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Experimental Analysis of mechanical properties of Aluminium Alloy 2219 reinforced with Si_3N_4

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Abstract: ***Composite material is less in weight, high in strength, or also less costly. Composite material is generally a mixture of two or more same or different metals. We can use composite metal in different mechanical sector, because of their multipurpose uses.***

In this work, we propose an Aluminium alloy 2219 based metal matrix composite with controlled distribution of silicon nitride to fabricate specimens with different composition of silicon nitride for the investigation of mechanical behaviour of the same. The fabrication of the composite is done by means of Stir Casting Process. The mechanical behaviour of the entire specimen is investigated such as change in microstructure, hardness test and compression test, to compare its result with existing composite materials. The work is intended to produce a totally new composite material with various composition of reinforcement and to investigate their mechanical properties.

The article present in the abstract contains an example of silicon nitride with aluminium alloy 2219 model and a result of simulation.

Index Terms: Stir casting, Aluminium alloy 2219, silicon nitride.

I. INTRODUCTION

As a matter of fact, every year production value of casting especially in production volume of nonferrous metals such as aluminum alloy grades mixed with silicon nitride with different proportion [1]. Aluminum place an important role because it is a lighter material used in aerospace, automobile industry etc[9]. We know composites are made out of matrix and reinforcement. Reinforcement can several forms so when we do mix with matrix and the reinforcement we get something called as metal matrix composites whatever all the possible matrix we can have aluminum, we can have magnesium we can have titanium, cobalt, etc. Depending upon their requirements.

Jayasheel Harti & etal. [2] Aluminum Alloy 2219 alloy was taken as the matrix and TiC as reinforcement material to metal matrix composites process prepared by stir casting method. For metal matrix composites the reinforcement material was varied from 0 to 6 wt. % .T. Adithiyaa & etal. [3] AA2219-Al2O3 (Nano) metal matrix composite was prepared by stir casting method.

The fabricated composites were subjected to microstructure investigations, tensile tests and hardness tests.

The addition of Nano Al_2O_3 particles increased the mechanical properties of the composites. In another work EssaZitoun and A. Chennakesava Reddy [4] AA3003/graphite metal matrix composites were fabricated by stir casting practice and bottom-up pouring technique to investigate the effect of clustering and porosity on their mechanical and wear properties. N.R. Rajasekaran & V.

Sampath[5] the addition of TiB_2 particles results is increased in mechanical properties, such as 0.2%YS, UTS and Hardness. The improvement in mechanical properties is correlated to microstructure. Siddeshkumar N G & etal.[6] the microstructure examination demonstrates that uniform distribution of B4C and MoS2 particles in matrix Al2219.In another work, G. Jims John Wessley & etal.[7] this paper presents the development and characterization of aluminum alloy 6063 based metal matrix composite with varying percentage combinations of fly ash and Borosilicate reinforcements. T. Dileep and P. N. S. Srinivas [8] the composites were fabricated by Stir Casting Process with controlled speed and feed parameters. The Prepared composites were examined for microstructure to know the particle distribution in matrix. Hardness and Tensile properties were also studied and compared with the Aluminum Alloy. Dr. N.Nandakumar & N.Muthukumaran [9] in case of MMC"s, Aluminum matrix composite due to their high strength weight ratio, low cost and high wear resistance are widely manufactured. Jayasheel I. Harti & etal. [10] this work, aims at investigating the wear properties of Aluminum Alloy 2219 before and after introducing micro size of TiC particulates.

II. OBJECTIVE OF THE PROJECT IS:

1. Development of the composite through stir casting/die casting technique for various percentage of addition of Si3N4 [7].
2. Casting of Si3N4 and evaluation of its composition.
3. Evaluation of mechanical properties such as tensile, compression, hardness and microstructure as per ASTM standards [7-8].
4. Analysis of results.

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III. METHODOLOGY:

Methodology used for the research work.

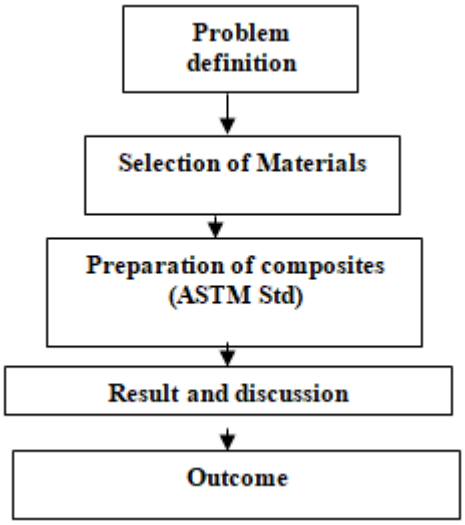

Fig 3.1: Methodology Flow Chart

IV. 1) ALUMINUM ALLOY2219 INGOTS

A) COMPOSITION OF ALUMINUM 2219 ALLOYS:

Weight%	2219
Al	Bal
Si	0.20Max
Fe	0.30Max
Cu	5.80-6.80
Mn	0.20-0.40
Mg	0.02Max
Zn	0.10max
Ti	0.02-0.10
others	0.050ea 0.15total

2) SILICON NITRIDE (Si3N4) POWDER

B) Silicon Nitride Analysis:

Parameters	Results
Form	Powder
Formula	Si 3N4
Si	60%
N	40%
Hall flow,50gms	40sec
Apparent density	3.21gm/cc

V. CASTING

FIG 5.1: CASTING PROCESS

Fig:5.1 Shows the casting process of aluminium alloy 2219 reinforced with si3n4 which is conducted in a hot furnace . After melting the composite material it is poured in a die with the help of holder and hand gloves [1].

VI. RESULT AND DISCUSSION

6.1 COMPRESSION TEST

SL NO	SAMPLE ID	MAX. LOAD	COMPRESSION STRENGTH
1	ALUMINUM ALLOY 2219 ASCAST (0%)	34820.000 N	259.426 MPA
2	ALUMINUM ALLOY 2219 REINFORCED WITH SI_3N_4 (3%)	39000.00 N	292.805 MPA
3	ALUMINUM ALLOY 2219 REINFORCED WITH SI_3N_4 (6%)	51480.000 N	385.318 MPA
4	ALUMINUM ALLOY 2219 REINFORCED WITH SI_3N_4 (9%)	52040.000 N	386.539MPA

6.1.1: BAR GRAPH OF COMPRESSIVE STRENGTH FOR DIFFERENT COMPOSITION OF SI_3N_4.

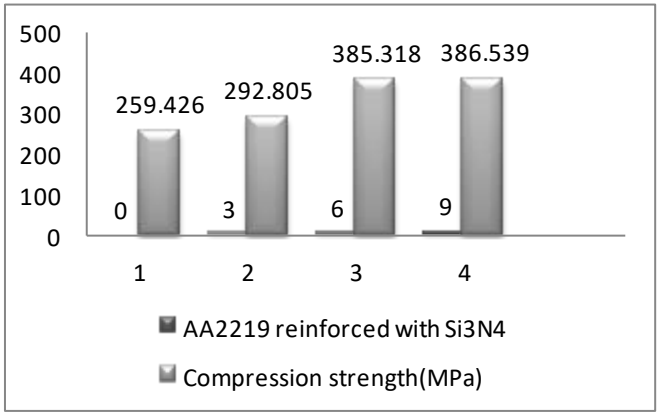

Fig: 6.1.1 Bar graph of Compressive strength for different composition of Si_3N_4.

Fig6.1.1 shows the effect of weight percentage of silicon Nitride on compressive strength of Aluminium Alloy 2219 / Si_3N_4 .In compression test, the loads varies at the various percentage of silicon nitride with the aluminium alloy 2219 at different loads, such as at 0% the load will be 259.426MPa similarly at 3% the load will slight increase as 292.805MPa, at 6% the load will continuous increasing at 385.318MPa and at the last at 9% the load will be maximum such as 386.539MPa.

6.2 TENSION TEST

SI No.	Sample ID	Tensile Strength(R_m)	Elongation	Yield Load	Yield Sterss
1	Aluminum Alloy 2219 ASCAST (0%)	150.139 MPa	6.340%	1536 0 N	127.551 MPa
2	Aluminum Alloy 2219 reinforced with Si_3N_4 (3%)	161.054 MPa	6.060%	1246 0 N	102.804 MPa
3	Aluminum Alloy 2219 reinforced with Si_3N_4 (6%)	165.980 MPa	4.280%	1530 0 N	127.322 MPa
4	Aluminum Alloy 2219 Reinforced With Si_3N_4 (9%)	135.861 MPa	2.760%	1558 0 N	128.754 MPa

6.2.1: BAR GRAPH OF TENSILE STRENGTH FOR DIFFERENT COMPOSITION OF SI_3N_4.

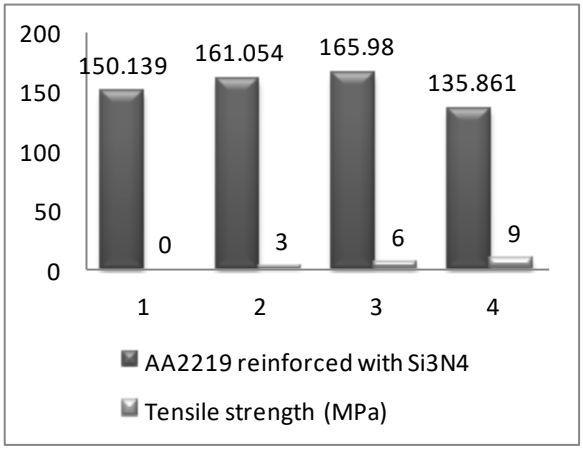

Fig 6.2.1: Bar graph of Tensile strength for different composition of Si_3N_4.

Fig 6.2.1 shows the effect of weight percentage of silicon Nitride on tensile strength of Aluminum Alloy 2219 / Si_3N_4. In tension test at 0% the load will be 150.139MPa, slightly the load will increase at 3% the load will be 161.054MPa, at 6% again the load will increase in small amount of 165.98MPa, at last 9% the load will suddenly decrease to 135.861MPa[7].

6.3 HARDNESS TEST

SL NO	SAMPLE ID	LOAD/INDENTER	RESULTS
1	ALUMINUM ALLOY 2219 ASCAST (0%)	1000 KG LOAD/10MM BALL	138.217HBW
2	ALUMINUM ALLOY 2219 REINFORCED WITH SI_3N_4 (3%)	1000KG LOAD/10MM BALL	162.697HBW
3	ALUMINUM ALLOY 2219 REINFORCED WITH SI_3N_4 (6%)	1000 KG LOAD/10MM BALL	198.869HBW
4	ALUMINUM ALLOY 2219 REINFORCED WITH SI_3N_4 (9%)	1000 KG LOAD/10MM BALL	185.115HBW

6.3.1: BAR GRAPH OF BRINELL HARDNESS TEST FOR DIFFERENT COMPOSITION OF SI_3N_4.

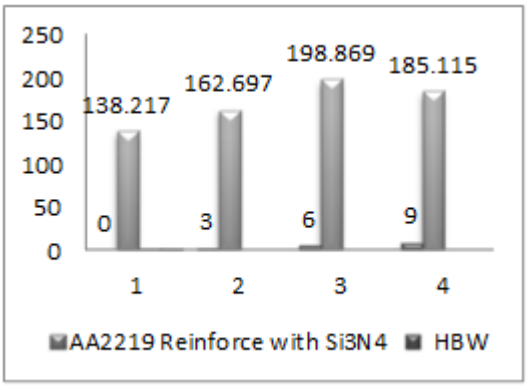

Fig 6.3.1:- Bar graph of Brinell Hardness Test for different composition of Si_3N_4.

Fig 6.3.1 shows the effect of weight percentage of silicon Nitride on Hardness number of Aluminium Alloy 2219 / Si_3N_4.Brinell hardness test is carried out to get a better understanding of the behaviour of Aluminium Alloy 2219 reinforced with different composition of Si_3N_4. The results shows that improvement in hardness was achieved up to 6 wt. % Silicon Nitride. As the Silicon Nitride content is increased from 0 to 6 wt. % the hardness increased.

Also from graph it is noticed that there is a sudden decrease in hardness of the composite at 9 wt. % of Silicon Nitride reinforcement, it's due to the clusters formation and mainly because of dislocation and de-bonding between the matrix and reinforcement [3].

6.4 MICROSTRUCTURE STUDIES

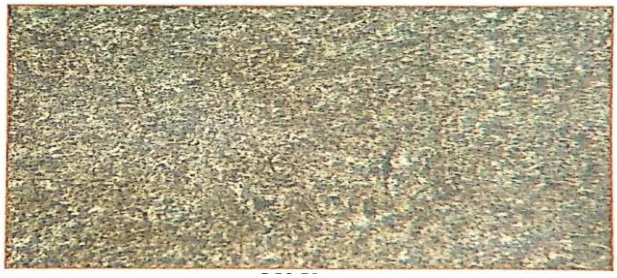

Fig 6.4(a):- Microstructure of 0% composition of silicon nitride

Fig 6.4 (a) Ascast Aluminum Alloy 2219 reinforcement while visual inspection it shows uniform distribution, should indicate dendrites, small amount of porosity occur in the material, and no other casting defect occur[8].

Fig 6.4(b):- Microstructure of 3% composition of silicon nitride

Fig 6.4(b) gives the microstructure of Aluminum Alloy2219 with adding 3% of reinforcement while visual inspection it shows uniformly distribution, it should indicates Si_3N_4 Particulates, dendrites, small amount of porosity occur in the material and no other casting defect occur[8].

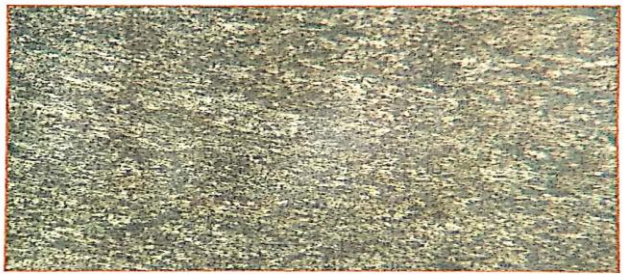

Fig 6.4(c):- Microstructure of 6% composition of silicon nitride

Fig 6.4(c) gives the microstructure of Aluminium Alloy2219 with adding 6% of reinforcement while visual inspection it shows uniformly distribution, it should indicates Si_3N_4 Particulates, dendrites, small amount of porosity occur in the material and no other casting defect occur. There were few large clusters of Si_3N_4 [8].

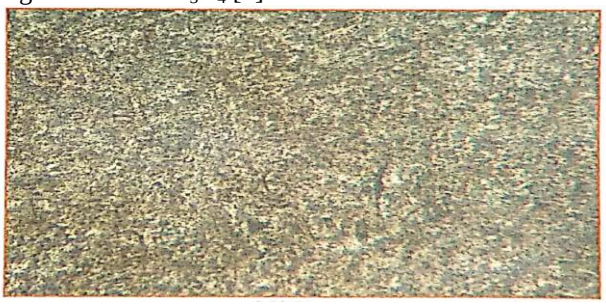

Fig 6.4(d):- Microstructure of 9% composition of silicon nitride

Fig 6.4(d) gives the final microstructure of Aluminium Alloy2219 with adding 9% of reinforcement while visual inspection it shows uniformly distribution, it should indicates Si_3N_4 Particulates, dendrites, porosity and no other casting defect occur. There were few large clusters of Si_3N_4 within some areas of the matrix while other areas were entirely Si_3N_4 depleted[8].

VII. CONCLUSION

The significant conclusions of study on AA2219+Si_3N_4 metal matrix composites are as follows:

The obtained casting was without any blow holes or any defect in the casting and it also reveals good bonding among matrix and reinforcement particles [7].

- HBW of the material gradually increases as 0-6% percentage composition of silicon Nitride[3].
- It was found that during compression Test the compression strength firstly increases from 0-9% .
- Tensile test result shows that Tensile strength also increases firstly from 0-6% and decreases suddenly at 9%[3].
- Inverted metallurgical microscope is used with magnification of 100x and 250x using kellers reagent as etchant to magnify the test sample[8]

REFERENCES

1. Sanjeevreddy K Hudjikarand N. Kishore kumar, "Fabrication of Aluminum alloy 2219 by using Stir Casting Process and Comparison of Micro structural and Mechanical Properties of Alloy 2219 with the Industrial based fabricated Alloy",Vol-3 Issue-4 2017.
2. JayasheelHarti , T. B. Prasad, MadevaNagaral, & K. NiranjanRao, "Hardness and Tensile Behavior of Al2219-TiC Metal Matrix Composites" Journal of Mechanical Engineering and Automation 2016, 6(5A): 8-12.
3. T. Adithiyaa, D. B. Jabara, P. V. Senthil1&K. R. Vijayakumar, "Effect of nano alumina particles on mechanical properties of AA2219 nano metal matrix composites",JCPS Volume 9 Issue 4 ,October - December 2016.
4. EssaZitoun and A. Chennakesava Reddy,"Analysis of Micromechanical Behavior of AA3003 Alloy – GraphiteMetal Matrix Composites Cast by Bottom-Up Pouring with Regard to Agglomeration and Porosity",International Conference on Composite Materials and Characterization December 2009.
5. N.R. Rajasekaran&V. Sampath, "Effect of In-Situ TiB2 Particle Addition on the Mechanical Properties of AA 2219 Al Alloy Composite",Journal of Minerals & Materials Characterization &Engineering,Vol. 10, No.6, pp.527-534, 2011.
6. Siddeshkumar N G, G S Shiva Shankar &S.Basavarajappa,"Comparative Study on Dry Sliding Wear Behaviour of MetalMatrix Hybrid Composites at Room and High Temperature Conditions",International Journal of Engineering Research & Advanced Technology (ijerat)Vol.01 Issue.01 June 2015.
7. G. Jims John Wessley, A. Gaith Franklin, S.J. Vijay, "Fabrication and mechanical characterization of stir casting AA6063-Borosilicate-Fly ash hybrid metal matrix composites",International Journal of Engineering&Technology, (2018) 101-105.
8. T. Dileep and P. N. S. Srinivas,"Enhancement Of Mechanical, Microscopic And Tribological Properties Of Hybrid Metal Matrix Composite Reinforced With Alumina, Graphite And Silicon Carbide",International Journal of Latest Engineering Research and Applications (IJLERA) ISSN: 2455-7137 Volume – 01, Issue – 04, July – 2016, PP – 41-49.
9. Dr. N.Nandakumar and N.Muthukumaran, " 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, Issue 9 (September. 2018),
10. Jayasheel I. Harti1, B. R. Sridhar , H. R. Vitala, and Pankaj R. Jadhav, "Wear Behavior of Al2219-TiC Particulate Metal Matrix Composites" American Journal of Materials Science 2015, 5(3C): 34-37.

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