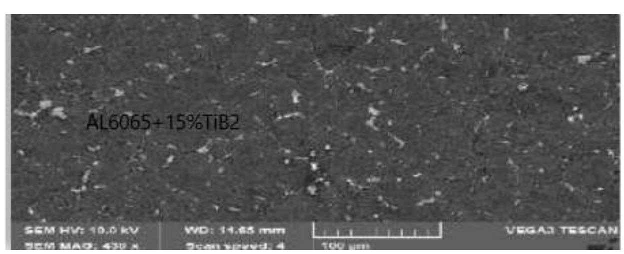


Figure: Micro structure of Al6061 and 15% of TiB2

Ultimate tensile strength (UTS):

Ultimate tensile strength variation (UTS) of the base alloy when reinforced with 5, 10 and 15 wt. TiB2 particulates percentage. In contrast with alloy cast Al6061, the ultimate tensile strength of Al6061-TiB2 increases. The composites are regulated with the microstructure and properties of the hard ceramic tin particles. Due to the strong relation of the interface, the load from the matrix to the arming results in increased tensile strength. This improvement in ultimate tensile strength is primarily due to the presence of Tin particles that avoid micro-structure dislocations.

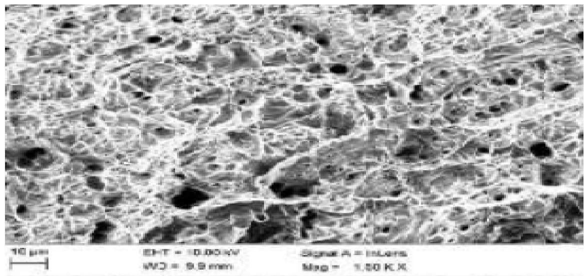


Figure: SEM image of ultimate tensile strength sample Al6061 and 5% of TiB2

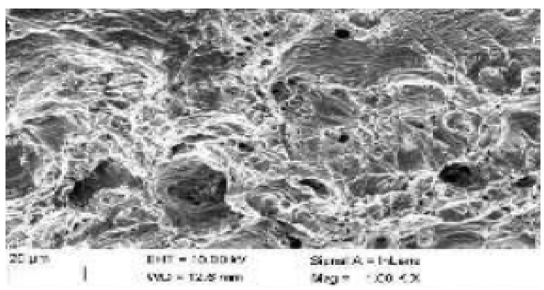


Figure: SEM image of ultimate tensile strength sample Al6061 and 10% of TiB2

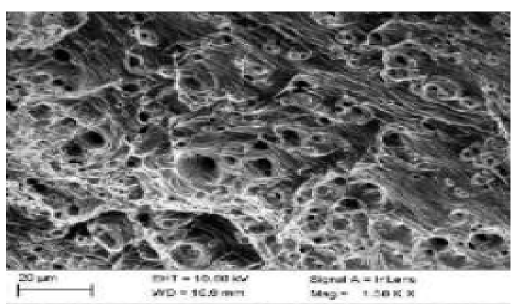


Figure: SEM image of ultimate tensile strength sample Al6061 and 15% of TiB2

Conclusion:

A study on the effect of tin element over the micro structural and mechanical characteristics of an aluminium alloy was successfully investigated in this research, where aluminium 6061 alloy is alloyed with varying weight fractions of tin element and successfully incorporated by the means of stir casting. Stir casted aluminium-Sn alloys were characterized by means of optical microscope and SEM so as to evaluate the evaluation of micro structure and its grain refinement with respect to tin addition. It was observed that a reduction in grain size occurs with respect to tin addition while SEM results expose nil detrimental phases and inter metallic formation during the entire casting. Aluminum composite has thus established a reliable matrix distribution and strong relation between the ceramic and the metal matrix interface. When the contents of TiB2 particles were increasing, the mechanical properties of AMCs improved. Once TiB2 particles exceeded 10 percent of the material, the tensile strength increased significantly to 220MPa. The hardness value of 15% TiB2 increased by 50% over the base alloy (5% TiB2)

Future scope:

Al 6061 alloy is widely used in transport, construction and similar engineering industries for commercial applications. In addition to its good resistance to corrosion, the alloy has outstanding mechanical properties because of the extensive use in the manufacture of naval vessels. Composite Al-TiB2 is a metal matrix composite (MMC) developed with the salt-metal reaction.

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