iJRASET
International Journal For Research in
Applied Science and Engineering Technology

# INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

**Volume:** 7 **Issue:** V **Month of publication:** May 2019

**DOI:** https://doi.org/10.22214/ijraset.2019.5078

International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.177
Volume 7 Issue V, May 2019- Available at www.ijraset.com

# Investigating the Influence of Cotton Shell Ash-SIC Weight Percentage on the Mechanical Behaviour of Aluminium Alloy Based Hybrid Composite

Pamarthi Harish[1], Veeranki Mohan Srikanth[2], P.Ravindra Babu[3], M. R. Ch. Sastry[4]
*[1]P.G Student, [2]Assistant Professor , [3]Professor & Principal , [4]Professor& Head, Department of Mechanical Engineering, Gudlavalleru Engineering College, Gudlavalleru, A.P, India.*

***Abstract—The effect of cotton shell ash (CSA) and abrasive ceramic particles (SIC) reinforced with aluminium alloy based metal matrix are enhancement of mechanical and metallurgical properties of the composite materials. Those strengthening of properties such as hardness, lower density, compression. The meal matrix hybrid composites (MMCH) are fabricated by the reinforcement with 30µm - 40µm. The hybrid composite accommodate the 1wt%, 3wt% and 5wt% CSA-SIC with percentage of 75:25 respectively it was fabricated by the bottom pouring stir casting method. Microstructure evaluation, calculate the density, estimate the porosity, mechanical behaviour was investigate the performance of prepared hybrid composite.***

***Keywords— AL-6063, Hybrid Matrix Composite, Cotton Shell Ash (CSA), Abrasive Ceramic Particles (SIC) , Stir- Casting , Micro Hardness, Lower Density, Compression, Microstructure.***

## I. INTRODUCTION

The hybrid Composite material are fabricated by the merging of two or more similar or dissimilar materials together. The mechanical behaviour of these composites will more-better than the alloying materials and individual pure materials. These hybrid composite materials will have composed of two or more phases. These are matrix phase and reinforcement phase.

The Hybrid Metal Matrix Composite is one type of composite in which the matrix phase is predominantly metal or metallic alloy. The matrix is the base material of which constitutes the major portion and the minor portion are reinforcement those are in the form of particles, nano-powders whiskers, continuous and discontinuous fibers etc. The reinforcements are ceramic or organic compounds. The MMHC consists of high ranking properties such as high strength, high fastness, toughness, creep resistance, high electrical and thermal conductivity, and better resistance to corrosion, oxidation and wear-behaviour when compared to the parent materials.

Aluminium Metal Matrix Hybrid Composites are broadly utilized due to their advantageous properties like low density, low-cost, high strength to weight ratio, better corrosion resistance, good thermal conductivity and high stiffness. These applications are desirable in manufacturing, thermal, ocean, defence and automobile industries.

## II. EXPERIMENTAL PROCEDURE

### *A. Materials and Methods*

Material selection

Parent Material Al-6063

Reinforcements – Cotton-shell Ash (CSA)
Silicon carbide (SIC)

The Al6063 is an aluminium based alloy, in which mainly magnesium and silicon are the alloying elements. The standard management of its composition was maintained by The Aluminum Association. It has generally good mechanical and tribological properties and is heat treatable and weldable. Al6063 alloy is the most favorable alloy used for aluminium extrusion. It allows the most compound-complex shapes to be formed with extremely smooth surfaces fit for anodizing and so it is popular for viewable architectural applications such as windows mountings, door-way frames, slab-ceilings, and sign boards.

**Fig: 1** Base material pure Al-6063

International Journal for Research in Applied Science & Engineering Technology (IJRASET)
*ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.177*
*Volume 7 Issue V, May 2019- Available at www.ijraset.com*

Aluminium pure 6063 alloy was stir-casted with cotton shell ash (CSA) and abrasive ceramic particles (SIC) particles of mass fraction of percentage as reinforcement so as to fabricate Al-6063 hybrid composites. The chemical composition of Al 6063 alloy is shown in Table 1. Cotton shell ash (CSA) was prepared by the cotton dry shells. It was collected from the cotton fields. The shell ash total preparation was in optimum methods. The temperature of the inside and outside furnace was precisely monitored and accurately controlled (±4ºC) utilizing two advanced thermocouples and one PID controller. The experimental setup of stir casting equipment used a 1HP motor to rotate the stirrer at different speeds in between 150 to 1500 rpm; a hydraulic mechanism was used to bring the stirrer and to move up and down moments in contact with composite material inside the furnace.

| Al | Cr | Cu | Fe | Mg | Mn | Si | Ti | Zn |
|---|---|---|---|---|---|---|---|---|
| 97.5 | 0.1 | 0.1 | 0.35 | 0.9 | 0.1 | 0.60 | 0.1 | 0.1 |

**Table: 1** Chemical Composition of Al-6063

In this work the stir casting procedure is used for fabrication of Al6063 alloy with fraction reinforcement of 0%, 1%, 2%, 3% of ocotton shell ash (CSA) and abrasive ceramic particles (SIC) particles of weight percentage on aluminium 6063 is matrix material possess vital mechanical properties i.e high strength , fatigue resistance, and tensile strength . It is used aks following application aircraft structure, automobile engines.

**Fig: 2** Preheated cotton shell ash (CSA)

**Fig: 3** Preheated SIC

| Constituent | SiC | Si | $SiO_2$ | Fe | Al | C |
|---|---|---|---|---|---|---|
| %Wt | 98.5 | 0.3 | 0.5 | 0.03 | 0.1 | 0.3 |

**Table: 2**. Chemical Composition of SIC

*B. Procedure for Stir Casting*

A bottom pouring type totally sensorised stir casting machine is used to produce the AMMCs material. Initially the matrix material Al6063 alloy cut bits placed into the 2 kg capacity furnace. The furnace temperature maintained was around 800 degrees centigrade. The matrix material Al6063 at above 750 degrees centigrade temperature material becomes at most liquid state. Then magnesium of 10 grams added to the molten metal for wetting agent. And maintain organ environment with help of pure organ gas (oxygen free). Before stirring the reinforcement is preheated up to 200◦c at 1 hour. The stirring was done by using mechanical stirrer and the stirrer speed was maintained 750 rpm and stirring time at 10 min. And its stirrer is dipped 3/4 height of molten metal in the furnace. During this stirring operation both matrix material Al6063 and reinforcement material are mostly mixed. The die was preheated at most 450◦c at 60 min. finally the melted aluminium hybrid metal matrix composites was transferred into the die.

**Fig: 4** Stir casting machine

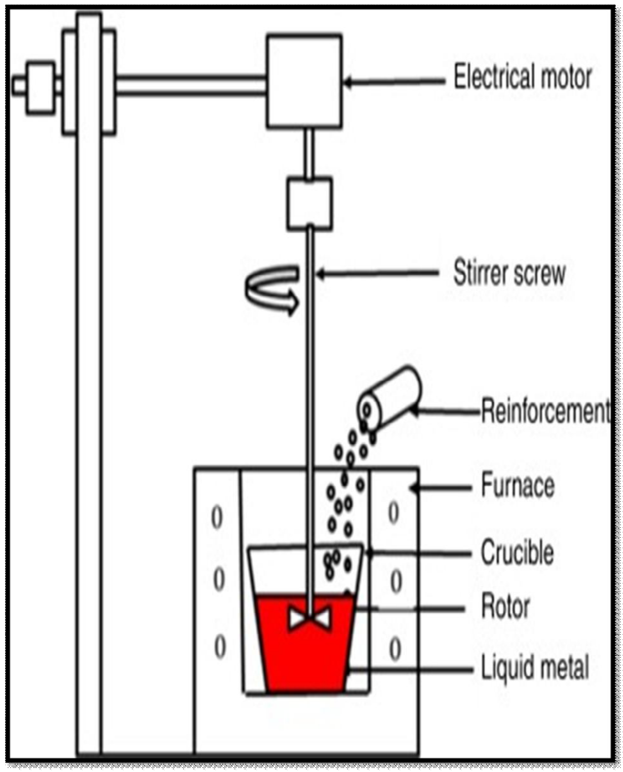



**Fig: 5** process

**Fig: 6** Casted specimens

**Processing parameters**

| Parameter | Unit | Value |
|---|---|---|
| Spindle speed | Rpm | 750 |
| Stirring time | Second | 480 |
| Stirring temperature of the melt | ºC | 750 |
| Preheating temperature of cotton shell ash (CSA) and abrasive ceramic particles (SIC) | ºC | 200 |
| Preheating time of the reinforcements | Minutes | 60 |
| Preheat temperature of die | ºC | 450 |
| Powder pouring rate | g/s | 1.4 |

**Table: 3** Process parameters for stir casting

*C. Tests conducted*
*1)Density*
*2)Hardness*
*3)Compression*
*4)Microstructure*

## III. RESULTS AND DISCUSSION

**Designations for the composites produced:**

| Samples Designation | % Wt. (CSA: SiCp) |
|---|---|
| 0% | 0 |
| 1% | 75:25 |
| 2% | 75:25 |
| 3% | 75:25 |

**Table: 4** Samples Designation

### *A. Density Evaluation*

The density measurements was carried out to evaluate the levels of porosity of the produced hybrid composites and in order to study the effect of the wt% proportions of the cotton shell ash (CSA) and abrasive ceramic particles (SIC) on the densities of the produced composites. This was achieved by comparing the experimental and theoretical densities of each weight percent of cotton shell ash (CSA) and abrasive ceramic particles (SIC) reinforced composites using established procedures. The experimental density ($\rho$EXT) was then determined by dividing the measured weight of the sample by its measured volume. The theoretical density ($\rho$T) was obtained by using the rule of mixtures.
The percentage porosity was evaluated using the relations:

$$\% \text{ Porosity} = \frac{\rho T - \rho EXT}{\rho T} * 100$$

| Sample Designation | Theoretical Density | Experimental Density | % Porosity |
|---|---|---|---|
| 0% | 2.72 | 2.69 | 1.10 |
| 1% | 2.61 | 2.58 | 1.14 |
| 2% | 2.59 | 2.555 | 1.35 |
| 3% | 2.52 | 2.482 | 1.5 |

**Table: 5** Density of Al 6063/ (CSA: SiCp) hybrid composite

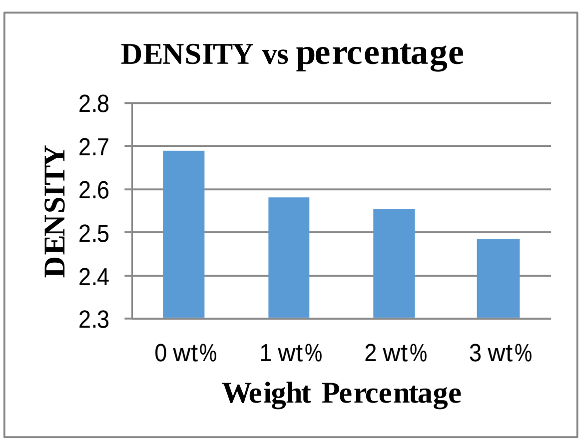



**Fig: 7** Density of Al 6063/ (CSA: SiCp) hybrid composite

International Journal for Research in Applied Science & Engineering Technology (IJRASET)
*ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.177*
*Volume 7 Issue V, May 2019- Available at www.ijraset.com*

### *B. Macro Hardness*

Mechanical properties such as hardness of the developed hybrid composites were evaluated using Brinell hardness tester with scale of BHN. The sample preparation and testing procedure for the hardness evaluation was carried out in accordance with ASTM E-8 standard in which the samples were exposed to a direct load of 187.5 kgf grams for 10s; multiple hardness tests were conducted on each sample and the average value was taken as the hardness of the samples.

**Fig: 8** Brinell hardness tester

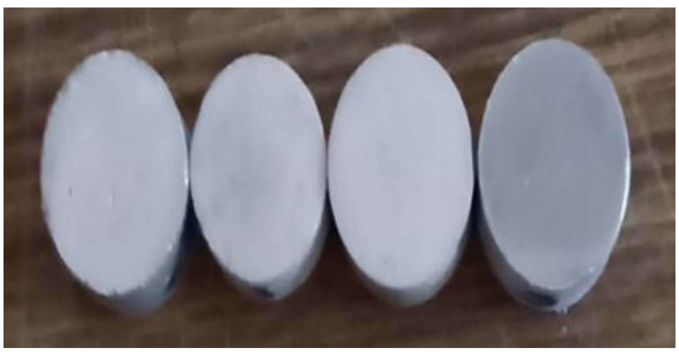


**Fig: 9** specimens for hardness

| S.no | Sample reinforcement % | Indenter Dia | Indentation Diameter | | | | BHN | Load |
|---|---|---|---|---|---|---|---|---|
| | | | Trail-1 | Trail-2 | Trail-3 | Average | | |
| 1. | Al-6063(Pure) | 2.5 | 1.7 | 1.6 | 1.75 | 1.683 | 72.37 | 187.5 |
| 2. | 1% | 2.5 | 1.6 | 1.65 | 1.55 | 1.616 | 82.36 | 187.5 |
| 3 | 2% | 2.5 | 1.55 | 1.5 | 1.6 | 1.55 | 88.43 | 187.5 |
| 4 | 3% | 2.5 | 1.5 | 1.45 | 1.55 | 1.5 | 95.5 | 187.5 |

**Table: 6** Brinell hardness values of Al 6063/ (CSA: SiC) hybrid composite

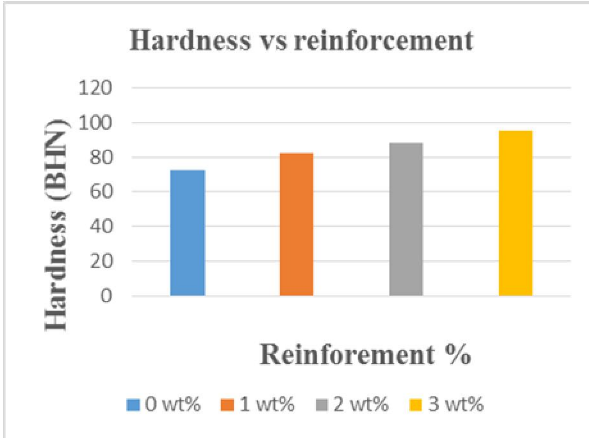



**Fig: 10** Effect of Hardness Al 6063/ (CSA: SiCp) hybrid composite

*C. Compression Test*

Uniaxial compression test trails was conducted on the universal testing machine equipped with all accessories. The sample specimens are prepared by compression test in the cylindrical type of dimensions of 13mm diameter and 26mm length was prepared from the machining with the help of lathe machine. The samples such as compression axis is similar to the height of the specimen direction. Compression tests was conducted to 50% of engineering strain. The distortion samples for metallographical evaluation was conducted by utilizing inverted metallurgical microscope. In that each composition is prepared by three samples, the test was conducted by three trails by three specimens. The average of three trails is taken as the ultimate load.


**Fig: 11** Specimens after compression test

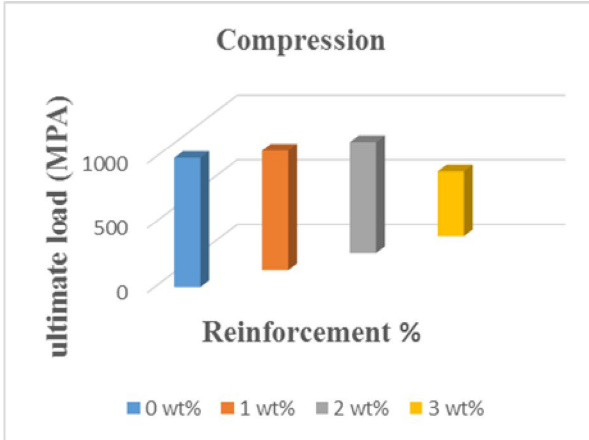
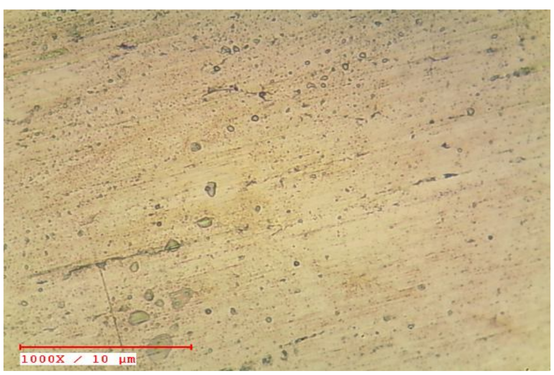



**Fig: 12** compression graph of Al 6063/ (CSA: SiC) hybrid composite

From the above graph it has been concluded that the ultimate compression strength will be decreases with increase the wt %pa of reinforcement of CSA-SIC at 0wt%, 1wt%, 2wt% and 3wt%. In this compositions preparation porosity will be slightly increase this causes compression strength will be decreases.

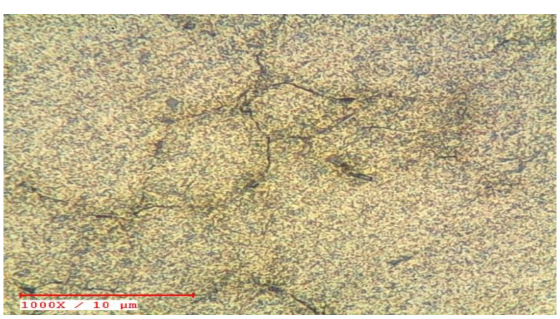
*D. Microstructure*

A computerized inverted metallurgical microscope with all accessories for analyzing the microstructure. Images was utilized to evaluate the microstructure of the metal matrix hybrid composites. Traditional enhance polishing of the routines following by the etching with solutions of 10ml hydrochloric acids, 10ml methanol and 5ml of hydrofluoric acid was utilized to preparation of the samples before microscopic evaluation



Pure Al-6063

1 wt% reinforcement



2 wt% reinforcement

3 wt% reinforcement

**Fig: 13** Microstructure images of 0%, 1%, 2%, & 3% of Al 6063/ (CSA: SiC) hybrid composite

## IV. CONCLUSION

We can conclude that by reinforcing with Cotton Shell Ash and silicon carbide. We have the following results:-

Improvement of hardness in the AL6063 alloy by reinforcing gradually.

Increase in compressive strength as reinforcement increases.

Decrease in Density as reinforcement increases from 1% to 3%.

Observations from microstructure:

Uniform mixing of 1% reinforcement (0.75% Cotton Shell Ash +0.25% Silicon Carbide).

Uniform mixing of 2% reinforcement (1.50% Cotton Shell Ash + 0.5% Silicon Carbide).

Uniform mixing of 3% reinforcement (2.25% Cotton Shell Ash +0.75% Silicon Carbide).

Hence we can conclude that

The optimum percentage of reinforcement in Al 6063 are 3% reinforcement such as 2.25%

Cotton Shell Ash and 0.75% Silicon Carbide for better mechanical and metallurgical properties.

## REFERENCES

[1] A.Shanmuga sundaram, Sanjivi Arul, R.Sellamuthu. Investigating the Effect of WC on the Hardness and Wear Behavior of Surface Modified AA 6063, Materials Today: Proceedings Vol.5, (2018), Pages 6579–6587.

[2] B. Praveen KUMAR, Anil Kumar BIRRU. Microstructure and mechanical properties of aluminium metal matrix composites with addition of bamboo leaf ash by stir casting method Trans. Nonferrous Met. Soc. China 27(2017) 2555−2572.

[3] Babu Rao J, Venkata Rao D, Narasimha Murthy I, and Bhargava NRMR, Mechanical properties and corrosion behaviour of fly ash particles reinforced AA 2024 composites", International Journal of Composite Materials (ISSN: 0021-9983) – Vol.46(12),( 2011), pp.1393-1404.

[4] David Raja Selvam. J, Robinson Smart. D.S. Dinaharan. I. Synthesis and characterization of Al6061-Fly Ashp-SiCp composites by stir casting and compocasting methods, Energy Procedia Vol.34, (2013), Pages 637 – 646.

[5] Davies Oladayo Folorunso a, Seun Samuel Owoeye. Influence of quarry dust-silicon carbide weight percentage on the mechanical properties and tribological behavior of stir cast ZA-27 alloy based hybrid composites,Journal of King Saud University – Engineering Sciences, (2017).

[6] Enzhao Wang, Tong Gao, Jinfeng Nie, Xiangfa Liu. Grain refinement limit and mechanical properties of 6063 alloy inoculated by Al–Ti–C (B) master alloys, Journal of Alloys and Compounds Vol. 594,(2014),Pages 7–11.

[7] Hafeez Ahamed, V. Senthilkumar. Hot deformation behavior of mechanically alloyed Al6063/0.75Al2O3/0.75Y2O3 nano-composite—A study using constitutive modeling and processing map, Materials Science and Engineering, AVol.539,(2012),Pages 349–359.

[8] Kenneth Kanayo Alaneme , Kazeem Oladiti Sanusi. Microstructural characteristics, mechanical and wear behaviour of aluminium matrix hybrid composites reinforced with alumina, rice husk ash and graphite. Engineering Science and Technology, an International Journal 18 (2015) 416e422.

[9] K.Vijaya Bhaskar, S.Sundarrajan ,B.Subba Rao , K.Ravindra. Effect of Reinforcement and Wear Parameters on Dry Sliding Wear of Aluminum Composites-A Review,Materials Today: Proceedings, Vol.5, (2018), Pages 5891–5900.

[10] K. Soorya Prakash, A. Kanagaraj, P. M. Gopal. Dry sliding wear characterization of Al 6061/rock dust composite, Trans. Nonferrous Met. Soc. China Vol.25, (2015), Pages 3893−3903.

[11] Kenneth Kanayo Alaneme, Bethel Jeremiah Bamike. Characterization of mechanical and wear properties of aluminium based composites reinforced with quarry dust and silicon carbide, Ain Shams Engineering Journal, 2018.

[12] K.Vijaya Bhaskara*, S.Sundarrajan b, B.Subba Rao c, K.Ravindrad. Effect of Reinforcement and Wear Parameters on Dry Sliding Wear of Aluminum Composites-A Review, Materials Today: Proceedings 5 (2018) 5891–5900.

[13] R. Siva Sankara Rajua, M.K. Panigrahib, R.I. Gangulyb, G. Srinivasa Raoc. Tribological behaviour of al-1100-coconut shell ash (CSA) composite at elevated temperature Tribology International 129 (2019) 55–66.

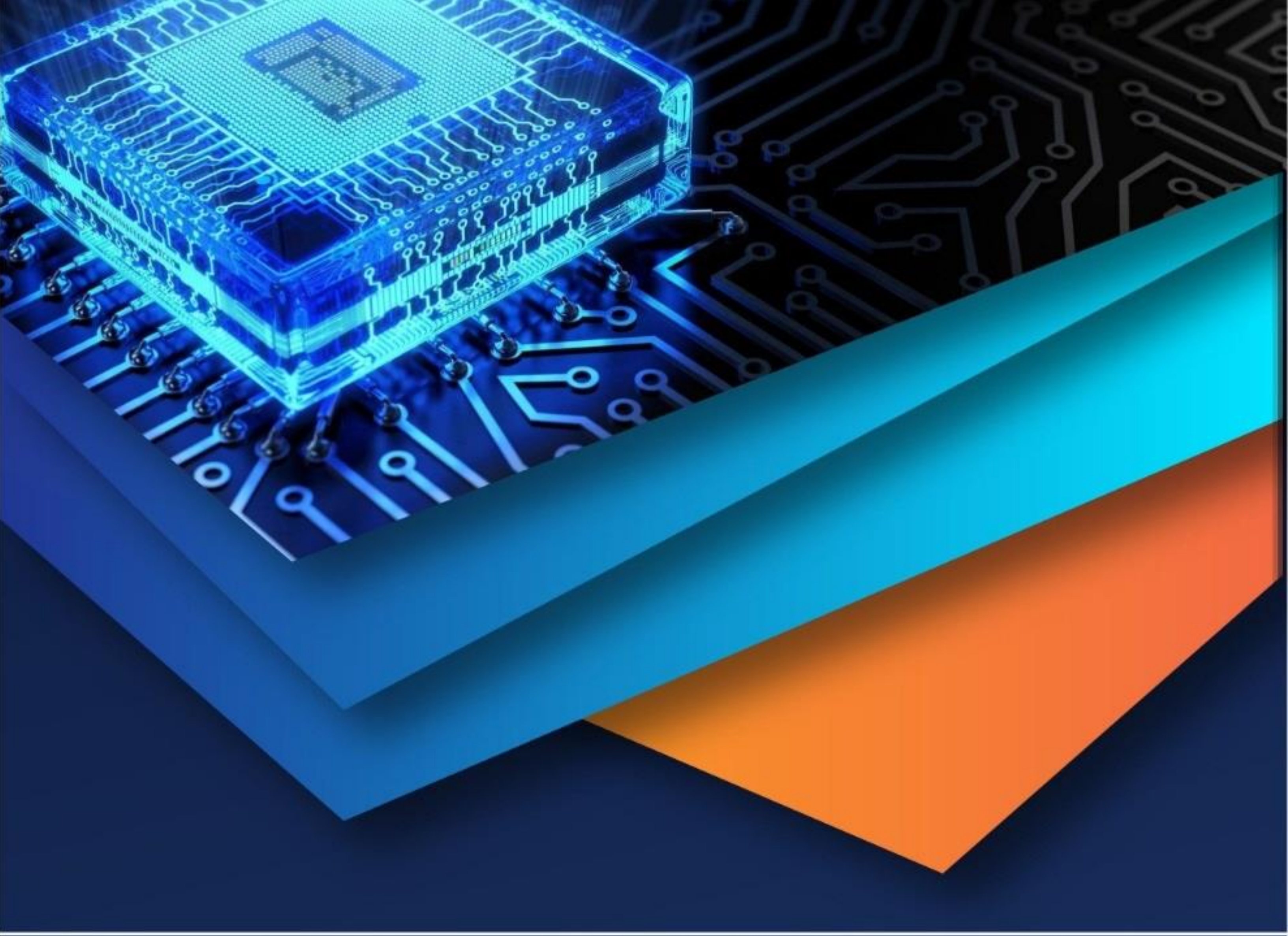
[14] S.Natarajan,R.Narayanasamy,S.P.Kumaresh Babu,G.Dinesh,B.Anil Kumar,K.Sivaprasad, Sliding wear behaviour of Al 6063/TiB2 in situ composites at elevated temperatures, Materials and Design 30(2009) 2521-2531.

[15] Shanmughasundaram palanisamy,Subramanian Ramanathan and Ravikumar Rangaraj, Analysis of Dry Sliding Wear Behaviour of Aluminium –Fly Ash Composites, Advances in Mechanical Engineering, Volume 2013,Article ID 658085.

[16] Sarbjit Singh. Wear Behavior of Al-6063/SiC Metal Matrix Composites Reinforced with Different Particles Sizes usingTaguchi's Methodology, Materials Today: Proceedings, Vol. 4, (2017), Pages 10148–10152.

[17] S. Natarajan , R. Narayanasamy , S.P. Kumaresh Babu , G. Dinesh , B. Anil Kumar , K. Sivaprasad. Sliding wear behaviour of Al 6063/TiB2 in situ composites at elevated temperatures, Materials and Design, Vol.30, (2009) Pages 2521–2531.

[18] Umanath K,Selvamani S T, Palanikumar K, Friction and wear behavior of Al6061 Alloy (Sicp+Al2O3p) Hybrid Composites.Intrnational journal of Engineering science and TechnologyVol.3 No.7 July 2011.




10.22214/IJRASET

INDEX COPERNICUS 45.98

IMPACT FACTOR: 7.129

TOGETHER WE REACH THE GOAL

IMPACT FACTOR: 7.429


# INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY