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# A Study on Mechanical Properties of Al 7075 Reinforced with TiC Particles of Different Weight Percentages

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**Abstract-***The aluminium metal matrix composites were produced by the stir casting technique method. Stirring was done to get uniform dispersal of reinforcement particulates in the matrix material. For the fabrication of a composite the aluminium (Al 7075) alloy used as matrix material and the titanium carbide particulates were used as reinforcements. The particulates having an average size 20 micrometer (µm). The reinforcement TiC particles were introduced in the matrix with different weight percentages 3%, 5%, 7% and 9%. Then the tensile strength, yield strength, percentage of elongation and hardness properties of the produced composites specimen studied. The tensile strength and yield strength increased with increasing reinforcement weight percentage. The percentage of elongation decreases with increasing reinforcement particles. As the wt% of reinforcement (TiC) increases the Vicker, s hardness of composite material increased and it is more than the base material. The 7% wt of reinforcement grant better properties. All the composite specimens shows the satisfactory mechanical properties.*

**Keywords:** Metal matrix composites, titanium carbide, stir casting.

## 1. INTRODUCTION

Traditional Inflexible materials own the restrictions to attain healthy amalgamation of strength, toughness, stiffness and density. To conquer these defects and to congregate the composites are most hopeful materials of modern importance. Metal matrix composites have outstandingly advanced properties incorporating high peculiar strength, specific modulus, damping capacity and better wear resistance matching with without reinforced alloys. Metal matrix composites (MMCs) drops in category of outstanding engineering in forth coming era for automotive, defense, constructional, thermal and electronic and wear application foundation on calibration work. At the present time appliance of metal matrix composites material has regard as in a lot of day by day life bring into plays and even this might for petite time utilize.

There are two types common methods are there for the AMMCs, namely casting method and powder metallurgy method. Finally proved that the casting method was gave the improved better mechanical properties than the powder metallurgy method for the aluminium metal matrix composites with reinforcements. In the preparation of Al 7075 – TiC composites stir casting procedures effectively implemented[1]. The aluminium metal matrix composites (AMCs) the reinforcement elements are usually emphasized in the matrix in volume fraction lower than 30% for used to constructional & wear opposition purposes. AMCs are fabricated by either by powder metallurgy process or by stir casting methods. AMCs are less expensive comparing to the uninterrupted fibers AMCs [2].

The improvement of a appropriate high strength metal matrix composite in relation with study of new material improvement, and in addition to find its mechanical properties. It was found that the deviation of the tensile potential of the composite improved by 50 percent from 10 to 15 weight percentage. This aspect be also make easy by the good bond among the metal and matrix and as a result the composite damage at that vital length happen to be rare, thus rising the potency of the composite and deliver the deviation in stress allocation of the composite [3].

The hardness of composite material increased as the incorporation of reinforcement in the metal matrix goes on increased based on the strength of the composite material the mechanical properties were viewed, so that it proves that the mechanical properties were controlled by the structural and reinforcement incorporated it that composites. It also verified that if the hard ceramic reinforcement particles adding increases the composite density also increases [4].

Hence in this paper attempts is made to produce Al matrix composites with varying weight percentage of 3%wt, 5%wt, 7%wt and 9%wt reinforcement particles of TiC and to assess the mechanical properties.

## 2. EXPERIMENTAL PROCEDURE

### 2.1 Matrix and Reinforcement material

The primary material designate in current exertion is A17075 because it one of most considerably

used for 7000 series A1 alloys. It is versatile heat cured extrude alloy with intermediate to soaring strength accomplishment.

Table: 1 Composition of Al 7075 alloy

| Element | Zn | Cu | Mn | Mg | Fe | Cr | Si | Al |
|---|---|---|---|---|---|---|---|---|
| % | 5.8 | 1.5 | .06 | 2.4 | .24 | .2 | .08 | Balance |

Table: 2 Particle size and Density

| Particulate | Density(kg/m$^3$) | Average particle size | Melting Temp |
|---|---|---|---|
| TiC, 99.5% (metals basis) | 4900 | 20µm | 3160 $^0$C |

Table: 3 Properties of Al alloy

| Al 7075 | Density (g/cc) | Melting Point($^0$c) | Youngs modulus | Poison's Ratio |
|---|---|---|---|---|
| Values | 2.81 | 483 | 71.7 GPa | 0.33 |

Fig: 1 Aluminium7075

Fig: 2 TiC Particles

### 2.2 Fabrication Technique

The stir casting method is simplest, most repeatedly used stategy. It is liquid state process for construction of composites materials. The composite, matrix material as Al7075 and reinforced material as titanium carbide with 3,5,7,and 9wt.% TiC concerning mean particulate size of 20 µm, composed by stir casting practice, vital volume of Al7075 material sustain into electic furnace and melted at 800 $^o$C . The experimental setup shown in fig3. Cover flux (45%NaCl + 45%KCl + 10% NaF) and degasifier Hexachloroethane assorted at elvated temperature, make greater aluminium wettability so reinforcement varied to metal is evenly diffused. The relevant consignment of TiC particulates then assort to molten metal. The TiC particulates added molten metal was pre heated up to 300$^0$C for remove the moisture in it. concurrently, molten metal was stirred rigorously at constant speed of 300 rpm with a mechanical stirrer. Carry for 5 minutes at that temperature, behind pour to mould, empower to solidified, after cooling take out cast product from mould box.

Fig: 3 Stir Casting Setup

Fig: 4 Composite Product

### 3. MECHANICAL TESTING

### 3.1Tensile Test

Tensile testing is conduct as per specification followed by ASTM standard tensilometer specimens. Testing of specimen for different reinforcement is to be conducted. Since strength is maximum stress that a matter can tolerate under external forces without demolition. Casted products to be machined according to wished standard dimensions of ASTM E8M -04 round

type specimen by lath and shaper machine. The dimensions of tensile specimens as shown in fig 5. The tensile test conduct by using the tensometer and strength was evaluated.

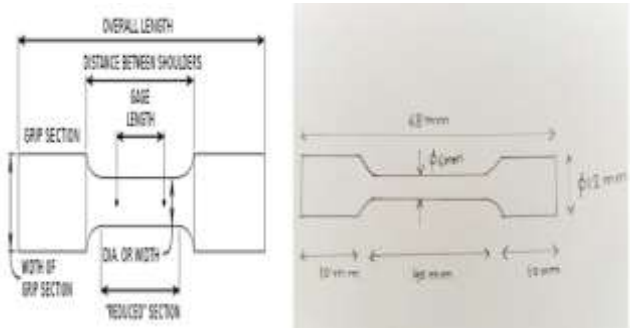


Fig: 5 Dimension of Tensile Specimen


Fig: 6 Tensometer and Tensile Specimens

### 3.2 Hardness Test

Since hardness is virtue property of material which it opposes plastic deformation. Hardness test measurement has been configured by Vicker's hardness tester. Hardness is estimated by THV-1M Automatic turret Micro Vickers hardness tester. It comprise a square based pyramid indenter with cone angle of $136^0$. The load applied depart from 10 to 30 kg to the dwell time of 10 second. After this dwelt time, the load was withdrawed. And then size of residual indent is measured under a calibrated microscope since it is too small (generally no more than 0.5) to be seen with naked eyes.

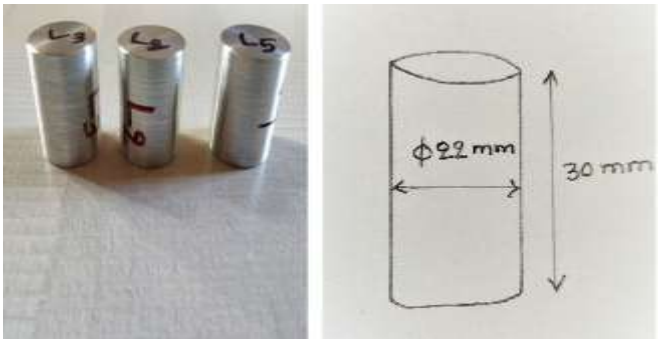


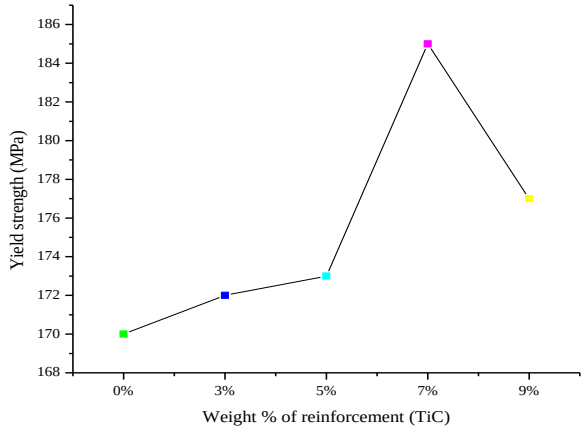
Fig: 7 Dimension of Hardness Specimens


Fig: 8 Hardness Testing Machine and Microscope

## 4. RESULT AND DISCUSSION

### 4.1 Tensile Properties

The tensile test conducted by using computerized tensometer as per the ASTM standards. The 10 fabricated composite specimens tested and that's results reported by chosen one of better values among the number of trials. We observed that comparing to Aluminium base material the yield strength of composites increases with increasing Weight percentage of reinforcement and at 7% it reach maximum value of yield strength of 185 MPa. After that further increasing of reinforcement for 9% there is a decrease in the yield strength. The ultimate tensile strength increasing with increasing in the weight % of reinforcement TiC up to 7% weight of reinforcement. About 221 MPa strength increases to the 7% of reinforcement. Hence the addition of 7% weight of TiC reinforcement to matrix is good for getting better UTS. The percentage of elongation of composite reduced with increasing percentage of reinforcement TiC up to 7%. After that for 9% of reinforcement percentage of elongation increasing. The addition of reinforcement significantly decreased the percentage of the elongation from 8.1 to 5.3. and improves the mechanical properties mainly by stress transference from the aluminium matrix to the reinforced particles TiC.



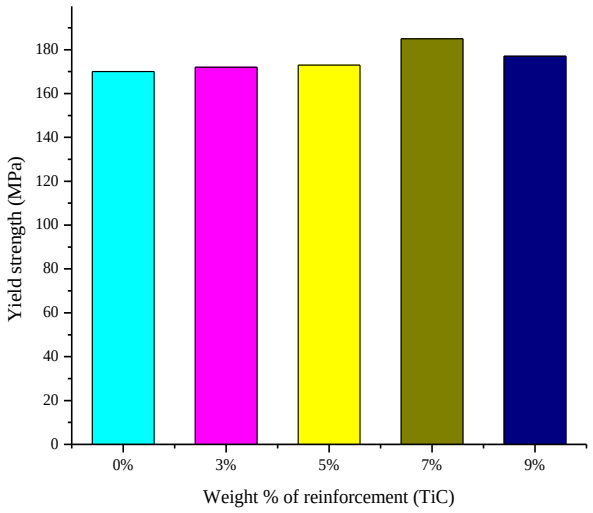
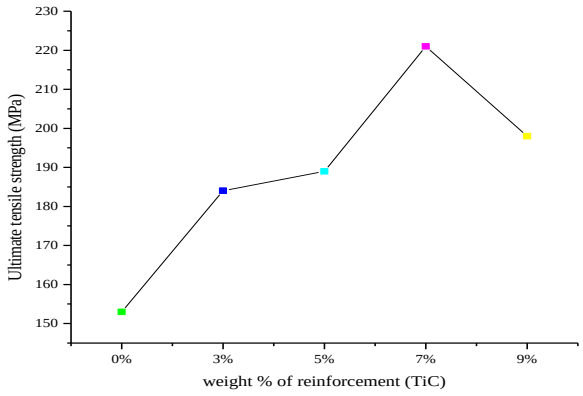



Fig: 9 Yield strength v/s wt% of Reinforcement (TiC)



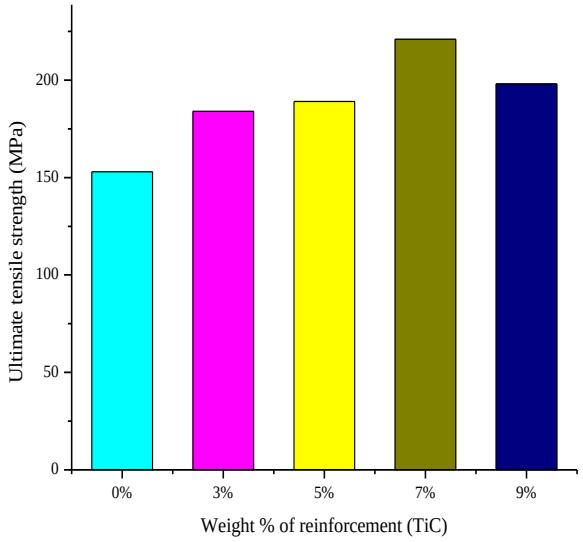
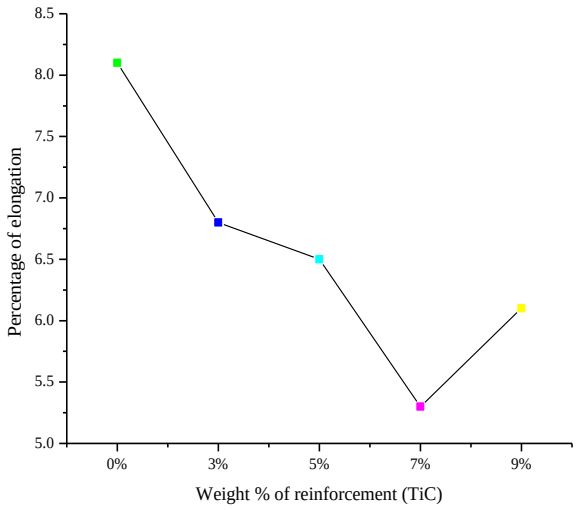




Fig: 10 Ultimate strength v/s wt% of Reinforcement (TiC)



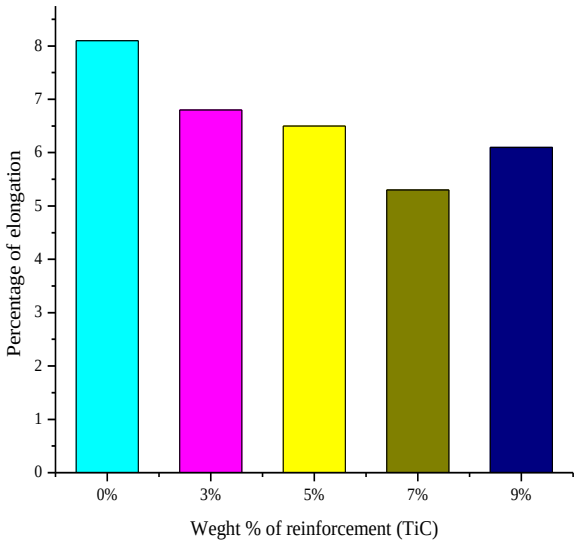




Fig: 11 Percentage of Elongation v/s wt% of Reinforcement (TiC)

### 4.2 Hardness

The Vickers hardness test method, also referred to as a microhardness test method, is mostly used to small sections. It is conducted on 5 number of composite specimens of different weight percentage of reinforcement. It clears from the graph that hardness of all composites significantly higher than that of matrix material characterized to the hard nature of TiC particulates. Observed that increasing hardness with increasing reinforcement percentage of TiC. for 7% reinforcement the hardness value maximum of 454, and however hardness drops after 7% that is for 9% reinforcement of TiC particulates. The some variations in the trend due to the non-uniform distribution of the particles in the metal matrix.

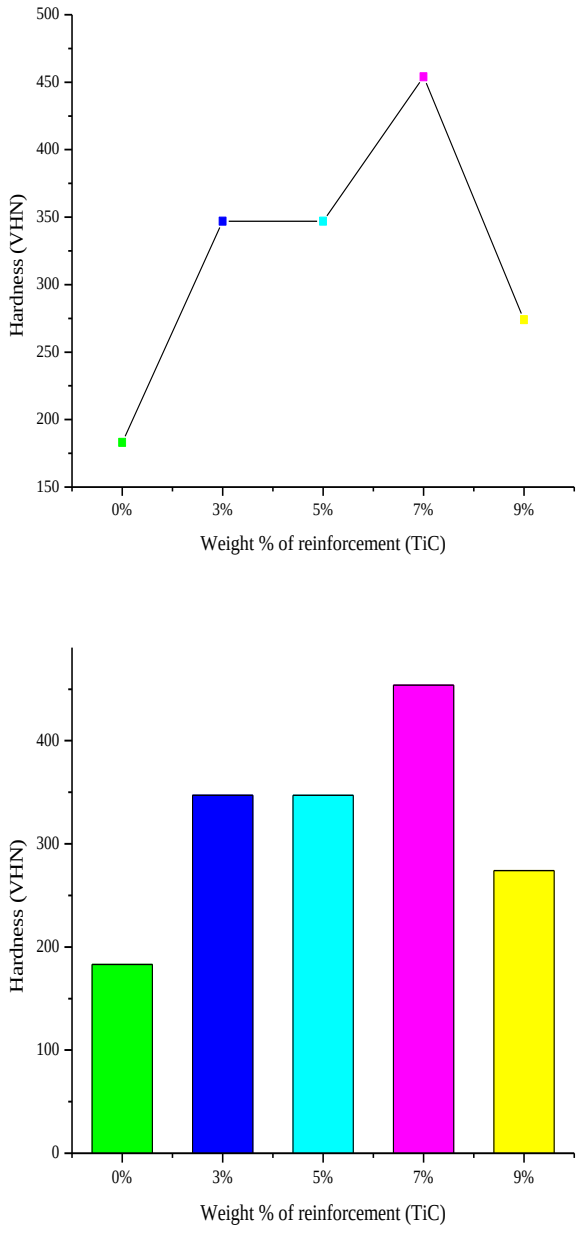



Fig: 12 Hardness v/s wt% of Reinforcement(TiC)

## 5. CONCLUSIONS

In this project work , Al 7075/ TiC composites fabricated by stir casting method and reinforcement particles effect on mechanica1 properties of fabricated aluminium metal matrix composites were investigated. The TiC particles integrated through matrix crucialy clarify the structure of the grain, causes to enlarge the composite strength. But in the case of higher percentage of TiC, there is decrease in mechanical properties. The experimental study discloses subsequent conclusions:

- The mechanical properties of TiC reinforced composite specimens such as tensile strength, hardness and percentage elongation were superior compared to Al7075 matrix material
- The tensile strength was increases with increasing Wt % of TiC, it maximum at 7% of reinforcement TiC and percentage of elongation reduced with increasing % of TiC and It decreases from 8.1 to 5.3 percentage.
- The hardness of composite increased as the reinforcement content increased in the matrix material when approach with base material. The hardness rate higher for 7% weight of TiC and later hardness dropped for 9% wt of TiC.
- Al 7075/ TiC composites shows a depletion in the average grain size during stir casting process.

**Future Scope:**

There is very broad opportunity for future scholars to prospect this region of research. This work can be promote to study further features of such composites like

- Reinforcement discontinuity test can conduct to evaluate with continuous reinforcement.
- Shape and size of reinforcement particulates can consider to the advanced studies.
- Some tests like compression, torsion, impact, fatigue, shear bending test can also be studied.

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