

International Journal of Innovative Research in Science, Engineering and Technology

(A High Impact Factor, Monthly, Peer Reviewed Journal)

Visit: www.ijirset.com

Vol. 8, Issue 7, July 2019

A Study on Tribological (Wear) Properties of Al 7075 Reinforced With TiC Particles of Different Weight Percentages

Ashvinkumar Havalagi¹, S B Mallur²

P.G Student, Department of Mechanical Engineering, University B.D.T College of Engineering, Davangere,
Karnataka, India.¹

Professor & HOD, Department of Mechanical Engineering, University B.D.T College of Engineering, Davangere,
Karnataka, India.²

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%. The wear test have been carried out using a pin-on-disc testing machine for different loads of 1,2,3 and 4kg. At constant time, speed of disc and track diameter. The loss of weight of specimen measured, the weight loss of composites decreases as increasing the % wt of reinforcement for different load conditions compared to the matrix material. The wear rate varied linearly with load. the wear rate decreases by increasing the weight percentage of reinforcement particles(TiC) and shows less wear rate for 7% wt of reinforcement. also the wear rate was notably less for the composite material compared to the matrix material. In the microstructure analysis observed that the distribution of TiC particles properly homogeneous in the composite irrespect of the volume fraction. A contraction in the standard prediction with incorporation of particulates indicates the grain structure much homogenised throughout the casting. All the composite specimens shows the satisfactory tribological(wear rate) properties.

KEYWORDS: Metal matrix composites, Titanium carbide, stir casting.

I. 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)

International Journal of Innovative Research in Science, Engineering and Technology

(A High Impact Factor, Monthly, Peer Reviewed Journal)

Visit: www.ijirset.com

Vol. 8, Issue 7, July 2019

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 aluminium matrix composite material reinforcing with the TiC, B₄C, and TiB₂ particulates on the sliding wear behaviors. and description that the comparing to the ash pure aluminium the wear rate and coefficient of friction are lesser/ lower. Also acknowledged about the many key aspects like kind of size/ dimensions of particles and fractional volume of particulates, in addition to the inter particulates/ matrix bondings manipulates on wear performance of composites reinforcing with in situ elements [3]. The aluminium composites were shows good resistance to the wear compared to without reinforced alloy. Additionally the wear resistance increases by increasing the reinforce content in the composite. and minimizes the co-efficient of friction of aluminium metal matrix composites[AMMCs] at all the loads studied. Also describes that Al 7075 series based aluminium metal matrix composites shows a decrease in the co-efficient of friction and rate of wear by raising the reinforcement particles amount [4]. In the current work, aluminium titanium carbide composite produced using stir casting process is inspect for wear performed. The wear carried out of the composite is investigated at room circumstances at different loads. Microstructural description of the surfaces of wear specimens.

II. EXPERIMENTAL PROCEDURE

Matrix and Reinforcement material

The primary material designate in current exertion is Al7075 because it one of most considerably used for 7000 series Al alloys. It is versatile heat cured extrude alloy with intermediate to soaring strength accomplishment.

| Element | Zn | Cu | Mn | Mg | Fe | Cr | Si | Ti | Al |
|------------------------------|-----|-----|------|-----|------|------|------|------|---------|
| Composition In percentage | 5.8 | 1.5 | 0.06 | 2.4 | 0.24 | 0.20 | 0.08 | 0.07 | Balance |

Table: 1 Chemical Combination of Aluminium Alloy 7075

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

Table: 2 Properties of Al

Particle size and density of reinforcement

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

Table: 3 Particle Size and Density

International Journal of Innovative Research in Science, Engineering and Technology

(A High Impact Factor, Monthly, Peer Reviewed Journal)

Visit: www.ijirset.com

Vol. 8, Issue 7, July 2019



Fig: 1 Aluminium 7075



Fig: 2 Titanium carbide particles

Fabrication Technique

The stir casting method is simplest, most repeatedly used strategy. It is liquid state process for construction of composite 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 electric furnace and melted at 800 $^{\circ}\text{C}$. The experimental setup shown in fig3. Cover flux (45%NaCl + 45%KCl + 10% NaF) and degasifier Hexachloroethane assorted at elevated 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 $^{\circ}\text{C}$ 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 Stircasting setup

International Journal of Innovative Research in Science, Engineering and Technology

(A High Impact Factor, Monthly, Peer Reviewed Journal)

Visit: www.ijirset.com

Vol. 8, Issue 7, July 2019

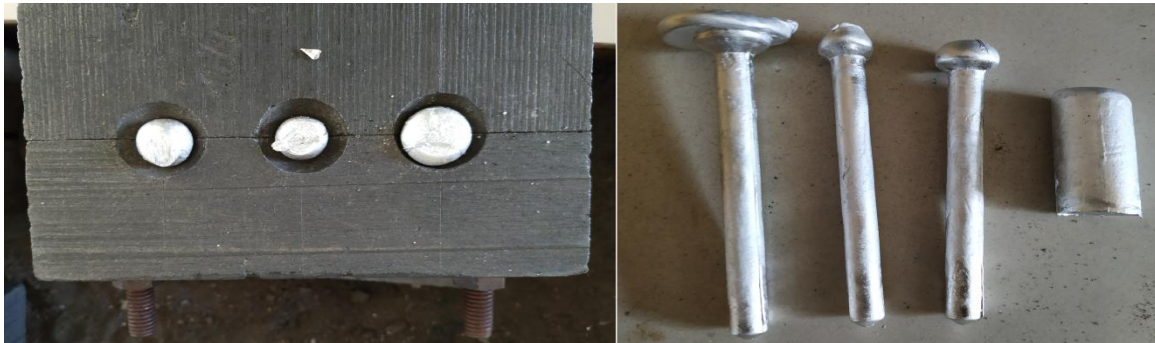


Fig: 4 Composite product

III. TESTING

Wear test

To assess the performance of Al 7075- TiC alloys under dry sliding conditions wear tests fetch out according to ASTM G99 standards using pin-on-disc wear testing machine, which is one of the habitually used test rigs. The computerized pin-on-disc machine (make: TR-20-PHM 400, DUCOM) used for these tests. The 10 numbers of test specimens of dissimilar weight percentage of TiC particulates with aluminium 7075 prepared and test on the pin-on-disc machine. Keeping speed 400rpm, track dia 100mm and time 5min constant and varies the load for 1,2,3, and 4 kg. The disc material made up of EN-31 steel (165mm dia, 8mm thick). Tangential frictional force, wear loss and frictional temperatures monitored and recorded using computerized -data acquisition system. The dimensions of wear test specimens as showed in the fig 5.



Fig: 5 Dimension of wear test specimen

At time of test first note the weight of specimen then start process pin press opposite to rotating steel disc by applied load friction finding arm coupled to strain gauge and pin specimen vertically loaded on the rotating hardened steel disc. The frictional traction accomplished by pin through sliding measure constantly in the data system. The specimen taken out beyond running through fixed sliding time, washed with acetone, again weighed to find out the loss of weight due to wear.

International Journal of Innovative Research in Science, Engineering and Technology

(A High Impact Factor, Monthly, Peer Reviewed Journal)

Visit: www.ijirset.com

Vol. 8, Issue 7, July 2019



Fig: 6 Wear Testing Setup

Microstructure Analysis

Detailed microstructural appraisal of the casted A7075 alloys before and after assortment of master alloys using digital microscope. Microstructural analysis testing is in world-wide industries to valuvate products and materials. The micro-structure of material can strongly authorized by physical properties like streangth, toughness, ductility hardness,temperature and wear resistance.

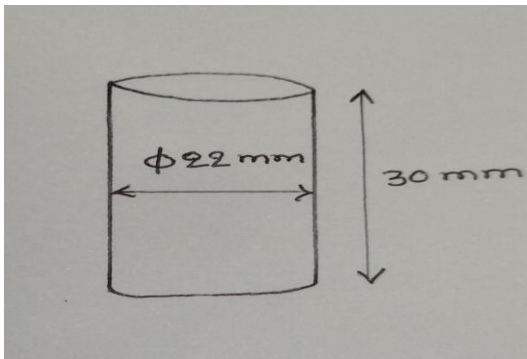


Fig: 7 Dimension of Specimen



Fig: 8 Optical Microscope Setup

This is the most suprem factor, by it we can forecast the behavior of component also important during forecasting failure of a component in definite condition. The 5numbers test specimens prepared for this test of dimension 30mm length and 22mm dia in cylindrical shape as shown in below figure. Before testing samples first polished the surface on 1000 grit size emery papers and on polishing machine using alumina polishing powder. Then test on the optical computerized microscope under 10X, 30X, 60X magnification by keeping sample on moving table of instrument, the images of that are stored in the computers.

International Journal of Innovative Research in Science, Engineering and Technology

(A High Impact Factor, Monthly, Peer Reviewed Journal)

Visit: www.ijirset.com

Vol. 8, Issue 7, July 2019

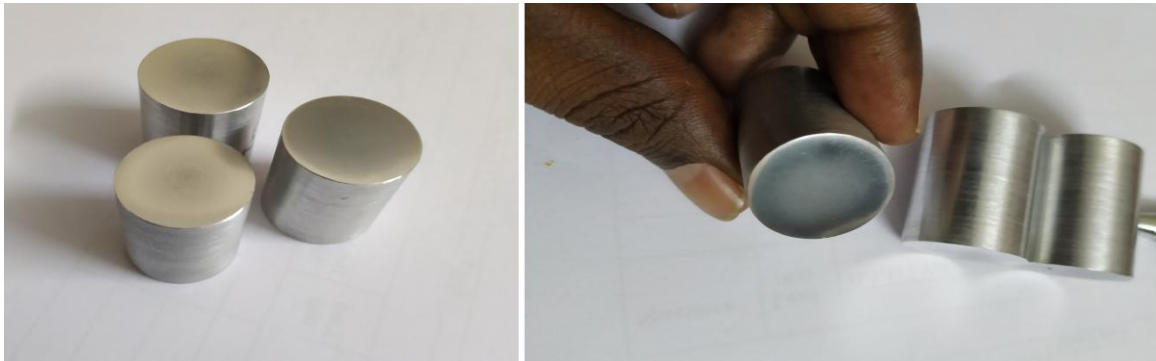


Fig: 9 Polished Test Samples

IV. RESULT AND DISCUSSION

Wear behavior

The testing of 10 numbers of wear samples according to the ASTM G99 standards. The wear test conducted for the weight loss condition. The sliding distance of specimen is given by considering track dia of disc, disc speed and time taken for slide.

$$S = \pi * D * N * T$$

Where,

S- Sliding Distance in m, D- Disc Track Dia in mm, N- Disc Speed in rpm, T- Sliding Time in min

$$\text{Wear rate} = \frac{\text{Weight Loss}}{\text{Sliding Distance}}$$

It is observed from fig 10. that is the weight loss of composite specimens compared to base material, weight loss decreasing as increasing of 5 of reinforcement up to 7% for different applied loads. After that for 9% of reinforcement the weight loss increases. from this clear that to get less weight loss the 7% of reinforcement to matrix is better selection.

International Journal of Innovative Research in Science, Engineering and Technology

(A High Impact Factor, Monthly, Peer Reviewed Journal)

Visit: www.ijirset.com

Vol. 8, Issue 7, July 2019

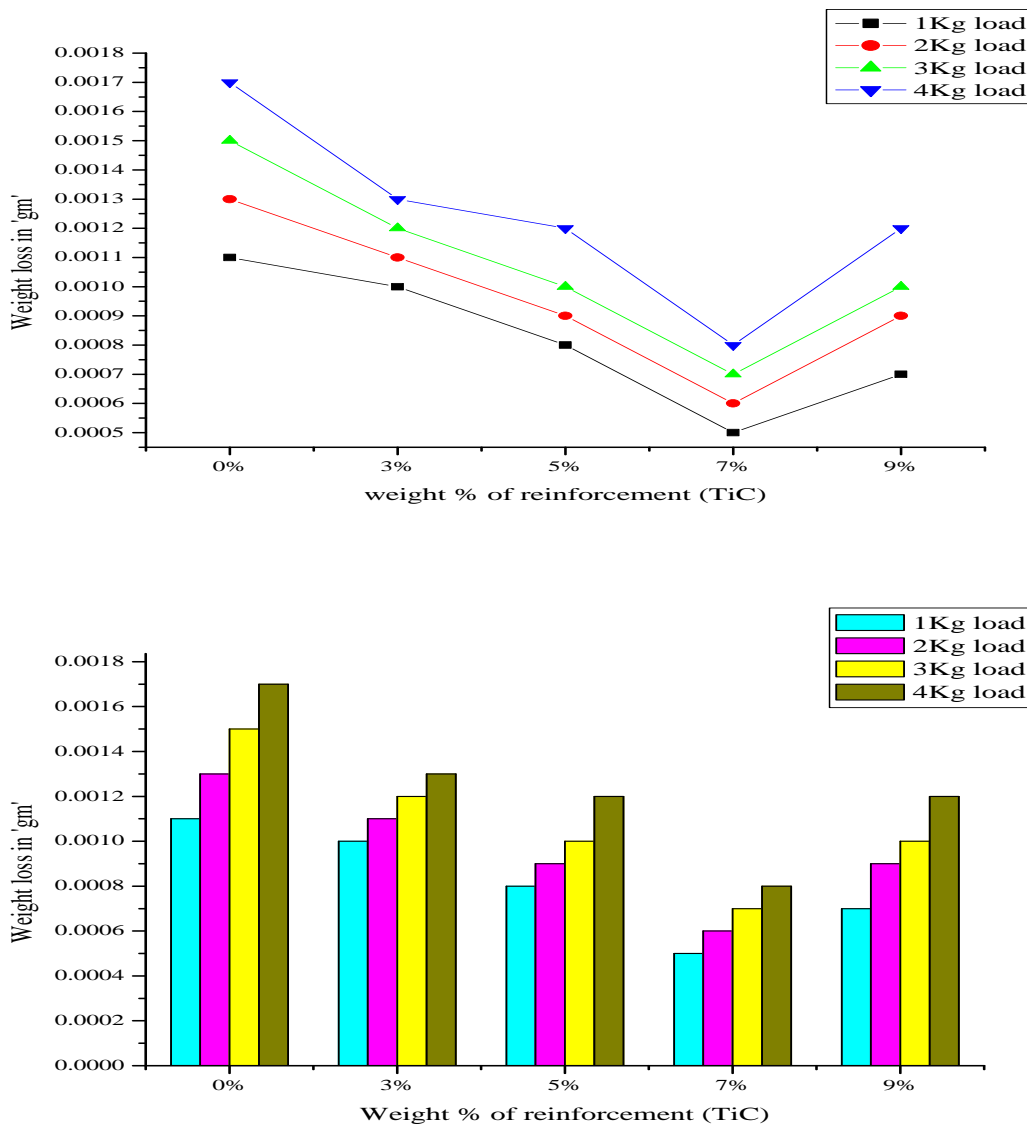


Fig: 10 Weight loss v/s Wt % of reinforcement

The wear rate of the Al7075 matrix material and its composites with adding TiC particles shown in fig 11. All the composites of aluminium with titanium carbide particles exhibit better wear resistance compared to the matrix. Reinforced of TiC particles in matrix significantly reduce the wear. the wear rate decreases with increasing TiC reinforcement particles. For 7% wt of reinforcement the wear rate is less compare to other wt % of reinforcement for different loads such as 1kg, 2kg, 3kg and 4kg. This may be attributed to the incorporation of hard TiC particles resulting in an improvement in the hardness and reduction in real area of contact. Beyond 7 wt% i.e for 9% wt, the wear rate increases and it was found to be less than that of the matrix material.

International Journal of Innovative Research in Science, Engineering and Technology

(A High Impact Factor, Monthly, Peer Reviewed Journal)

Visit: www.ijirset.com

Vol. 8, Issue 7, July 2019

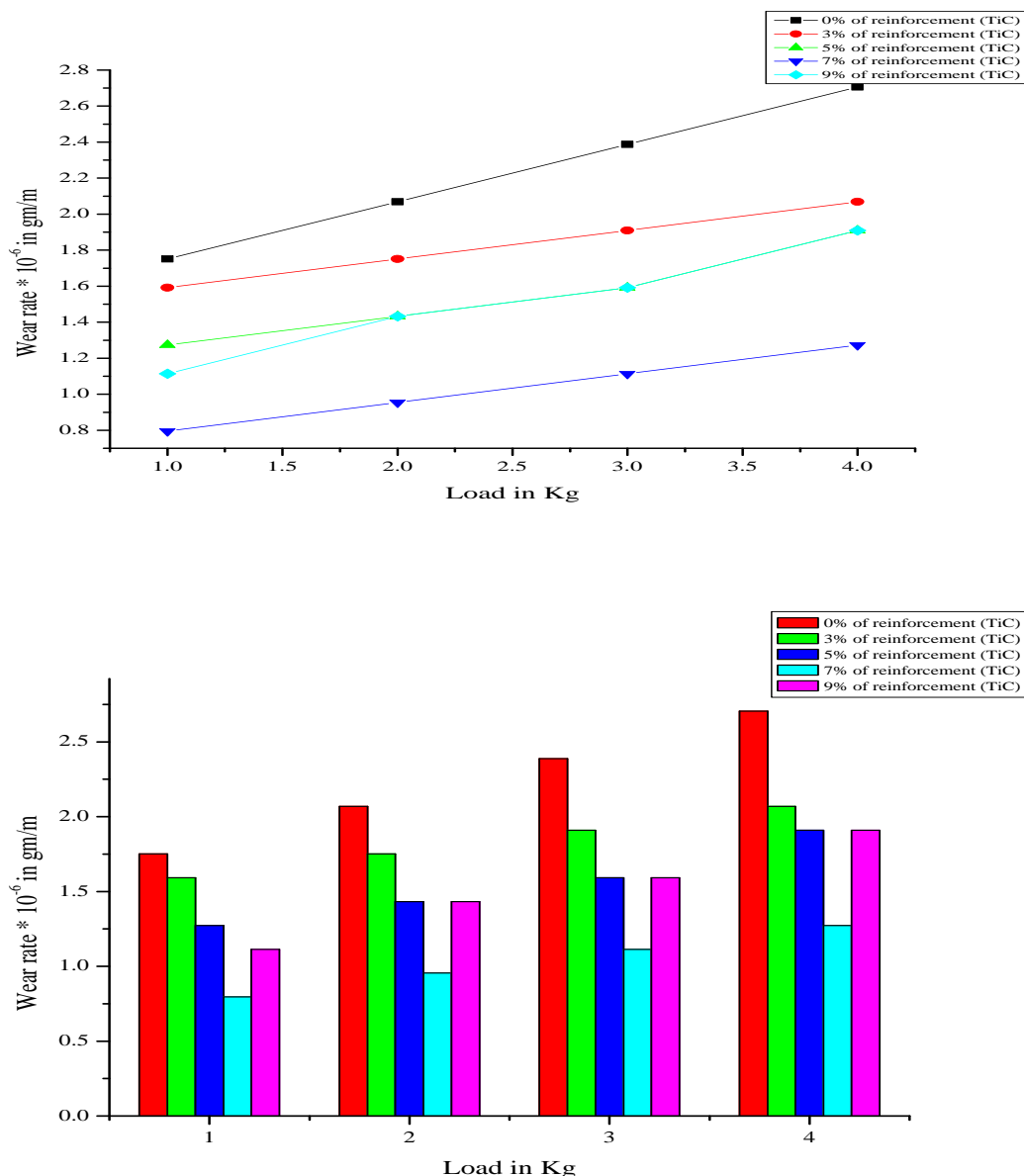


Fig: 11 Wear Rate v/s Load

Microstructural Analysis

It noticed that, there is no remarkable inequality in the average grain size through the position of sample, whatever of the occupancy or not of TiC elements. This is obviously the induced of the TiC particles appreciably contract the grain

International Journal of Innovative Research in Science, Engineering and Technology

(A High Impact Factor, Monthly, Peer Reviewed Journal)

Visit: www.ijirset.com

Vol. 8, Issue 7, July 2019

size in Al7075 matrix of the metal matrix composite. A contraction in the standard prediction with incorporation of particulates denotes the grain structure much harmonized throughout the casting and that means as well the evenly consistent particles assignment takes place. In fig 12, shows the particles dispersion of TiC in the Al7075 matrix material while overlooked within optical microscope remarkably even allocation of the reinforcement is acknowledged among some gatering of the particles to the Al7075/TiC composites. beyond the adding master alloy interested in the Al 7075 melts and upon separation it, on the molten bath surface a dark scrap floated. This scrap related to the flux confined in master composite. even though the melts wiped previous to casting, the composite matrix having lower reinforcement contents still expressed few attendance of entrapped flux.

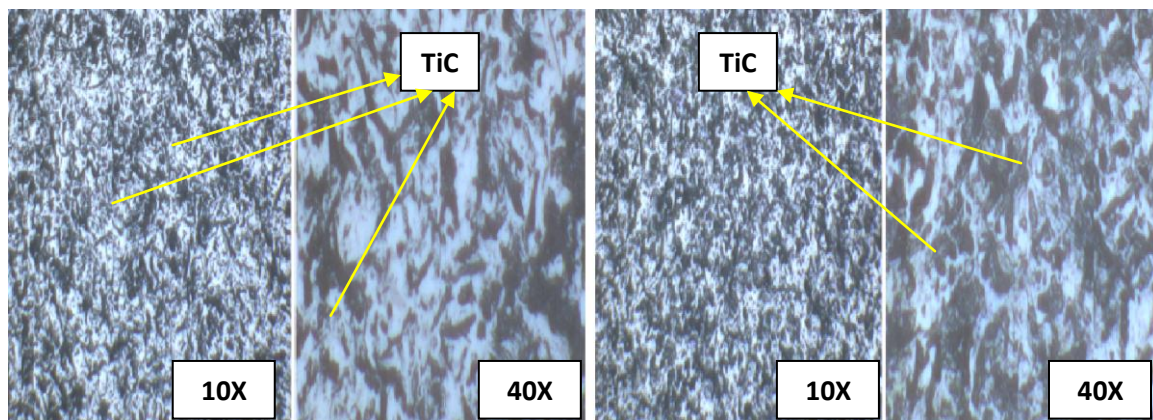


Fig: 12 Optical Micrographs of Al7075 Reinforced with TiC Particulates

V. CONCLUSIONS

In this present work , Al 7075 reinforced with TiC composites fabricated by stir casting method and reinforcement particles effects wear behavior of fabricated aluminium metal matrix composites investigated. The experimental study discloses subsequent conclusions:

- The weight loss of composite material decreased as the reinforcement(TiC) content increased in the matrix material when approach with base material. The weight loss lower for 7% weight of TiC reinforcement and later increased for 9% wt of TiC reinforcement particulates.
- Aluminium composites revealed excellent wear resistance approached to the unreinforced alloy. The more proportion of TiC particles in AMMCs leads to higher wear resistance to the 7% wt and after that 9% wt wear rate was starts increasing.
- The distribution of TiC particles properly homogeneous in the composite irrespect of the volume fraction. A contraction in the standard prediction with incorporation of particulates indicates the grain structure much homogenised throughout the casting.
- Al 7075/ TiC composites shows a depletion in the average grain size during stir casting process.

REFERENCES

- [1]. Ramakoteswara Rao V, Ramanaiah N, Sarcar MMM. Fabrication and investigation on properties of TiC reinforced Al7075 metal matrix composites. Appl Mech Mater 2014;592-594:349-53.
- [2]. A.R.Kennedy, Karantzalis, A.E, Wyatt, S.M., 1999. The microstructure and mechanical properties of TiC and TiB₂ Reinforced cast metal matrix composites, Journal of Material science 34,933-940.

International Journal of Innovative Research in Science, Engineering and Technology

(A High Impact Factor, Monthly, Peer Reviewed Journal)

Visit: www.ijirset.com

Vol. 8, Issue 7, July 2019

- [3]. V.C.Uvaraj, Natarajan.N, Shivakumar.K., “Tribological behavior of heat treated Al 7075 metal matrix composites”.
- [4]. R.Tyagi. Synthesis and tribological characterization of in situ cast Al–TiC composites. Wear 2005;259:569–76.
- [5]. Michael.HB, S.Ramabalan, I.Dinakaran, Effect of TiB₂ content and temperature on sliding wear behavior of Al7075/TiB₂ in situ aluminum cast composites. Arch CivilMech Eng 2014;14(1):72-92
- [6]. A.Kalkanlı, S.Yılmaz. Synthesis and characterization of aluminum alloy 7075 reinforced with silicon carbide particulates. Mater Des 2008:775–80.
- [7]. SURAPPA M.K., ROHATGI P.K., Metal Tech., 4 (1981), 41.
- [8]. Atrian A, Majzoobi GH, Enayati MH, Bakhtiari H. Mechanical and microstructural characterization of Al7075/SiC composites fabricated by dynamic compaction. Int J Miner Metall Mater 2014;21(3):295–303.