Influence Of Flyash & Silicon Nitride On Mechanical & Tribological Properties Of Aa 7075 Hybrid Composite

T. Sharanya Balaji, A. Shanmugasundaram

Abstract*: The main objective of this research work is to study the effect of Silicon Nitride (Si_3N_4) and Flyash on the mechanical and tribological properties of AA 7075 hybrid composite. The Stir casting technique has been used for the fabrication of composite material. sAA 7075 were reinforced with 2 wt. % of Silicon Nitride and 2.5, 5, 7.5 wt. % of Flyash. Pin-on-disc equipment is used to evaluate the wear rate of the base alloy and hybrid composite. Dry sliding wear test were performed with the contact load which is varied by 10, 20 & 30 N. Sliding velocity is varied by 1, 1.5 and 2 m/s. Sliding distance is kept constant at 1000 m. The Scanning Electron Microscope (SEM), Energy Dispersive X Ray Spectroscopy (EDAX) and X-ray diffraction (XRD) were used for the characterization of the composites. The maximum hardness of 173 HV is achieved for 5 wt% Flyash and 2 wt% of Silicon Nitride addition. The percentage increase in hardness is 155 % above the base metal. AA 7075 with the 5 wt % reinforcement of Flyash shows the minimum wear rate. With respect to the base the wear rate is reduced by 59 %.

***Index Terms*: Stir Casting, AA7075, Fly-ash, Silicon Nitride.**

I. INTRODUCTION

In Industrial world aluminium alloys are very popular as structural materials, mainly because of its high strength-weight ratio. Aluminium alloys are mostly preferred in many industries; especially in the aircraft industry it is very important to reduce the weight of airplanes as much as possible. Among most of the heat treatable aluminium alloy AA7075 are preferred in automobile and aerospace sectors due to its high tensile strength and toughness. Also, AA 7075 is heat treatable and the properties can be further enhanced. Although aluminium alloy possess many good characteristics, its hardness and wear resistance are poor when compared to ferrous alloys. Various hard ceramic particles are used as reinforcement in order to improve the mechanical properties of aluminium metal matrix composite (AMMC).

In one of the research work Aluminium scrap is melted and reinforced with SiC with wt. % of 5, 10, 15, 20, 25 and 30 and AMMC is fabricated through stir casting route. Maximum hardness of 45.5 BHN and impact strength of 36 N-m is obtained with the SiC wt % 25 [1]. Flyash is a waste product from thermal power plant and is abundantly available all over the world. Many researchers used the flyash to improve the properties of existing aluminium alloy. AA 7075 is reinforced with 4, 8 and 12 wt. % of flyash using stir casting technique and found that the highest hardness (81 HV) is obtained with flyash reinforcement of 12 wt. %. Hardness is improved by 21 % when compared to base metal (67 HV). Similarly, ultimate tensile strength is highest (181 MPa) with 12 wt. % of Flyash [2]. AA 6061 is reinforced with flyash of three different size ranges (4.25, 45-50 and 75-100 µm). The wt. % is also varied by 10, 15 and 20. The result shows that the hardness increases with respect to increase in wt. % of flyash. At the same time the ductility reduces with the increase in wt. % of flyash. When the flyash wt % increases from 0 to 15 % tensile strength also increases but after 15 % it reduces. Also, the tensile strength reduces when the flyash particle size is increasing [3]. Later researches started to add more than one reinforcement particles in order to achieve distinctively superior properties and are termed as Hybrid Metal Matrix composites. In one of the attempt AA 6061 is reinforced with SiC and TiB_2. Size of SiC and TiB_2 used in the experiment are 25 and 10 µm respectively. SiC wt % is fixed as 10 % and TiB_2 wt. % is varied by 2.5 and 5 %. Stir casting is used to fabricate the hybrid composite. With an addition of 10 % of SiC with AA 6061 the hardness improves significantly but when TiB_2 is added along with SiC up to 2.5 % there is slight improvement in hardness after that with 5 % of TiB_2 the hardness reduces. Tensile strength with SiC wt. % of 10 is 150 MPa but with the addition of TiB_2 of 2.5wt. % the tensile strength significantly reduces to 55 MPa. The microstructure investigation shows that the SiC particles are surrounded by TiB_2 due to non-uniform distribution of reinforcements. This lack of interfacial bonding is due to many process parameters of stir casting technique. Wear resistance of the AA 6061+ SiC + TiB_2 is higher by 20 % than the AA 6061+ SiC composite [4].

Silicon Nitride (Si_3N_4) is one of the hard-ceramic particles with outstanding high temperature applications, mechanical, wear and thermal properties. In one of the research work aluminium powder is reinforced with gas atomized Silicon Nitride powder of 100 microns with varying wt. % of 5, 10 and 15 through powder metallurgical technique. The reinforcement of Silicon Nitride is done through two processes. One is ball milling and mixing the Aluminium and Silicon Nitride powders. The other one is through mechanical alloying technique. The result shows that the highest hardness is obtained with 10 % of mechanical alloying and 15 % of ball milling process. In both process 5 % Silicon Nitride shows the lowest hardness [5]. Cylindrical polyhedron shaped Si_3N_4 – AA 2024 has been squeeze casted and extruded into rod form. 10:1 ratio is used to extrude the rod. The tensile strength of the composite is increased

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by 134 % after extrusion and ageing. The elastic modulus of Si_3N_4 – AA2024 composite is not improved much after ageing, whereas it is increased from 115.1 GPa to 151.7 GPa after extrusion [6]. Hybrid Metal Matrix composite of AA 6082-Si_3N_4-Gr with varying weight % of 0 to 12 wt. % in a step of 3 wt. % is developed through Stir Casting method. 50 µm Si_3N_4 & Gr powders, which are ball milled for 100 hours is used. The result shows the hardness and tensile strength are improved from 49.5 HV to 84 HV and 161.5 MPa to 186 MPa respectively with the addition of Si_3N_4 & Gr with the wt. % of 12. But ductility is reduced from 8.6 to 5.5 % [7]. AA 7075 is reinforced with Si_3N_4 and Graphite. The Si_3N_4 wt % is kept as constant (8%) and Gr is varied from 0 to 6 wt. %. The hybrid composite is fabricated through stir casting method. The result shows that the addition of graphite leads to reduction in hardness and increase in wear resistance [8].

In this study AA 7075 is reinforced with Fly-ash and Silicon Nitride using stir casting route. The fabricated hybrid AA 7075 composite is subjected to three step ageing process. The hybrid composite is characterized using FE-Scanning Electron Microscope (SEM), Energy Dispersive X-Ray Spectroscopy (EDAX) and X-ray diffraction (XRD).

II EXPERIMENTAL PROCEDURE

AA 7075 is used as base alloy. Si_3N_4 with average particle size of 132 nm is used. The weight percentage of Si_3N_4 is kept as constant (2%). The flyash wt. % is varied by of 2.5, 5 and 7.5 wt.%. The average particle size of Flyash used is 300 nm. Spectroscopic analysis was done to obtain the weight percentage of elements present within the AA7075 alloy (substrate) and the purity of the alloy is confirmed. The aluminium alloy lattice contains an extensive variety of secondary stage particles that have been classified into three classifications viz., precipitates, dispersoids and constituent particles.

A. Stir Casting:

A conventional Stir casting technique has been followed to fabricate the three variants of composites. Whereas Stir casting is one of the liquid state methods used to manufacture Metal Matrix Composites. Here discontinuous reinforcement is stirred into the molten metal, which is allowed to solidify to form Metal matrix Composite. Calculated weight percentage of Aluminium alloy 7075 was charged in a furnace and heated above the liquidous temperature so that it is completely in molten state and then it is cooled down to a semi-solid state that is a temperature between liquid and solid states. Then preheated reinforcement particles are added to the molten metal matrix and again heated to liquid state so that they mix evenly with each other [7]. The stir casting process parameters are listed in **Table 1.** The reinforcement weight percentage for three variants are listed in **Table 2.** Here Graphite stirrer, which can withstand higher temperature than the melting temperature of the matrix material, is used as a stirrer. The stirrer mainly consists of two components – cylindrical rod and impeller. Whereas one end of the cylindrical rod is connected to the impeller and other to the shaft of the motor. This motor is connected to a speed controller through which we can control the rpm of the stirrer. The major factors, which affect the Stir casting process, are as follows – stirring speed, stirring temperature and stirring time.

Table 1: Stir casting process parameters.

S. No	Parameters	Values	Units
1	Mould preheat temperature	300	^{0}C
2	Reinforcement preheat temperature	450	^{0}C
3	Stirring temperature	800	^{0}C
4	Stirring speed	400	Rpm
5	Stirring time	10	Mins

Table 2: Reinforcement wt% for three variants.

S. No	Material	Variant-I (wt%)	Variant-II (wt%)	Variant-III (wt%)
1	Flyash	2.5	5	7.5
2	Silicon Nitride	2	2	2
3	AA7075	95.5	93	90.5

B. Heat Treatment:

The composites are supposed to be subjected to post heat treatment process such as solution heat treatment and artificial ageing after the reinforcement of Silicon Nitride and Flyash through Stir Casting process. This will eventually improve their mechanical properties. The casted composites are first solution heat treated to 480 °C for 2 hours [9], [10] . Then to achieve the super saturated solid solution state these samples are quenched for about 10 to 15 minutes. Then they are artificially aged by subjecting it to temperature of 120°C for 24 hours. The specimens were cut into 12 pieces and tested for different ageing period 2, 4, 6, 8, 10, 12, 14, 16, 18, 20, 22 and 24 hours [11].

C. Hardness Measurement:

Initially, using carborundum abrasive paper of grade 320 and 400 the specimens were polished. Then the specimens were polished using fine abrasive papers of grade 800, 1200, 2500 and 4000. The carborundum acted as rough emery thereby, helped to attain flat surfaces whereas fine polishing with abrasive papers helps to achieve mirror finish across the surface. Finally, the micro hardness of polished specimens was measured. The micro hardness of the surface was measured using the MITUTOYO Micro Hardness Tester MVK-H11 machine with an applied load of 300gf for 15 seconds. Hardness measurements of the three variants are done and compared with the base substrate and are reported in the results and discussion section to do a comparative analysis.

D. Wear Test:

Pin-on disc wear test apparatus shown in was used to investigate the dry sliding wear behaviour of base metal AA70750 and the reinforced composite. Pin specimen of 10 mm diameter and 40 mm height were prepared from the above categories of substrates. The test was conducted at room temperature according to the ASTM G99 standard. A new wear disc was procured from DUCOM instruments Bangalore. The wear disc was made of EN 31 material with the diameter of 165 mm having the hardness of 60 HRC was used to slide against the pin surface [8]. The wear testing parameters considered for dry sliding wear test are applied load, sliding velocity and sliding distance. The sliding distance was fixed at 1000 m whereas the applied load and sliding velocities were subjected to various levels as shown in the **Table 3.** The specimens were taken out, remove excess burs, clean it with acetone, then dried and weighed to determine the reduction of weight due to the wear with the help of 1mg accuracy electronic balance. The wear rate of the samples was measured using the standard formula as shown in **Equation-1**

$$Wear\ rate = \frac{(Mass\ loss\ /density)}{Sliding\ distance} \qquad (1)$$

Table 3: Wear Test Parameters.

S. No	Applied Load (N)	Sliding Velocity (m/s)
1	10	1
2	20	1.5
3	30	2
The track diameter is fixed as 70 mm.		

E. Tensile Test:

The Tensile test for the fabricated composites were carried out using computerized Universal Testing Machine (UTM). The samples with 36 mm gauge length and 9 mm diameter rods are prepared as per the ASTM 8 standard to evaluate ultimate tensile strength, percentage elongation and yield strength [12].

F. Porosity Test:

The porosity and density of the composite are determined by the Rule of Mixtures. through immersion test the density and the porosity percentages of AA7075, 2.5 wt%, 5 wt% and 7.5 wt% of Flyash were determined [13]. Small pieces with sample size of 1.5 x 1.5 x 1.5 mm are machined and weighed using an electronic balance with an accuracy of 1mg. For immersion test 10 ml graduated test tube is taken and partially filled with distilled water. Initial volume in the test tube is noted down. Then weighted sample is immersed in the liquid and the final volume is noted down as shown in the **Table 4.** Then actual, theoretical densities and porosity percentage are calculated using the following formulae and results are obtained as shown in the **Table 5.**

Table 4: Immersion Test Values

Materials	Weight (gms)	Initial Volume (ml)	Final Volume (ml)	Change in Volume (ml)
AA7075	0.522	7	7.2	0.2
2.5 wt%	0.383	8	8.2	0.2
5 wt%	0.367	7	7.2	0.2
7.5 wt%	0.657	7.4	7.8	0.4

Theoretical Density $\delta_t = \frac{W_c}{\frac{W_m}{\delta_m} + \frac{W_{FA}}{\delta_{FA}} + \frac{W_{Si3N4}}{\delta_{Si3N4}}}$

Actual Density $\delta_c = \frac{M}{V}$

$$\boldsymbol{Porosity\ percentage} = \left(1 - \frac{\delta_c}{\delta_t}\right) * 100$$

Table 5: Density and Porosity results.

Materials	Actual Density (gm/cm^3)	Theoretical Density (gm/cm^3)	Porosity %
AA7075	2.61	2.81	7.12
2.5 wt%	1.915	2.68	28.61
5 wt%	1.835	2.52	27.24
7.5 wt%	1.6425	2.39	31.56

G. Characterization technique:

The polishing of specimen was carried out according to standard metallographic procedure and etching was done with Keller's reagent (150 ml H_2O, 3 ml HNO_3 and 6 ml HF) [14]. The etched samples were subjected to microstructural analysis by using Carl Zeiss metallurgical microscope. SEM analysis was done to reveal different microstructural evolution present in the alloy as well as the presence of Flyash and Silicon Nitride particles in the aluminium substrate. In addition to the microstructural analysis, line EDAX and XRD were carried out to confirm the presence of Flyash and Silicon Nitride particle in AA7075.

III RESULTS AND DISCUSSION

A. Chemical Composition

Spectroscopic analysis was done to obtain the weight percentage of elements present within the base alloy. From Table 7 we can see the presence of major constituents like Zinc, Magnesium, Copper etc., within the range, which confirms it to be AA7075 according to ASM standards.

Table 7 Chemical composition of AA7075

Element	Composition (wt. %)	Element	Composition (wt. %)
Al	90.19	Mn	0.072
Zn	5.228	Ti	0.036
Mg	2.131	Zr	0.002
Cu	1.654	Ca	0.005
Fe	0.292	Sr	0.002
Cr	0.222	Be	0.001
Si	0.085	Bi	0.047
Pb	0.035	Ga	0.001

B. Energy Dispersive X-Ray Analysis (EDAX):

In order to confirm the elemental composition available in the hybrid composite an EDAX characterization is done. The result of area EDAX is shown in the Fig. 1. The result reveals the major alloying elements and reinforcements of AA7075 hybrid composite such as Zinc, Magnesium, Silicon, Calcium, Oxide, Iron, Aluminum etc. A line EDAX is performed over the reinforcements available in the hybrid matrix which is shown in Fig. 2. The resulting spectrum shows the elements required for forming Si3N4 and other major constituents of Flyash such as Al_2O_3, Fe_2O_3, SiO_2.

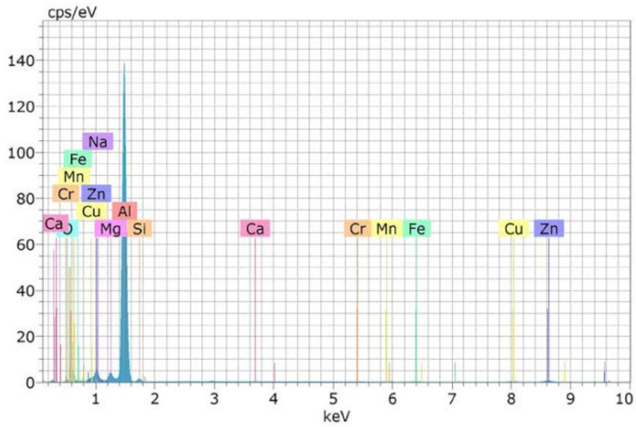


Fig. 1 Area EDAX of AA7075-Si_3N_4-FA composite.

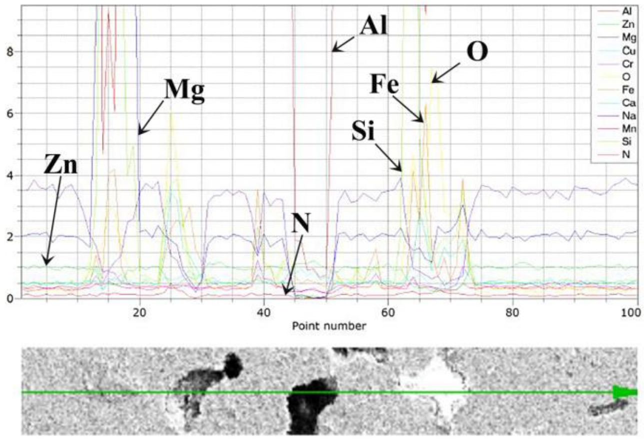


Fig. 2 Line EDAX spectrum of AA7075-Si_3N_4-FA composite.

C. X Ray Diffraction (XRD):

In order to find the reinforcement Si_3N_4 and other major constituents of Flyash such as Al_2O_3, Fe_2O_3, SiO_2 characterization is performed and is shown in Fig. 3. The diffraction peak of Silicon Nitride, Silicon Oxide, Magnesium Oxide, Calcium, Sodium, Aluminium Silicate, Iron, Manganese and Aluminium can clearly be seen in the XRD spectrum. The reference codes of Si_3N_4 and major constituents of Flyash are given below.

- Copper Zinc (Cu-Zn) precipitate – 01-071-5033
- Silicon Oxide – 01-073-3407
- Calcium Sodium Aluminium Silicate ($Ca_{3.84}$ Na_4 Al_{12} Si_{12} O_{48}) - 01-078-2451
- Magnesium Oxide (MgO) - 00-001-1235
- Silicon Nitride (Si_3N_4) - 01-075-8456
- Aluminium Iron Manganese ($Al_{0.5}$ $Fe_{0.9}$ $Mn_{0.6}$) - 01-074-5202

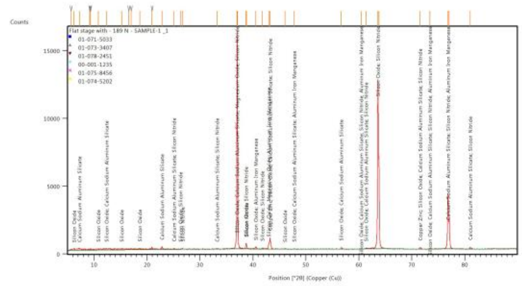
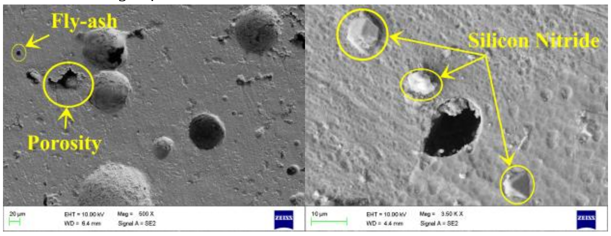


Fig. 3 XRD spectrum of AA7075-Si_3N_4-FA composite.

D. Microstructure Analysis using FE-SEM:

The microstructure image of AA7075 Hybrid composite is shown in Fig. 4 (a) & (b). The microstructure image shown in Fig. 4 (a) shows the reinforcement particle of Fly-ash along with some porosity and Fig. 4 (b) shows the reinforcement particle of Si_3N_4.



(a) (b)

Fig. 4 (a) & (b) SEM Images of AA7075-Si_3N_4-FA composite.

E. Colour Mapping:

Colour Mapping is used for visual understanding of the presence and distribution of the elements in the Aluminium 7075 matrix and is shown in Fig. 5. The figure 5 shows the reinforcement elemental composition of Si_3N_4 i.e. Si and N. Also, it shows the constituent particles of reinforcement Flyash such as Fe, O, Mg, Na and Ca.

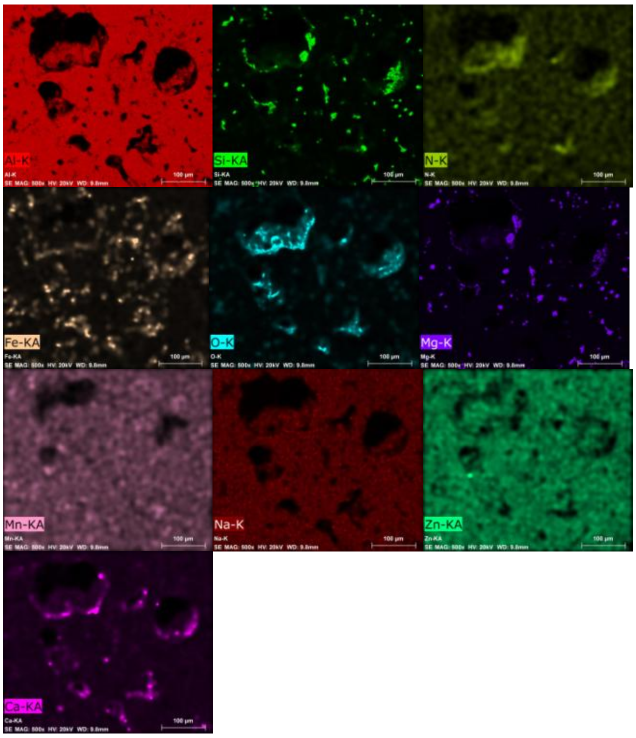
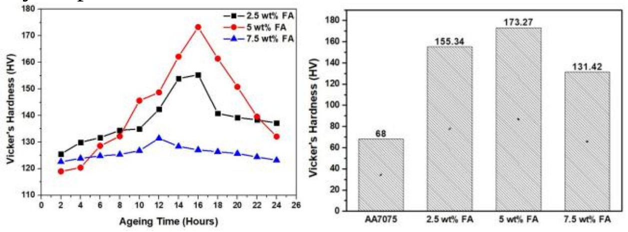


Fig. 5 Colour Mapping Images of AA7075-Si3N4-FA composite.

F. Hardness:

Microhardness of three variants is measured after artificial ageing. The Fig. 6 (a) shows the microhardness of the three variants with an interval of 2 hours. Microhardness is maximum at 16 hours for variant I & II whereas it is maximum for variant III at 12 hours. The maximum hardness of variant I, II & III are 132, 174 & 156 HV respectively. The hardness of composite increases up to 5 wt% reinforcement of Flyash beyond which it tends to decrease. Similar results were obtained during the fabrication of pure aluminium powder reinforced with Flyash using powder metallurgy technique [15]. The improvement of microhardness of three variants with respect to base metal AA7075 is shown in Fig. 6 (b). The improvement of microhardness in percentage with respect to base metal for the variants I, II & III are 128, 155 and 93 % respectively. The reason of hardness reduction in case of variant III is due to increased tendency of crack initiation and propagation at the Flyash – metal interface and the increased amount of brittle Flyash particles.



(a) (b)

Fig. 6 (a) Microhardness for 24 hours Ageing period. (b) Hardness comparison between base and composite.

G. Porosity:

The porosity and density of the composite are determined by the rule of mixtures. The density and porosity percentage of AA7075, variant I, II & III are determined by immersion test. The result is shown in Table 8. The result reveals that when the percentage of reinforcement increases then the density of composite decreases [2]. This is due to very low density of Flyash as 0.86 gm/cm^3 when compared to the base metal density of 2.81 gm/cm^3. This density difference between base metal and the Flyash causes increase in porosity of the composite [16]**.** Other reasons might be due to the evaporation of the grease film which is applied to the mould surface. Due to the high temperature of the molten metal, the entrapment of evaporated grease film causes more porosity [17]. The comparison of density and the porosity values of base and composites are shown in Fig. 7.

Table 8: Porosity and Density Values of base and composite.

Material	Density (gm/cm^3)	Porosity (%)
AA7075	2.61	7.117438
2.5 wt% FA	1.92	27.24082
5 wt% FA	1.84	28.61338
7.5 wt% FA	1.64	31.56018

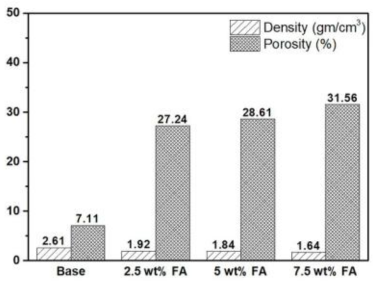


Fig. 7 Comparison of Porosity values between base and composites.

H. Tensile:

The ultimate tensile strength of the base and the three variants are shown in Fig. 8. The result reveals that when the percentage of reinforcement increases then the Ultimate tensile strength of composite decreases. It's evident in the graph that there is a huge decrease in the ultimate tensile strength of the composite when compared to the substrate AA7075 for the variants I, II & III are 28, 37 and 48 %

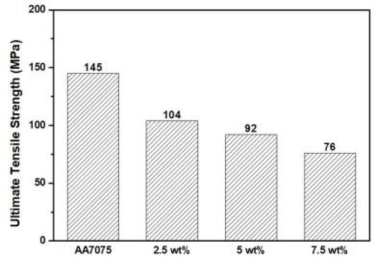


Fig. 8 Comparison of UTS values for base and composites.

respectively. Earlier research result shows that decrease in the tensile strength of the AA7075 alloy is mainly due to the brittle Silicon Carbide particles. Also, it states that stresses will be highly concentrated on the reinforcement particles of AA7075. The reinforced particles are fractured due to the locally induced stress will initiates crack propagation and thus bringing down their yield stress limit [18]. Another reason for the variation of Ultimate Tensile Strength is due to high percentage of porosity level in the composite which promotes the easy propagation of the crack.

I. Wear:

The dry sliding wear tests were performed for the base metal and three variants of hybrid composite using pin-on-disc equipment. The wear rate of the variants I, II and II with respect the load and the sliding velocity are listed in the Table 9

Table 9: Wear rate of base, V – I, V - II and V - III

Sl. No.	**Load (N)**	Slid. Vel. m/s	Base	Wear rate (mm^3/m * 10^{-3}) V - I	Wear rate (mm^3/m * 10^{-3}) V - II	Wear rate (mm^3/m * 10^{-3}) V - III
1	10	1	4.1400	2.7792	1.6858	3.2898
2	10	1.5	3.7138	2.7154	1.6475	2.5068
3	10	2	3.4094	2.2454	1.4176	1.9618
4	20	1	5.7838	3.8642	2.1455	4.6321
5	20	1.5	5.4794	3.5509	1.9157	4.4686
6	20	2	5.1141	3.4464	1.7241	4.2506
7	30	1	7.4885	4.6997	3.1034	5.5040
8	30	1.5	6.6362	4.4386	2.4137	5.3950
9	30	2	6.2100	3.9686	2.0306	5.1771

It can be noted that wear rate of base and all the variants are very low at the load of 10 N and with the sliding velocity of 2 m/s. when compared to the other combinations of load and sliding velocity.

Similarly it can be noted that the wear rate of base and all the variants are very high at the load of 30 N and with the sliding velocity of 1 m/s.

So it can be concluded that within the range of load and sliding velocity the minimum wear occurs at minimum load (10N) and with the maximum sliding velocity (2 m/s.). Similarly the maximum wear occurs at maximum load (30 N) and with the minimum sliding velocity (1 m/s).

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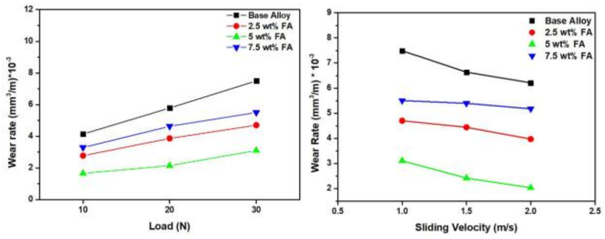
The effect of load on the wear rate and the effect of sliding velocity on the wear rate of the three variants of AA 7075 hybrid composite are shown in Fig. 10 (a) and (b) respectively.



(a) **(b)**

Fig. 9 (a) Effect of load on wear rate at constant sliding velocity of 1 m/s. (b) Effect of sliding velocity on wear rate at constant load of 30 N.

It is understood that from Fig. 9 (a), when the load increases the wear rate also increases considerably. When the contact pressure increases the high asperities of the hybrid composite specimen at stationary position is ruptured with the rotating disk which is having much higher hardness (700 HV). When the load increases, the debris of the broken-down particles act as abrasive slurry and the hybrid test specimen worn out very quickly [19]. With the constant sliding velocity of 1 m/s. the wear rate of variant II is lowest when compared to the base and other variants. Also, it can be inferred that the variant III is having more wear than that of the variant I and II.

It is clear from the Fig. 9 (b), the wear rate decreases with increasing sliding velocity. When the sliding velocity increases the worn-out debris forms an oxide layer at the tip of the test sample. This oxide layer will decrease the friction between the test sample and the disc which will result in the slipping and thus the material removal rate is reduced [20]. With constant load of 30 N the wear rate follows the same trend with variant II as lowest and variant III as highest when compared to the base and other variants.

Out of the wear tests done on base and hybrid composite it is observed that minimum wear takes place with the load of 10 N and 2 m/s with all variants. Maximum wear rate occurs at load of 30 N and 1 m/s. The comparison of wear rate at the maximum wear condition is displayed in the Fig. 10.

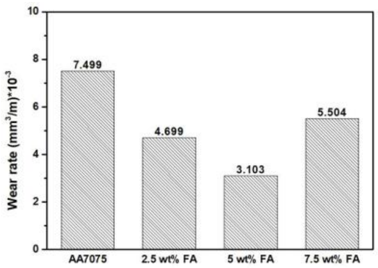


Fig. 10 Comparison of wear rate between base and composites at 30 N and with 1 m/s sliding velocity.

When compared to all three variants the wear rate of the variant II is minimum. The percentage of reduction with respect to the wear rate of base is 59%. Whereas the variant I and III wear rate reduction are 37 % and 27% respectively. It can be observed that the variant III wear resistance is less than that of the variants I and II. This is due to the fact that hardness of the composite decreases with the further addition of Flyash which in turn reduces the wear resistance [21].

IV CONCLUSION:

➢ In the present work AA7075 – Flyash – Silicon Nitride composites were successfully fabricated through Stir Casting method.

➢ AA 7075 were reinforced with 2 wt. % of Silicon Nitride and 2.5, 5, 7.5 wt. % of Flyash.

➢ After casting the samples are subjected to three step ageing process comprises solution heat treatment, water quenching and artificial ageing.

➢ The effect of Flyash and Silicon Nitride particles on the Porosity of AA7075 were investigated.

- The result reveals that when the percentage of reinforcement increases then the density of composite decreases.
- The porosity of base metal is only 7 % whereas the porosity of hybrid composite having 2.5, 5 and 7.5 wt % of Flyash is 27, 28 and 31 % respectively.
- This density difference between base metal (2.81 gm/cm^3) and the Flyash (0.86 gm/cm^3) causes increase in porosity of the composite

➢ The effect of Flyash and Silicon Nitride particles on the Hardness of AA7075 were investigated.

- The hardness of the composite is increasing gradually up to 5 wt% of Flyash reinforcement beyond which a considerable fall in the trend is observed.
- The maximum hardness of 173 HV is achieved for 5 wt% Flyash and 2 wt% of Silicon Nitride addition. The percentage increase in hardness is 155 % above the base metal.

➢ The effect of Flyash and Silicon Nitride particles on the Tensile strength of AA7075 were investigated.

- A gradual decrease in the tensile strength is found with increasing reinforcement percentage. This is due to the reinforcement of brittle particles (Silicon Nitride) and high porosity level that are seen in the composite which initiates and promotes the propagation of the cracks.
- The tensile strength of the hybrid AA 7075 composite having 2.5, 5 and 7.5 wt % of Flyash reduces by 28, 37 and 48 % respectively with respect to base metal.

➢ The effect of Flyash and Silicon Nitride particles on the Wear rate of AA7075 were investigated.

- With the addition of Flyash up to 5 wt %, the wear rate of the composite decreases beyond which it increased.
- AA 7075 with the 5 wt % reinforcement of Flyash shows the minimum wear rate. This is due to the high hardness of the composite. With respect to the base the wear rate is reduced by 59 %.

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