

# Dry Sliding Wear Behavior and Mechanical Properties of Al7075 - SiC - Granite Dust by Using Stir Casting Method for Piston

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**Abstract:** Aluminum Metal Matrix Composites (AMMCs) are promising as the most flexible materials for advanced in automotive, structural, aerospace, aviation, marine, defense applications and other interrelated sectors because of their tremendous combination properties. In this work we have taken Al 7075 -SiC- Granite dust. By varying the weight percentage of Al 7075 (75%, 80% and 85%) and the reinforcement materials like SiC (15%, 10% and 5%) and taking Granite dust as constant (10%), by using stir casting technique the material is fabricated.

The wettability of SiC and Granite dust particles in the matrix was improved by adding them. The optical and scanning electron micrographs showed a homogeneous dispersion of composition material. The result shows that the Sample-3 (Al85%+SiC5%+Granite dust 10%) shows improvement in mechanical properties like hardness, the wear properties has been reduced and their Micro structural characterization clearly shows uniform distribution of SiC and Granite dust in the composition.

**Keywords:** Al7075-Aluminium 6061 grade, SiC-Silicon carbide, TiB2-Titanium diboride, Stir casting method, AMMCs-Aluminium metal matrix composites.

## I. INTRODUCTION

Today's the world has been looking for the maximum optimization as possible in every field. Engineering is not an exception. Engineers are looking for creating the extreme best from the best. During these developments some way or the other much affected is the environment. The development of low cost metal matrix composites reinforced with eco-friendly material has been one of the major innovations in the field of materials in the past few decades. Aluminum alloys reinforced with ceramic particles exhibit superior mechanical properties to unreinforced Al alloys and hence are candidate for engineering applications. The organic matters also contain some useful materials and have good physical properties for the example of

egg shell contains calcium carbonate it will give good bonding between the material particles.

This work is a contribution to efforts aimed at the development of Aluminum matrix composites (AMCs) with high performance indices at reduced cost. The well acknowledged good performance in service and consequent high demand for AMCs is attributed to its excellent combination of properties such as high specific strength and stiffness, good wear and high temperature resistance among others. These property combinations are very useful for the design of a wide range of components and parts utilized for automobile and aerospace applications. For example, use of AMCs with high specific strength and stiffness for engine components can contribute significantly to the reduction of the overall weight and fuel consumption of automobiles and aircrafts. Compare to normal aluminium alloy the AMCs is having the better mechanical properties with less cost.

## II. MATERIALS

TABLE I: CHEMICAL COMPOSITION ALUMINIUM 7075

Element	Content (%)
Al	87.1 - 91.4
Cr	0.18 - 0.28
Cu	1.2 - 2
Fe	Max 0.5
Al	87.1 - 91.4
Mg	2.1 - 2.9
Mn	Max 0.3

## III. SILICON CARBIDE

Silicon carbide (SiC), also known as carborundum is a compound of silicon and carbon with chemical formula SiC.

It occurs in nature as the extremely rare mineral moissanite. Silicon carbide powder has been mass-produced since 1893 for use as an abrasive. Grains of silicon carbide can be bonded together by sintering to form very hard ceramics that are widely used in applications requiring high endurance, such as car brakes, car clutches and ceramic plates in bulletproof vests. Electronic applications of silicon carbide such as light-emitting diodes (LEDs) and detectors in early radios were first demonstrated around 1907. SiC is used in semiconductor electronics devices that operate at high temperatures or high voltages, or both. Large single crystals of silicon carbide can be grown by the Lely method; they can be cut into gems known as synthetic moissanite. Silicon carbide with high surface area can be produced from SiO<sub>2</sub> contained in plant material.

#### IV. GRANITE DUST

Granite an industrial waste is an igneous hard rock consists of 20% quartz by volume. It has high strength, stiffness and better wear resistance properties. Granite powders are largely available in stone crushers and in granite stonemines. Density of granite is 2.7 gm/cc and its thermal conductivity is 2.85 W/m-K. Granite Dust is waste material in the stone crushing industries. It is available easily with low cost or without cost. The reason for choosing Granite Dust as the third composition means it has good wear resistance property and also has good strength.



Fig. 1: Pictorial view of granite dust

#### V. STIR CASTING

In a stir casting process, the reinforcing phases are distributed into molten matrix by mechanical stirring. Stir casting of metal matrix composites was initiated in 1968, when S. Ray introduced alumina particles into an aluminum melt by stirring molten aluminum alloys containing the ceramic powders. Mechanical stirring in the furnace is a key element of this process. The resultant molten alloy, with ceramic particles, can then be used for die casting, permanent mold casting, or sand casting. Stir casting is suitable for manufacturing composites with up to 30% volume fractions of reinforcement. The cast composites are sometimes further extruded to reduce porosity,

refine the microstructure, and homogenize the distribution of the reinforcement. A major concern associated with the stir casting process is the segregation of reinforcing particles which is caused by the surfacing or settling of the reinforcement particles during the melting and casting

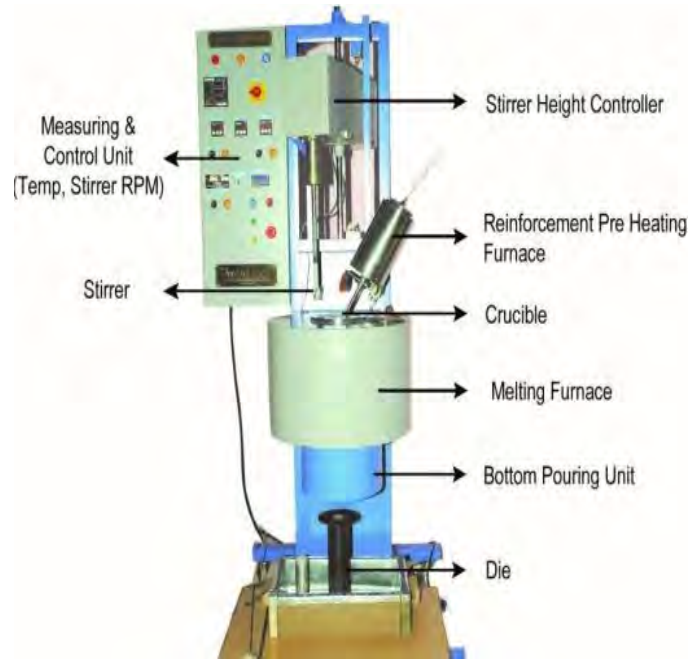


Fig. 2: Stir casting machine schematic diagram

The slurry is again heated to a fully liquid state and mixed thoroughly. This two-step mixing process has been used in the fabrication of aluminum. Among all the well-established metal matrix composite fabrication methods, stir casting is the most economical. For that reason, stir casting is currently the most popular commercial method of producing aluminum based composites.

#### VI. ROCKWELL HARDNESS TEST

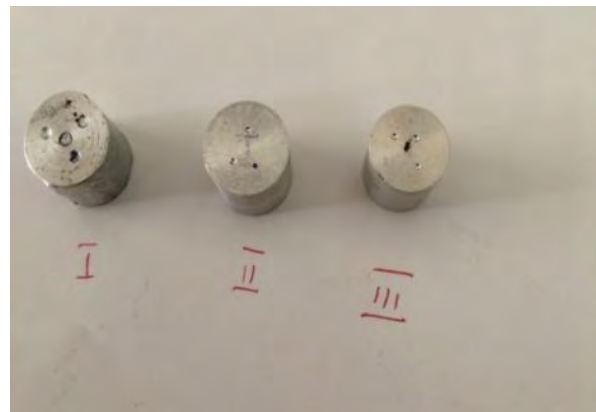


Fig. 3: ASTM sized hardness test work piece

TABLE II: ROCKWELL HARDNESS TEST RESULT

Sample name	Rockwell hardness test				Mean hardness
	Trail 1	Trail 2	Trail 3	Trail 4	
Sample 1	56	55	53	59	56.75
Sample 2	70	63	61	65	64.75
Sample 3	81	84	87	81	83.25

VII. TENSILE TEST



Fig. 4: ASTM sized tensile test work piece

VIII. PIN ON DISC FRICTION AND WEAR TESTER



Fig. 5: ASTM sized work piece

TABLE III: TENSILE TEST RESULT

Material Properties	Yield Strength	Ultimate Tensile Strength	% Of Elongation	% Of Reduction in Cross Section
Sample 1	103.6	129.5	0.9	1.1
Sample 2	125.3	147.5	1.5	1.6
Sample 3	126.1	154.4	1.9	1.3

TABLE IV: WEAR TEST RESULT

Work pieces	Speed in (RPM)	By load in Kg	By Time in Min	Track Radius	Speed in (RPM)	Frictional Force in (N)	Wear in (Micron)
Sample1	300	5 Kg	5Min	30mm	500	104.31	196.40
				40mm	600	103.69	315.50
				50mm	700	104.13	330.08
Sample2	300	5 Kg	5Min	30mm	500	107.12	167.34
				40mm	600	106.39	322.11
				50mm	700	107.52	339.13
Sample3	300	5 Kg	5Min	30mm	500	108.11	164.07
				40mm	600	107.04	333.01
				50mm	700	108.60	374.82

### IX. MICROSTRUCTURE TEST (SEM TEST)

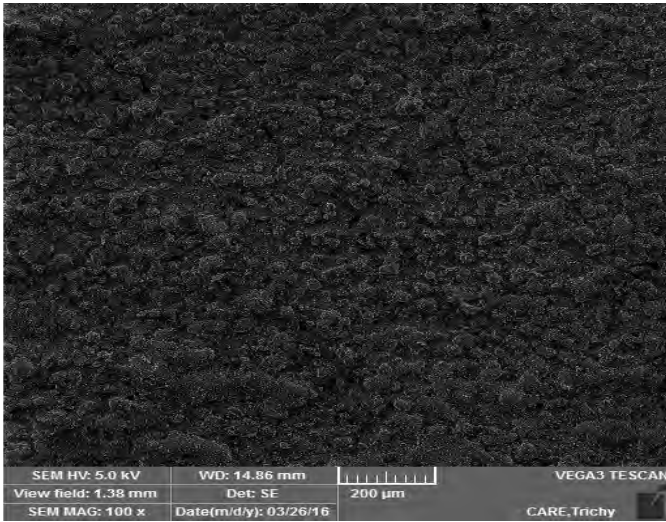


Fig. 6: SEM image of Al7075

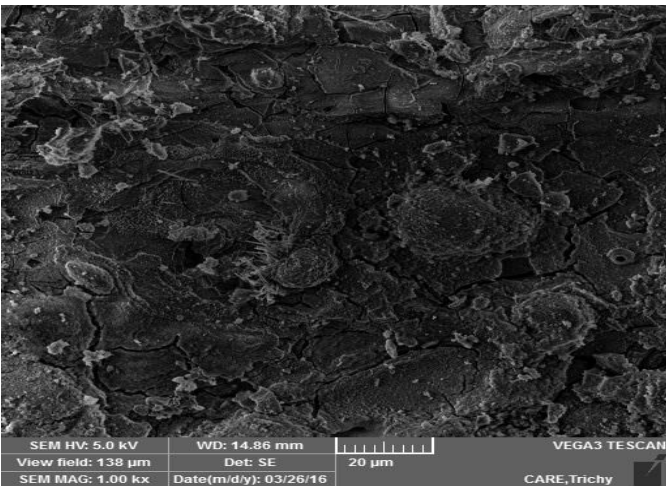


Fig. 7: (Al75%+SiC15%+Granite dust 10%)

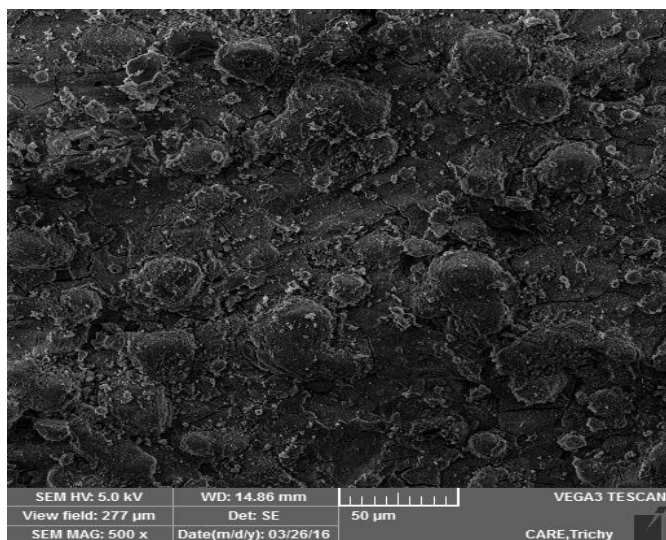


Fig. 8: (Al80%+SiC10%+Granite dust 10%)

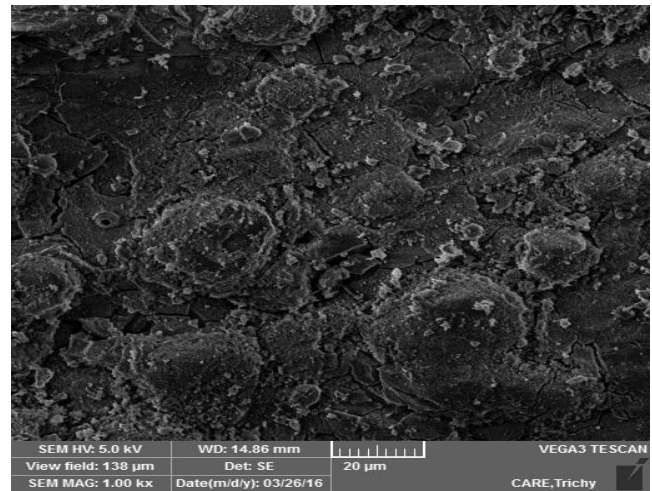


Fig. 9: (Al85%+SiC5%+Granite dust 10%)

### X. CONCLUSION

The mechanical characteristics of Al7075, SiC, Granite Dust in the form of three different sample were prepared by using stir casting furnace were detail study has been made. The result show that the sample III (Al85%+SiC5%+Granite dust 10%) hardness property of Aluminium will increases when it is reinforced with SiC along with Granite Dust. By increasing the reinforcement materials along with aluminium will improve the micro hardness value. Inclusion of SiC along with the Granite Dust will certainly increases the strength of the materials. Wear test were conducted by using pin on disc wear tester for three various specimen among that sample III (Al85%+SiC5%+Granite dust 10%) has maximum of wear resistance characters and co-efficient of friction. scanning electron microscope clearly reveals of that the composites materials produced by stir casting method shows fairly uniform distribution of SiC and Granite Dust particulates in the 7075Al metal matrix.

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