

# Effect on the Mechanical Properties of Al 7075 Reinforced with SiC and TiC Particles



M.Subramanian, B.Aravinth

**Abstract:** In the present industrial scenario, Aluminium and its alloy based composites have more importance in the growing fields of engineering. Aluminium reinforced metal matrix composites are broadly speaking desired because it has the excessive strength along with less weight, hardness, corrosion resistance, fatigue and creep resistance. The Al composites are focused to use in aerospace, automobile and also in structural domain because it gives good strength with less weight. This paper discussed about the mechanical residences of Aluminium 7075 alloy strengthened with SiC and TiC. Stir casting process was utilized for fabrication of composites and composite specimens are subjected to tensile test by using Universal Testing Machine. The composite hardness was tested by using Brinell hardness tester and the Charpy impact tester used for findings the impact strength. An experimental results are compared with unreinforced alloy of Al 7075. Micro structural characterization confirms the particles of reinforcement are distributed to the entire structure of matrix. The experimental result shows the mechanical properties slightly increased by varying wt% of reinforcements in the matrix material. The better tensile strength (252MPa), hardness (83HB) and impact strength (4.6 Joules) is obtained by the composition of 60% wt of Al 7075, 20% wt of TiC and 20 %wt of SiC.

**Keywords :** Al 7075, Hardness, SiC and Stir Casting.

## I. INTRODUCTION

The composites are having ability materials for diverse applications owing to their precise properties of physical along with mechanical. The adding reinforcements with matrix material for enriching the mechanical properties when compared to conventional materials. A vehicle's performance and complex behavior are highly determined by its weight. Lightweight architecture is more of a challenge than ever in automotive engineering, taking into account convenience, protection and pollution in new vehicles. Against this context, the production of materials plays an essential role when substantial weight loss is made feasible by substituting high density materials and more precisely adapting material specifications to the practical requirements of the parts.

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Therefore, hardened light metals, because of their strong strength to weight ratio, provide a promising solution. The metal matrix composites are metals that incorporate particles, whiskers, and fibers made of different composition materials. These materials will be tailored to be light-weight and with varied different properties including: high strength, high coefficient of elasticity, high toughness and impact resistance, low sensitivity to changes in temperature or thermal shock, high surface sturdiness, low sensitivity to surface flaws, high electrical and thermal conduction, minimum exposure to the potential downside of wetness absorption leading to environmental degradation, and improved the method of fabrication with standard metal operating instrumentation. The study is focused to fabricate of Aluminium 7075 hybrid composites containing a variable volume fraction of particles (SiC and TiC).

## II. LITERATURE SURVEY

Zhang, H. (2008) have studied the Al-7075 reinforced SiC composites are fabricated through spray deposition technique for finding deformation and also fracture of the composite. Baradeswaran et.al. (2014) developed of Al7075 hybrid metal matrix composite through stir casting method. The findings showed increase in toughness, ultimate tensile strength, flexural strength, wear resistance thus growing the Al<sub>2</sub>O<sub>3</sub> reinforcement weight fraction. Efzan (2016) prepared LM 6 alloy reinforced different wt% of (0%, 4%, 5% and 6 wt.%) fly ash particles based composite produced by compo casting and it observed that the macro-hardness and the UTS increases with varying wt% of fly ash particles. Selvam (2013 ) developed composite AA6061 / fly ash and assessed composite mechanical and micro-structural characterization. It concluded that an improvement in the weight of fly ash particles in the aluminium matrix and superior qualities in contrast with base alloy. Ramesh CS (2011) studied mechanical properties for Al 6061-TiB<sub>2</sub> in-situ composites fabricated by liquid metallurgy and the evolved in-situ composites exhibited full-size improvement of mechanical properties as compared to the base metal. Muruganandan et al. (2015) used Aluminium 7075 is matrix material with fly ash and TiC as reinforcement materials. An evaluation has made among the reinforced and unreinforced alloys which include Al 6061, Al 7075 and concluded that the mechanical properties of composite is extended by using various the wt% of fly ash and titanium carbide. From the above discussion, there are not sufficient records available at the mechanical properties of particulate

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(SiC and TiC) strengthened Al 7075 composites.

### III. MATERIALS

The matrix is the monolithic material into which reinforcement is embedded. It is completely continuous and surrounds other phases. Reinforcements are distributed randomly throughout the matrix. Reinforcement is the secondary part of the composite which it provides strength, stiffness and has transfer the load to the entire structure. Aluminium 7075 (Al7075) is selected because of the matrix material because it's far low price and has higher properly like thermal conductivity, high shear power, abrasion resistance, and high-temperature operation. It possesses outstanding properties of casting and fair strength. This alloy is ideally suited for lightweight metal castings in industrial manufacturing.

**Silicon carbide (SiC):** Silicon carbide (SiC) is a combination of silicon and carbon. Silicon carbide is mainly used as abrasive particles in grinding wheel because it has excessive thermal conductivity, excessive-temperature power, low thermal growth, and resistance to chemical response, makes SiC precious in the manufacture of high-temperature bricks and different refractoriness.

**Titanium carbide (TiC):** Titanium carbide is an artificial, excessive-melting, heat-resistant cloth which is broadly used for production metal-running tools, defensive coatings and carbide steel and also it is used in resistant packages, thin movie ultra capacitors, bearings, nozzles, reducing gear, and many others. SiC and TiC are used as a reinforcement material in this study.

### IV. EXPERIMENTAL PROCEDURE

Before The composite specimens were prepared with help of stir casting method. Table 1 shows the composition of different reinforcements which were added in matrix material Al 7075. The dry crucible and furnace are used for composite fabrication. Initially, the electric furnace is set at 150°C for removing moisture inside the furnace and Al 7075 alloy rod was used. At the beginning of melting a 150g of Aluminium scraps is heated and melted to a molten stage by utilizing the Stir casting apparatus and then the weighted Al 7075 rods are added as per the compositions and the temperature is raised to 840°C for complete melting to form a molten liquid state.

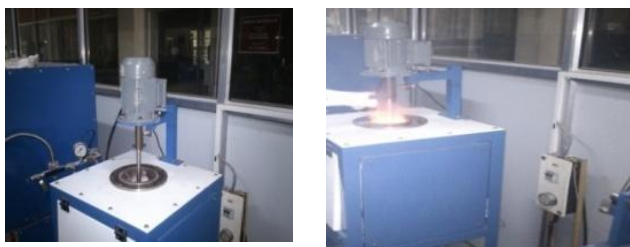


Fig. 1, 2 setup of stir casting and melting of Aluminium 7075

Figure 1 and 2 shows setup of stir casting and melting of Aluminium 7075. The preheated (40° C) TiC powder is added into matrix molten metal then mechanical stirrer is rotated at 150 rpm for complete mixing of the particle reinforcement into a matrix. After that weighted SiC powder is added and the stirrer is rotated at 200 rpm for avoiding settle down of Silicon Carbide particles in the furnace. The 150mg of Magnesium is

added for improving the wettability. Then the complete melting molten metal transferred constantly into the prepared steel mould die to avoid gas bubbles formations and then its allowed to solidify. The machining is done in the lathe to get required size and shape as per required ASTM standards for conducting mechanical test.

Table 1 Composition of different reinforcements and matrix material

S.NO.	Matrix Al 7075 Wt %	Reinforcement Materials (Wt %)	
		TiC	SiC
C <sub>1</sub>	100	—	—
C <sub>2</sub>	90	5	5
C <sub>3</sub>	80	10	10
C <sub>4</sub>	70	15	15
C <sub>5</sub>	60	20	20

### V. RESULT AND DISCUSSION

#### a) Tensile Test

Tensile strength is a calculation of the force used to lift anything to the stage before it falls and the Universal Testing Machine (UTM) test was used. The Specimen used for testing according to ASTM E8 standard. The figure 3 shows Tensile strength for MMCs. It may inferred that SiC and TiC debris are very powerful in enhancing the tensile strength from 210 MPa to 252 MPa because of the strengthening mechanism by the reinforcement. The inclusion of reinforcing particles in the matrix causes substantial resistance to matrix alloys by supplying greater tensile stress resistance. Higher dislocation intensity in the matrix and load is induced by the thermal imbalance among matrix and reinforcement-bearing power of the hard particles, which consequently improves composite strength

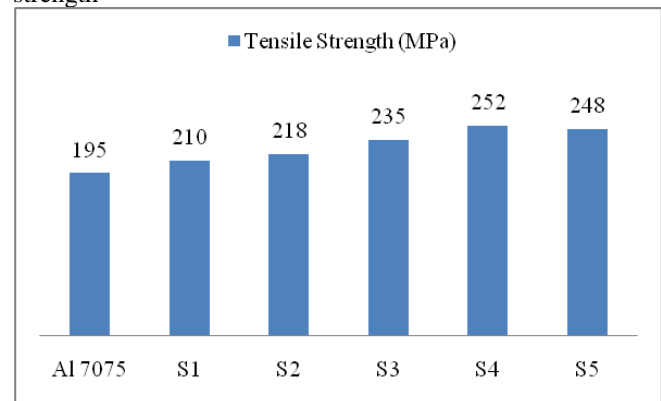


Fig.3 Tensile strength of the composite and Al 7075

#### b) Hardness Test

Hardness is the material resistance to restricted deformation when applying the load. A tough material surface resists indentation or scratching and has the ability to indent or cut other substances. The hardness of the composite was examined with the help of Brinell Hardness Tester. Within the Brinell hardness tester, a hardened steel ball is pressed into the flat surface of a work piece with distinct pressure. The ball is then removed and the diameter of indentation has measured using a microscope.



It is observed from experimental results hardness of MMCs is increased when the amount of reinforcement particulates increases. At the presence of such difficult surface place of debris gives greater resistance to plastic deformation which showing in results in increase the hardness of composites. It's far cautioned that the availability of hard ceramic segment inside the soft ductile matrix reduces the ductility for composites because discount of ductile metal content which notably increases the hardness. Figure 4 represents the hardness test specimen and figure 5 shows the hardness of the composite.



Fig 4. Hardness test specimen

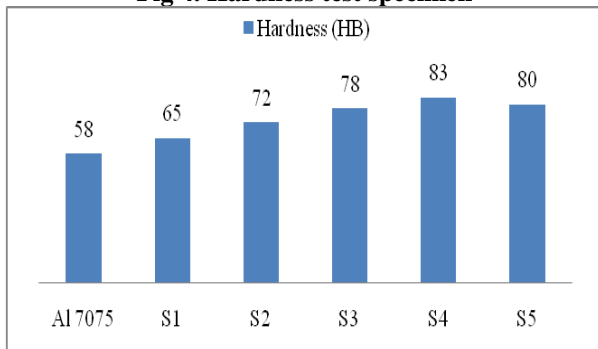


Fig. 5 hardness value of the composite and matrix material

c) Impact test

Inside the impact test type of notched bar material is used both as a cantilever and truly supported beam, is broken by one blow in such how that the overall strength had to fracture it will be determined. The energy needed to fracture a material is of importance in cases of shock loading once a part or structure is also needed to absorb the K.E of a moving object. The absorbed energy by the materials was calculated in joules. The energy absorbed is found with the assistance of Charpy impact tester. The standard specimen size used for conducting Charpy impact test and observed that the impact strength is increased by varying wt% of the SiC and TiC particles within the matrix material. Figure 6 shows the impact strength of reinforced composites and pure Al 7075 alloy.

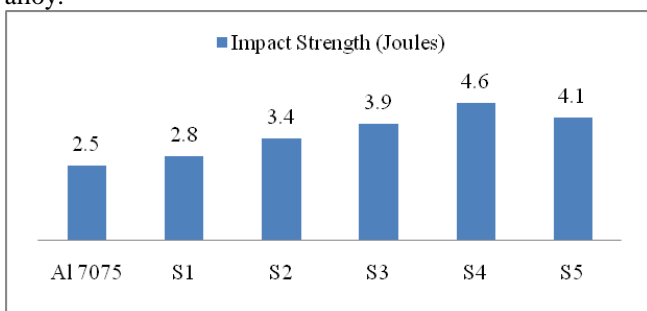


Fig.6 Impact strength of the Al 7075 and its composite

d) Microstructure

The composite samples are ultrasonically washed and assaulted to expose their microstructure with Keller reagent.

The Microstructure is analyzed by using SEM. The microstructure have revealed that there is a uniform distribution of particles reinforcement within the matrix material. The figure 7 shows the SEM images of Aluminium based hybrid MMCs.

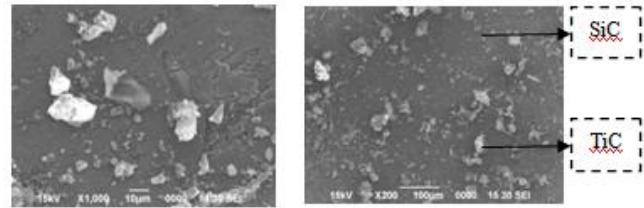


Fig.7 SEM images of hybrid metal matrix composite

VI. CONCLUSION

Composites were effectively manufactured by utilizing techniques of stir casting and the SEM display reasonably standardized distribution in the Al7075 metal matrix of reinforcement particles. It is demonstrated that the hardness improves with the matrix varying wt% of reinforcing materials. An increased in tensile strength, impact strength and also stiffness has culminated in the particle inclusion by TiC and SiC. The tensile strength increased when changing the wt% of reinforcement particles in base alloy. However, further advances in functional properties also culminated in the inclusion of these reinforcement products. As the reinforcement content increases the tensile strength, impact strength and hardness increases up to 15 wt% of TiC and SiC reinforcement and slightly decreases at 20 wt% SiC and TiC reinforcement. From the investigation, it was concluded that composites containing 15wt% Titanium carbide and 15 wt% SiC reinforcements exhibited better mechanical properties.

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