Investigation on Mechanical Properties of Gr+ Tio_2reinforced Composite

Dr. G Elango[1], K Balaji[2], R M Kingsley Solomon[3], R Vallal Peruman[4]
[1]*Professor, Department of Mechanical Engineering, Krishnasamy College of Engineering and Technology, cuddalore*
[2, 3, 4] *UG Scholars, Department of Mechanical Engineering, Krishnasamy College of Engineering and Technology, cuddalore*

***Abstract*- In the present stage, metal matrix composite MMC's is more acceptable because they are suitable for applications requiring high strength and thermal conductivity, damping properties, lower density, etc. The properties of MMC's enhance their usage in automotive and many other applications. In the field of automobile, MMCs are used for cylinder block, brake drums, because of better corrosion resistance and wear resistance.TiO2&graphite is used as the reinforcement to produce the composite by the stir casting process. The matrix combination with Al6061 as base was varied in terms of weight percentage of Titanium Oxide (5%, 7.5% & 10%) and Graphite (5%, 7.5% & 10%) separately and hybrid composite with titanium oxide and graphite producing specific test specimen suitable to specific test conditions. Experiments such as tensile test, izod impact test, hardness test, micro structure, etc. which determine the mechanical behaviors were conducted on both base metal (Al6061) as well as on the composites. The results provides inside view of effects of reinforcement on particulate reinforced composites.**

Index Terms- TiO_2&graphite, TiO_2&graphite, hardness test, reinforcement

1. EXPERIMENTAL DETAILS

At present Al6000 series alloy are very extensively used matrix material for producing hybrid composites for high and heavy load wear applications. High pressure of elongation and high hardness of Al6000 series materials has enabled and achieved its usage for most of the industrial applications. In this study, Al6061 was used as the matrix material because of the dominant hardness it possess over the other aluminium alloys. Al6061 was obtained at a grain size of 100 microns. The chemical composition of the material is detailed below.

Element	Cr	Fe	Mg	Mn	Si	Zn	Ti	Al
Amount (Wt. %)	0.3	0.5	1.2	0.15	0.6	0.15	0.1	Bal

Table:1.1 Chemical composition of Al6061.

Titanium dioxide, also known as titanium (IV) oxide or titania. It has molecular formula TiO2 and molecular weight 79.87. It is a kind of powder. Titanium dioxide color is white. TiO2is a soft solid and melts at 1800 Degrees Celsius. It has exceptional performance such as insulation, corrosion resistance, flags, etc. It is polymorphous and it exists in three types of crystal structures: (i) Rutile, (ii) Anatase and (iii) Brookite. Among them rutile is used commercially.

Graphite will be used as soft reinforcement on account of its low coefficient of friction, superior thermal conductivity and resistance to corrosion. Also, graphite will act as good solid lubricant for friction applications. Preparing composite with built in solid lubricating characteristics is one of the major importance for antifriction applications. The formation of third body films consists of solid lubrication layers or particulate reinforcement of solid lubricants plays an important role during practical applications of composite. Graphite procured in the form of powder at a grain size of 100 microns.

2. CASTING PROCESS

In stir casting process, the reinforcing phases are distributed into molten matrix by mechanical stirring using mechanical stirrer. Stir casting of metal matrix composites was first introduced in 1968, when S. Ray introduced alumina particles into aluminium melt by stirring molten aluminum alloys which contains the

ceramic powders. Mechanical stirring in the furnace is a mandatory element of this process. The produced molten alloy, with ceramic particles, can then be used for die casting, mold casting or sand casting. Stir casting is the best suited to manufacture composites with up to 30% volume fractions of reinforcement. The cast composites are sometimes again extruded to reduce porosity, refine the microstructure, and homogenize the distribution of the reinforcement, etc. One of themajor concerns associated with the stir casting process is thesplitting of reinforced particles which is caused by the surfacing or settling of the reinforcement particles atthe time of melting and casting processes. The ultimate distribution of the particles in the solid depends onprocess parameters such as the particle's wetting conditions with the melt, strength of producingrelative density, andthe rate of solidification. The final distribution of the particles in the metal matrix depends on the geometry ofstirrer used, stirring parameters and mechanical stirrer's placement in the melt, temperature at which it melts and the characteristics of the particles added.An interesting and innovative development in stir casting is a twostep mixing process. In this process, the matrix material isheated to a temperature above its liquids temperature so that the metal is completely melted. The melt is then cooled down to a temperature which liesin between the liquids and solidus points where it is kept in a semi solid state. At this stage, the preheated particleswere added and mixed. This slurry is once again heated to a fully liquid state and mixed thoroughly. This two-step mixingprocess has been used extensively in the fabrication of aluminium. Among all the well-established metal matrix composite (MMC) fabrication methods, stir casting is likely to be the most economical. For this reason, stir casting is used extensively and it is the most popular commercial method of producing aluminum based composites.

3. RESULTS AND DISCUSSION

3.1HARDNESS TEST

Hardness measurements quantify the resistance of a material to plastic deformation. Indentation hardness tests compose the majority of processes used to determine the material's hardness.

Sample 1-80%Al6061+10%Gr+10%TiO_2

Sample 2 - 85%Al6061+7.5%Gr+7.5%TiO_2

Sample 3 - 90%Al6061+5%Gr+5%TiO_2

S.NO	SPECIMEN	OBSERVED VALUES, HRA			AVERAGE HR15N
		1	2	3	
1	Sample 1	62	62	61	62
2	Sample 2	57	58	58	58
3	Sample 3	55	54	55	55

Table:3.1.1 Sample Details

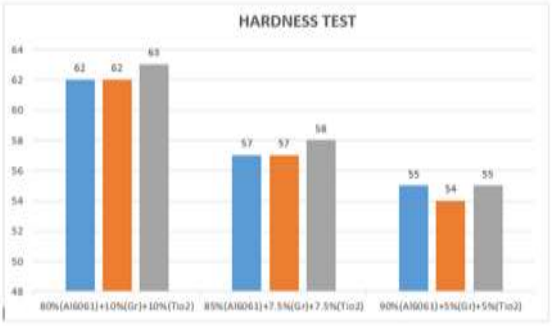


Fig :3.1.1variation of hardness test

Fig:3.1.2 Impact Test sample

Impact is a very important phenomenon in governing the life of a structure. Impact tests are used in studying the toughness of material. A material's toughness is a factor of its ability to absorb energy during plastic deformation. Brittle materials have low toughness as a result of the small amount of plastic deformation that they can endure.

SPECIMEN	Impact Load Nm
80%Al6061+10%Gr+10%Tio_2	7.2
85%Al6061+7.5%Gr+7.5%TiO_2	6.3
90%Al6061+5%Gr+5%Tio2	5.8

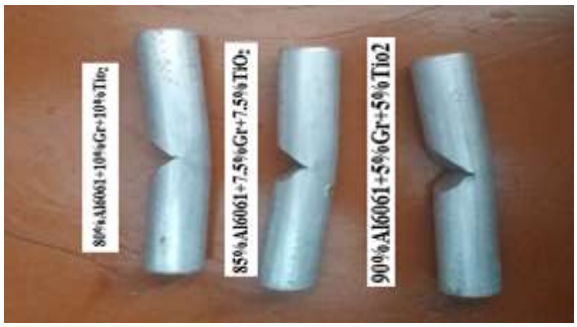


Fig:3.1.3 Impact Test sample

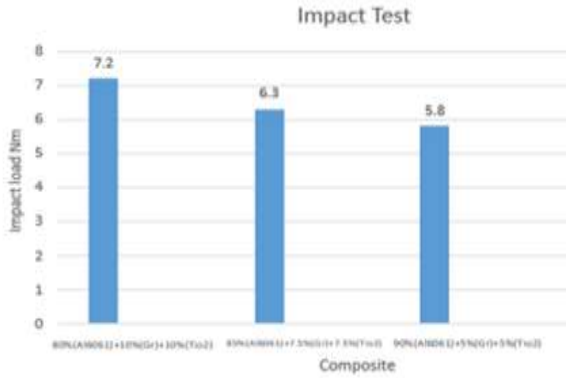


Fig:3.1.4 Variation Impact Test

3.2 TENSILE TEST

Tensile testing, is also known as tension testing, is a fundamental materials science test in which a sample is subjected to a controlled tension until failure. The results from the test are commonly used to select a material for an application, for quality control, and to predict how a material will react under other of forces.

Material Composition	Yield strength N/mm²	UTS MPa
80%Al6061+10%Gr+10%Tio2	115.61	7.96
85%Al6061+7.5%Gr+7.5%TiO2	112.42	8.20
90%Al6061+5%Gr+5%Tio2	113.17	9.96

Table:3.2.1 Material Composition

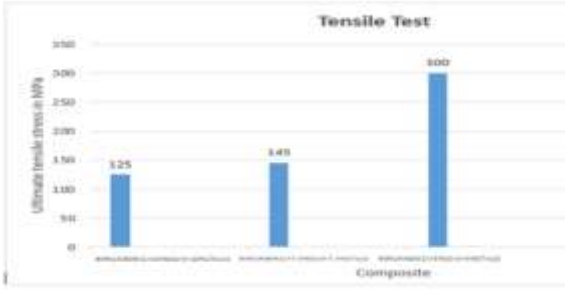
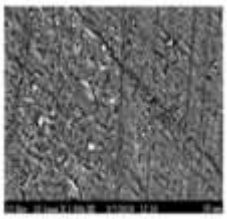


Fig:3.2.1 Variation Impact Test

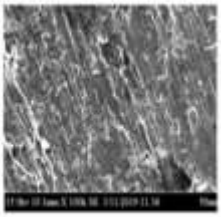
Fig:3.2.2 Tensile Test sample

4. MICROSTRUCTURAL TEST

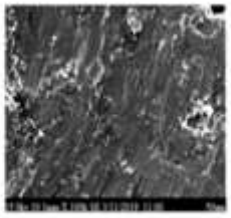
Computer simulated microstructures are generated to replicate the microstructural features of actual microstructures.



80%Al6061+10%Gr+10%Tio2



85%Al6061+7.5%Gr+7.5%TiO2



90%Al6061+5%Gr+5%Tio2

FIG:4.1 Sem Image of Specimen

CONCLUSION

- The hybrid composite of Al6061 matrix and reinforcement of (Gr+TiO2) was successfully fabricated by stir casting technique and conducted various mechanical behavior testing on fabricated composite material.The following conclusions are drawn from the test results.
- The study reveals that TiO2 and Gr particles increases the hardness of the composites.
- Impact resistance of the composite increases with increase in Wt. % TiO2 and Gr.

- The tensile strength resistance of the composite decreases with increase in addition of TiO2 and Gr.
- Scanning electron microscope image of prepared composites shows uniform distribution of reinforced particles in matrix alloy.
- Reinforcement have significant role in enhancing the properties of particulate reinforced composites up to a certain volume fraction.
- Heat treatment may be employed to increase the hybrid composite resistance to wear, abrasion, and corrosion.

REFERENCES

[1] "Comparative Study On Individual And combined Elects Of Zirconium Dioxide And Graphite Reinforcements On Mechanical Properties of Al 6061 Composites Harish BR, A K ShaikDawood Et Al (2016).
[2] "Mechanical Properties of Al-Si-Sicp Composites" OluwascunAyotundeAloAndSaheedAkande (2015).
[3] "Fabrication and Characterisation of Al-Based Hybrid Composite Reinforced with SiC,Al2O2, And C Particles By Squeeze Casting". Gurvinder Singh&Charanjeet Singh Kalra (2015).
[4] "Bijay Kumar Show, Dipak Kumar Mondal, JloyleepMaity". Dry Sliding wear Behavior of aluminum-based metal matrix composites with single (Al2O3) and hybrid (Al2O3+ SiC).
[5] Aluminun-Based Metal Matrix Composites with Single (Al2O3) And Hybrid (Al2O3 + SiC)'Metallogr. Microstruct. Anal. (2014).
[6] "Mechanical BehaviourOfAluminium 6061 Alloy Reinforced With Al2O3& Graphite Particulate Hybrid Metal Matrix Composites" MadevaNagaral Et Al (2013).
[7] "Strength Of Material (Book) By R.K.Bansal.
[8] A.B. Gurcan, T.N. Baker, 'Wear beahaviour of Al6061 aluminiumalloy and its composites'. Wear 188 (1995) 185-191.
[9] S. V. Prasad, B. D. McConnell, 'Tribology of aluminium metal matrix composite: lubrication by graphite'. Wear, 149 (1991) 241-253.
[10] L. H. Hihara, R. M. Latanision, 'Residual microstructural in chloride in graphite – aluminium metal matrix composites'. Materials science and engineering Al26 (1990) 231-234.