IOSR Journal of Engineering (IOSRJEN) **www.iosrjen.org**
ISSN (e): 2250-3021, ISSN (p): 2278-8719
Vol. 08, Issue 9 (September. 2018), ||V (V) || PP 07-13

Experimental Investigation on Mechanical Properties of Quartz reinforced Aluminum alloy metal matrix Composite as cast and heat treated

Dr. N.Nandakumar[1], N.Muthukumaran[2]
[1]Assistant *Professor,* [2]PG Scholar, *Department of Mechanical Engineering,*
Government College of Technology, Coimbatore, India.
nannthu@yahoo.com

Abstract: - In recent years the demand for the light weight material, low cost and high performance material is needed. In case of MMC's, aluminium matrix composite due their high strength to weight ratio, low cost and high wear resistance are widely manufactured. In this present experimental work the production of Alsi 10mg is reinforced with quartz material by stir casting method. The resulting composite produced from cast is tested for their mechanical properties without heat treatment and with heat treatment on the casting samples and compared with each other.The project aims to provide solution for optimum reinforcement percentage, and also suggest that the heat treatment on casting will increase their mechanical properties substantially.

Keywords: - *Hybrid Composite material, Hardness, Impact test, Stir casting process, Tensile strength.*

Date of Submission: 13-09-2018 Date of acceptance: 29-09-2018

I. INTRODUCTION

In the last two decades, research has shifted from monolithic materials to composite materials to meet the global demand for light weight, high performance, environmental friendly, wear and corrosion resistant materials.Metal Matrix Composites (MMCs) are suitable for applications requiring combined strength, thermal conductivity, damping properties and low coefficient of thermal expansion with lower density. These properties of MMCs enhance their usage in automotive and Tribological applications. In the field of automobile, Dr.Thirumalai, [1] et al.Revealed reinforcing quartz with aluminum alloy Lm9 in the respective weight percentages has shown appreciable increase in its mechanical properties, also Stir casting method can be successfully used to manufacture metal matrix composite with desired properties. G. Mallikarjuna [2]et al.revealed that strength is increases up to weight percentage of 9 of silica for micron size of 106 µm, after that decreases. Micro hardness of the composites found increases with increased weight percentage of 9 of silica for micron sizes of 106 µm, after that decreases.

S.D.Saravana n[3] et al. Studied the mechanical behavior of aluminum and rice husk ash of three different particle size ranges which was reinforced with aluminum alloy using stir cast method. The results reveal that the tensile strength, compressive strength and hardness of the aluminum alloy composites decrease with increase in particle size of RHA. But increase in the weight fractions of RHA particles decreases the ductility of the composite. Addition of organic reinforcement like Rice husk ash (RHA), Coconut ash, fly ash etc. to the aluminum or its alloy has also shown an appreciable increase in mechanical along with Tribological behavior of the Al metal matrix composite reviewed by A. P. S. V. R. Subrahmanyam [4] et al. S.Sawla [5] et al. investigated the combined effect of reinforcement and heat treatment on the two body abrasive wear of aluminum alloy composites Mousa Javidani **[6]** et al...Studied heat treatment investigation of the Alsi10mg alloy produced by SLM microstructure and hardness.

II. EXPERIMENTAL WORK

In this experimental work composite material is casted by stir casting method for the application of connecting rod. The AlSi 10Mg has been taken as the matrix material while quartz has been considered as the reinforcement. Ball milling machine is used to crush the quartz in to powder form. After crushing the powder is segregated to under 75 microns using with sieve shown in figure 2.1. According to design of experiments eight samples were casted with different proportions and analysed for the optimum composition for its performance.

Fig 2.1 Quartz powder (75µm)

Fig 2.2 Prepared samples

The materials selected for this experimental investigation are AlSi10Mg alloy for the matrix and SiO2 of 75 µm as particulates with different percentages (in wt% 0, 5, 10 and 15) based on the variation in weight. Different specimen of the MMC with aluminium alloy having 5wt% quartz, 10wt% quartz, 15wt% quartz is taken. The quartz is taken in the proportion of 5, 10 and 15% is for carried to find out the increase in quartz in the composites will increase the mechanical properties of the AlSi10Mg-Quartz composite formed. In the process of development the matrix material, AlSi10Mg was melted in the furnace which was originally developed for MMCs production. The melting temperature of AlSi10Mg is about 750˚C. And the quartz is preheated to a temperature of about 500˚Celsius. Sample prepared for this work is shown in figure 2.2. After fabrication of composite samples were machined for various tests. For optimization Design of experiment method is selected and the % values were shown in table 2.1

Table 2.1 Design of experiments

Sample I.D	Reinforcement size	% of SiO2	Status
1	50-100 microns	0	As cast
2	50-100 microns	5	As cast
3	50-100 microns	10	As cast
4	50-100 microns	15	As cast
5	50-100 microns	0	Heat treated
6	50-100 microns	5	Heat treated
7	50-100 microns	10	Heat treated
8	50-100 microns	15	Heat treated

III. RESULTS AND DISCUSSION

From the experimental work, the mechanical properties of AlSi 10Mg-Quartz reinforced composite material produced from the stir casting process were analyzed. The comparison of hardness values, tensile properties, and Impact strength of composite which has been prepared by stir casting method as cast and T6 heat treated were discussed. The tests were conducted from the cast samples with heat treatment and without heat treatment and the final results were discussed based on the optimum values.

Rockwell hardness test

In Rockwell hardness testing machine (model MRS 2010/878) the samples those having dimensions dia20 x 30 mm specimens were tested as per ASTM E10-2015 by Using steel ball indenter with load of 100 kgf. The testing is conducted on the specimen as cast and heat treated and three values for each category were arrived for the mean value and the results are tabulated as show in table 3.1 and plotted graphs as show in figure 3.1,figure 3.2,figure 3.3.

Table 3.1 Hardness values as cast and heat treated

Sl.No.	Specimen	Percentage of reinforce material	HRB value
1	As cast	0	41
2	As cast	5	45
3	As cast	10	56
4	As cast	15	43
5	Heat treated	0	52
6	Heat treated	5	55
7	Heat treated	10	70
8	Heat treated	15	56

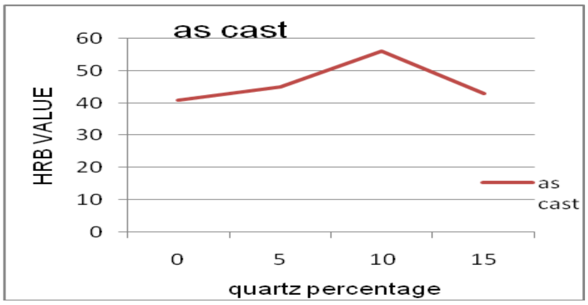

Fig 3.1 Hardness values as cast

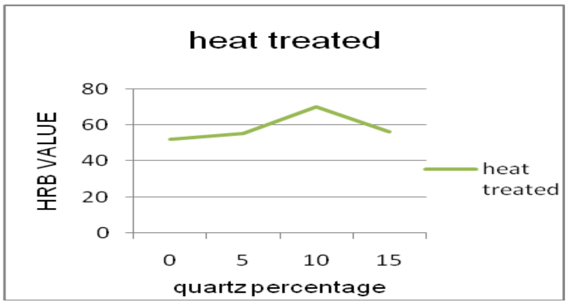

Fig 3.2 Hardness values as Heat treated

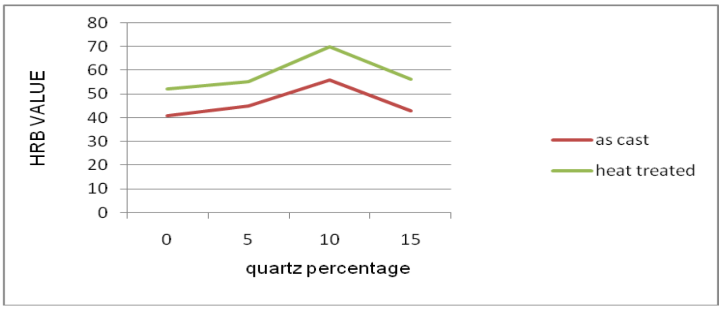

Fig 3.3 Hardness values as cast + Heat treated

Impact testing (charpy's test):

Impact Strength tests were performed by Charpy V Notch pendulum impact testing machine. Specimens were prepared from AlSi 10Mg and Quartz MMC by square cross section 10 mm x 10mm and 55mm in length with 45-degree V Notch at the centre. At the mid span of the specimen there was a single blow of hammer given. The blow was sufficient to bend or break the specimen at the centre. The striking energy was measured and tabulated as in table 3.2.and graph are plotted as shown in figure3.4, figure 3.5 and figure 3.6.

Table 3.2 Energy absorbed by specimen

State	% of quartz	Energy Set	Energy Spent	Energy Saved
As cast	0	300	280	20
As cast	5	300	270	30
As cast	10	300	250	50
As cast	15	300	280	20
Heat treated	0	300	250	50
Heat treated	5	300	240	60
Heat treated	10	300	230	70
Heat treated	15	300	250	50

Table 3.3 Impact strength

Sl No	% of quartz	Saved energy	State	Absorbed Energy
1	0	20	As cast	2000
2	5	30	As cast	3000
3	10	50	As cast	5000
4	15	20	As cast	2600
5	0	50	Heat treated	5000
6	5	60	Heat treated	6000
7	10	70	Heat treated	7000
8	15	50	Heat treated	3000

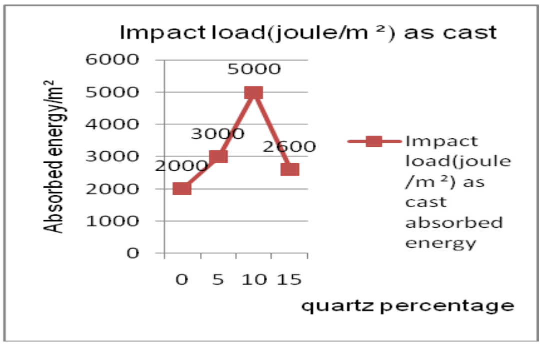

Figure 3.4 Impact test result as cast

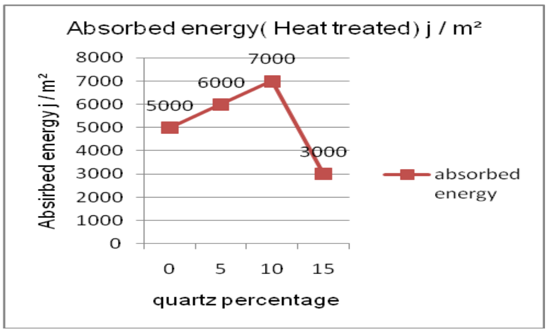

Figure 3.5 Impact test result as Heat treated

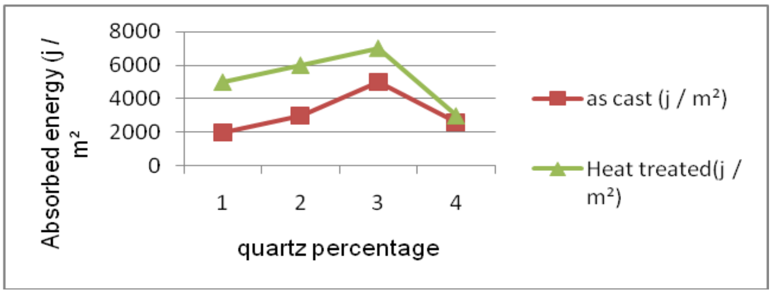

Figure 3.6 Impact test result as cast and Heat treated

Tensile strength

Tensile test samples using the As per ISO-6892-1998-tensile testing in Annex- C C.2.3.2 as per table C.1 standard with the 50 mm gauge length were as cast and heat treated are Precision machining and polishing by abrasive papers were carry out on the gage length to improvise the surface quality. A UTM testing machine with 0.5 mm/s test speed was used to measure the mechanical properties. Samples for transverse rupture strength test were prepared according to the ISO-6892-1998 Type are tabulated in table 3.4 and make charts as shown in figure 3.7, figure 3.8, and figure3.9.

Table 3.4 Tensile strength of specimen

Sl no	Specimen	Percentage of reinforce material	Tensile strength (mpa)
1	As cast	0	120
2	As cast	5	160
3	As cast	10	195
4	As cast	15	145
5	Heat treated	0	210
6	Heat treated	5	275
7	Heat treated	10	310
8	Heat treated	15	240

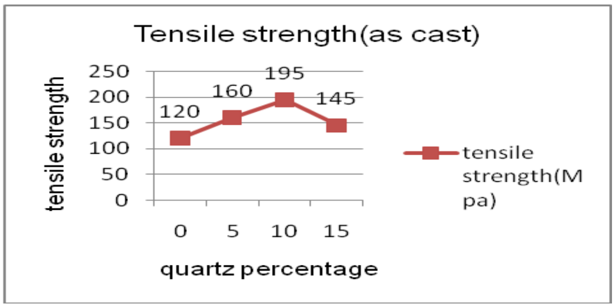

Figure 3.7 Tensile tested specimen as cast

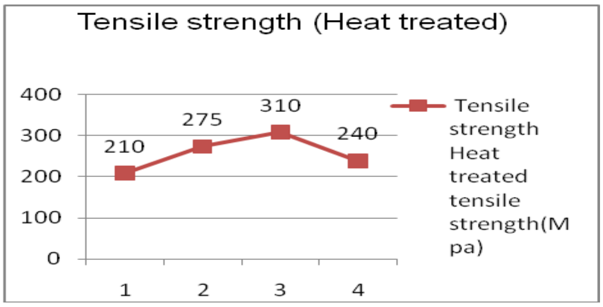

Figure 3.8 Tensile tested specimen as Heat treated

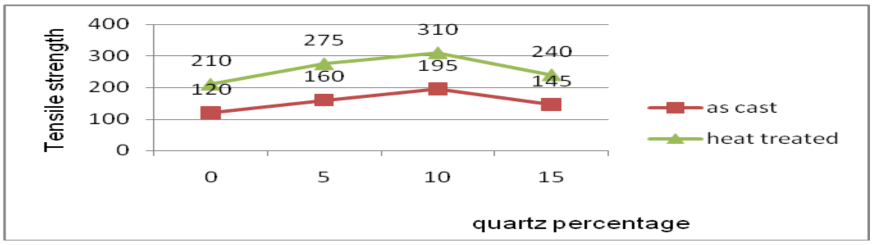

Figure 3.9 Tensile tested specimen as cast and Heat treated

Hardness comparison as cast and heat treated

Hardness comparison as cast and heat treated is shown in the table 3.5.and plotted in graph as in figure 3.10.

Type	0%SiO2	5%SiO2	10%SiO2	15%SiO2
As cast	41	45	56	43
Heat treated	52	55	78	56

Table 3.5 Hardness values of specimen

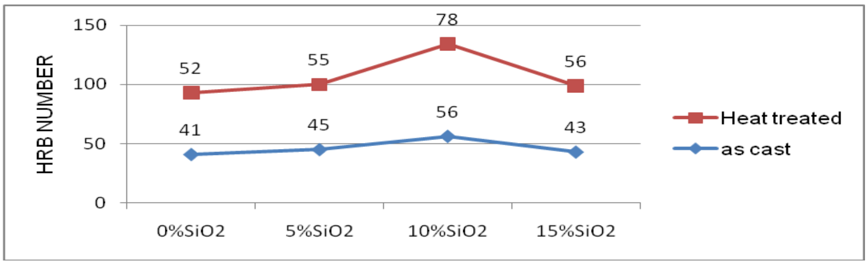

Fig 3.10 Compared result between as cast and Heat treated

Tensile strength comparison as cast and heat treated

Tensile strength comparison as cast and heat treated shown in table 3.6 and figure 3.11.

Table 3.6 Tensile strength values of specimen

Type	0%SiO2	5%SiO2	10%SiO2	15%SiO2
As cast	135	170	210	145
Heat treated	210	275	310	240

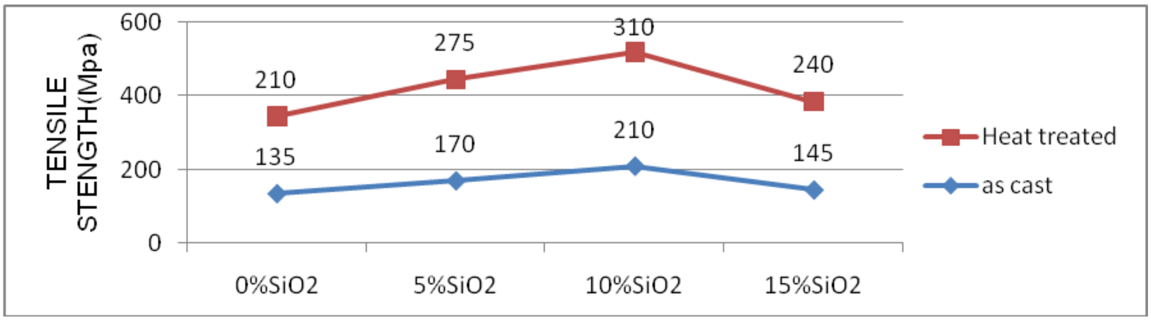

Fig 3.11 Compared result between as cast and Heat treated

Impact strength comparison as cast and heat treated

Impact strength comparison as cast and heat treated shown in table 3.7 and figure 3.12

Table 3.7 Impact strength values of specimen

Type	0%SiO2	5%SiO2	10%SiO2	15%SiO2
As cast	1980	2690	4880	2810
Heat treated	4820	6020	6890	3020

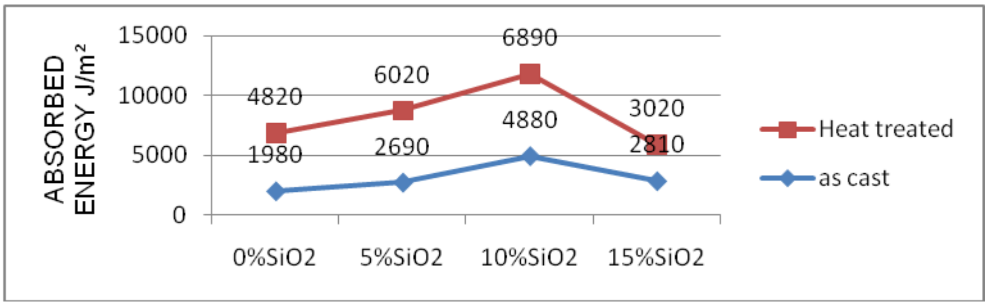

Fig 3.12 Compared result between as cast and Heat treated

IV. CONCLUSION

The AlSi 10Mg-Quartz metal matrix composite shows a considerable improvement in the mechanical properties. The addition of quartz in the composite decreases the weight there by improving the mechanical properties. Replacement of existing Aluminium alloy connecting rod material by SiC and other reinforcements cost high. Hence we are in the need of reinforcement with low cost and low density. Therefore the AlSi10Mg-Quartz MMC is best suitable material for connecting rod. Based on the test results and interpretation following conclusions were reached. Stir casting process is low cost method its applicability to mass production, Compared to other fabrication methods(Reinforcement size is 75 micron and 10 % weight fraction). 10 % of quartz is the best fraction of reinforcement in to AlSi10Mg is proper mixing by stir casting process. Hardness of the composite is found to be high on sample no 7(Reinforcement size is 75 micron and 10 % weight fraction) heat treated as compared to other results. Ultimate tensile and Yield Strength is maximum in sample no 7 (Reinforcement size is 75 micron and 10% weight fraction) heat treated as compared to other results. Impact strength of the composite is found to be high on sample no 7 (Reinforcement size is 75 micron and 10 % weight fraction) heat treated as compared to other results. The mechanical properties of this material as per present project prepared and heat treated as per T6 standard is near to match the properties of forged steel those are used to produce connecting rod (300 mpa 450 mpa).

REFERENCES

[1] Dr. Thirumalai.T1, Dr.Boopathi.L and Shreedhar.T3,Manufacturing of Aluminium Reinforced With Quartz in Composites, International Conference on Emerging trends in Engineering, Science and Sustainable Technology (ICETSST-2017)E-ISSN: 2348 – 8352.

[2] Mallikarjuna G B1*, K V Sreenivas Rao1 and R H Jayaprakash1 “Preparation and property evaluation of aluminium-silica composites by casting route”.

[3] S.D.Saravananet al.” Prediction of Tribological behavior of rice husk ash reinforced aluminum alloy matrix composites using artificial neural network “Russian vol.56(no.1):pp.97-106 · January 2015

[4] A. P. S. V. R. Subrahmanyam, G. Narsaraju and B. SrinivasaRao ‘Effect of Rice Husk ash and Fly ash Reinforcements on Microstructure and Mechanical properties of Aluminium alloy (AlSi10Mg) Matrix Composites’ International Journal of Advanced Science and Technology Vol.76 (2015), pp.1-8.

[5] S.Sawlaet.al., “Combined effect of reinforcement and heat treatment on the two body abrasive wear of aluminum alloy and aluminum particle composites” Wear 257(5-6):555-561 · September 2004 DOI: 10.1016/j.wear.2004.02.001

[6] MousaJavidaniet.al. Additive Manufacturing of AlSi10Mg Alloy Using Direct Energy Deposition: Microstructure and Hardness Characterization Journal of Thermal Spray Technology · December 2016 DOI: 10.1007/s11666-016-0495-4.

[7] M. Singh, D.P. Mondal, A.K. Jha, S. Das and A.H. Yegneswaran, “Preparation and properties of Cast Aluminium Alloy–Sillimanite Particle Composite”, Composites, (2001) Vol.42, pp.787-795.

[8] M. Singh, D.P. Mondal, O.P. Modi and A.K. Jha, “Two-Body Abrasive Wear Behaviour of Aluminium Alloy–Sillimanite Particle Reinforced Composite”, Wear, (2002) Vol.27, pp.357-368.

[9] G. Ranganath, S. C. Sharma and M. Krishna, “Dry sliding wear of garnet reinforced zinc / aluminium metal matrix composites”, Wear, (2001) Vol.25, pp.1408-1413.

[10] S.C.Sharma, “The sliding wear behavior of Al6061–Garnet Particulate Composites”, Wear, (2001) Vol.42, pp.1036-1045.

[11] S.K. Chaudhury, A.K. Singh, C.S. Sivaramakrishnan, S.C. Panigrahi; "Wear and Friction Behavior of Spray Formed and Stir Cast Al–2Mg–11TiO2 Composites", Wear, (2005) Vol.35, pp.759–767.

[12] Abdulhaqq A. Hamid, P.K. Ghosh, S.C. Jain and Subrata Ray, “The influence of porosity and particles content on dry sliding wear of cast in situ ppAl(Ti)–Al2O3(TiO2) composite”, Wear, (2008) Vol.65, pp.14-26.

[13] S.K. Chaudhury, C.S. Sivaramakrishnan and S.C. Panigrahi, “A new spray forming technique for the preparation of aluminium rutile (TiO), ex situ particle composite”, J. Mater. Proces.Technol., (2004) Vol.56, pp.385-390.

[14] HemanthKumar.T.R., Swamy. R.P and Chandrashekar T.K., “Taguchi Technique for the Simultaneous Optimization of Tribological Parameters in Metal Matrix Composite ”, J. Min. Mater. Charact. Engg. (2011) Vol.36, pp.1179-1188.

[15] Sanjeev Das., V. Udhayabhanu and S. Das "Synthesis and Characterization of Zircon Sand/Al-4.5 wt% Cu Composite produced by Stir Casting route., J. Mater. Sci., (2006) Vol.65, pp.4668-4677.

[16] Ali Mazahery and Mohsen OstadShabani, “Study on Microstructure and Abrasive Wear Behavior of Sintered Al Matrix Composites”, Ceramics Inter., (2012) Vol.75, pp.4263–4269.

[17] Ranvir Singh Panwar and O.P. Pandey, “Study of Wear Behaviour of Zircon Sand- Reinforced LM13 Alloy Composites at Elevated Temperatures”, Journal of Materials Engineering and Performance, (2013) Vol.85, pp.1765-1775.

[18] E.G. Okafor and V.S. Aigbodion, “Effect of Zircon Silicate Reinforcements on the Microstructure and Properties of as Cast Al-4.5 Cu Matrix Particulate Composites Synthesized via Squeeze Cast Route”, Tribol. Indus., (2010) Vol.45, pp.31-37.

[19] Kumar, S., Panwar, R. S., and Pandey,O. P., Effect of dual reinforced ceramic particles on high temperature Tribological properties of aluminum composites, Ceramics Inter.; (2013) Vol.84, pp.6333-6342.

[20] Kumar, S., Panwar, R. S., and Pandey,O. P., “Tribological characteristics of Aluminium tri reinforced particles composites developed by liquid metallurgy route”,Advd .Mater.Rsch., (2012) Vol.64, pp.574-578.

[21] Kumar, S., Sharma, V., Panwar, R. S., and Pandey, O. P., Wear behavior of dual particle size (DPS) zircon sand reinforced aluminum alloy, Tribol. Letts., (2012) Vol.38, pp.231-251.

[22] A. Sreenivsan, S.PaulVizhian, N. D. Shivakumar. M. Muniraju , M.Raguraman,”A study of the microstructure and wear behaviour of TiB2 /Al metal matrix composites,’’ lajss. (2011) Vol.12, pp.1-8.

[23] R.N. Rao and S. Das, “Effect of Applied Pressure on the Tribological Behaviour of SiCp Reinforced AA2024 Allo”, Tribol. Inter., (2011) Vol.43, pp.454-462.

[24] H.N. Reddappa, K.R. Suresh, H.B. Niranjan and K.G. Satyanarayana, “Dry Sliding Friction and Wear Behaviour of Aluminium/Beryl Composite”, Inter. J. App. Engg. Rsch., (2011) Vol.33, pp.502-511.

[25] N. Radhika, R.Subramanian and S. VenkatPrasat, "Tribological behaviour of Aluminium/Alumina/Graphite Hybrid Metal Matrix Composite Using Taguchi's Techniques", J. Mater. & Mater. Character. &Engg., (2011) Vol.58, pp.427-443 .

Dr. N.Nandakumar" Experimental Investigation on Mechanical Properties of Quartz reinforced Aluminum alloy metal matrix Composite as cast and heat treated” IOSR Journal of Engineering (IOSRJEN), vol. 08, no. 9, 2018, pp. 07-13.