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Microstructure, Mechanical properties and Damping behaviour of hybrid composite of A356.0

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Abstract: In this study, A356.0 alloys were reinforced with varied percentage of Alumina and Graphite by liquid metallurgy route and tested for Microstructure, Mechanical properties and Damping behaviour. Microstructure revealed uniform distribution of reinforcement in the matrix resulting in improved Mechanical properties and Damping behaviour compared to un-reinforced material. The ceramic reinforced alloys were found to have improvement in Mechanical properties and Damping behaviour which may be attributed to the uniform distribution and bonding of reinforcement in the matrix.

Key words: Composites, MMC's, Damping ratio, Microstructure, Mechanical behaviour.

I. INTRODUCTION

Aluminium-silicon alloy and its composite possess light weight, high specific strength and good heat transfer ability which make them suitable material to replace components made of ferrous alloys. Estimating damping characteristics in structures made of different materials remains as one of the biggest challenges. Aluminium, its alloys and its composites is one such pioneer material which is being used extensively in Aerospace, Automotive and the manufacturing industries. The damping capacity of a material refers to its ability to convert mechanical vibration energy in to thermal energy. Passive damping is critically important material property from the view point of vibration suppression in aerospace and submarine structures. Attempts are made to increase the strength of Al-Si-Mg by various manufacturing processes, heat treatment and reinforcement of hard and soft reinforcements etc.

In this paper, an attempt is made to study the effect of reinforcement of Alumina and Graphite on microstructure, mechanical properties and damping behaviour of A356.0.

II. MATERIALS

A356.0 alloys were reinforced with Alumina and Graphite and were cast using liquid metallurgy route in the form of cylindrical bars of length 300mm and diameter 25mm.Cantilever beams of cross section 15mm X 3mm X 180mm for Damping test were machined from the cylindrical bars.

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TABLE I
CHEMICAL COMPOSITION OF A356.0

Element	Weight %
Si	7.25
Mg	0.45
Fe	0.086
Cu	0.010
Mn	0.018
Ni	0.025
Zinc	0.005
others	0.028
Al	Balance

TABLE-II
DESIGNATION OF ALUMINA AND GRAPHITE REINFORCED ALLOYS

Sl No	Alloy/Composite	Designation	Damping ratio of Untreated alloy and its composites
1	As cast A356.0	As cast A356.0	0.026
2	3% A+5% G	3A	0.0243
3	5% A+5% G	5A	0.02757
4	10% A+5% G	10 A	0.02205
5	3% G+5% A	3G	0.02092
6	10% G+5% A	10G	0.028112

III. TESTING

A: Microstructure

The samples for microstructure examination were prepared by following standard metallurgical procedures, etched in etchant prepared using 90 ml water, 4ml of HF, 4ml H_2SO_4 and 2g CrO_3 and were examined using Optical Microscope.

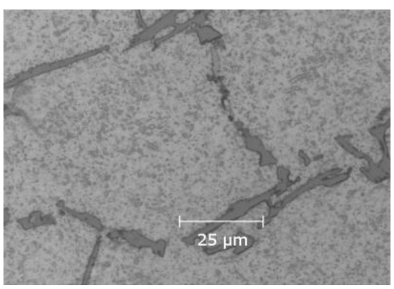

Fig. 2.1
Microstructure of As Cast A356.0

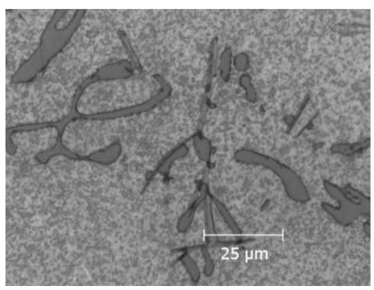

Fig. 2.2
Microstructure of 3A

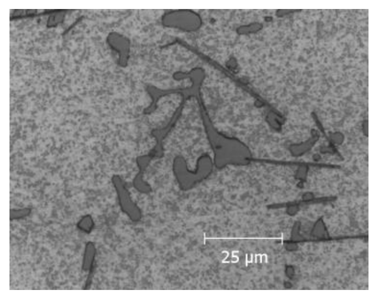

Fig. 2.3
Microstructure of 5A

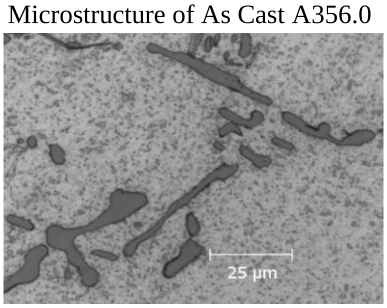

Fig. 2.4
Microstructure of 10A

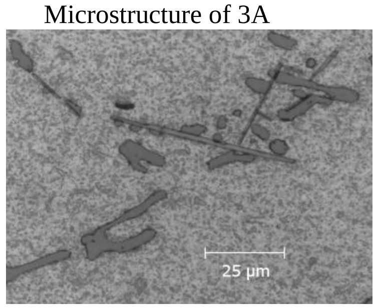

Fig. 2.5
Microstructure of 3G

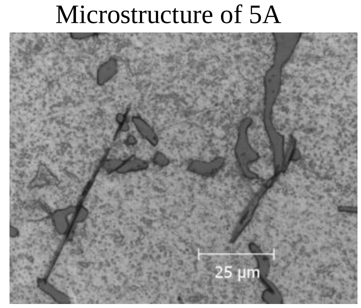

Fig. 2.6
Microstructure of 10G

Figures 2.1 to 2.6 show the uniform distribution of ceramic reinforcements namely, Alumina and Graphite in A356.0 matrix.

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B. Hardness test

The hardness tests were conducted as per ASTM E10 norms using Brinell hardness tester. Tests were performed at randomly selected points on the surface by maintaining sufficient spacing between indentations and distance from the edge of the specimen.

Fig.2.7: Hardness test specimens

TABLE III

Alloy Designation	Hardness (B H N)
As cast A356.0	51
3A	58
5A	39
10 A	41
3G	42
10G	46

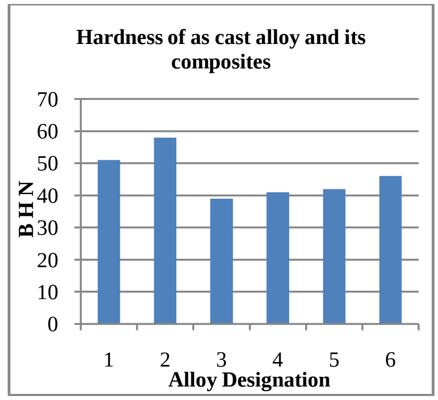

Fig.2.8
Hardness of as-cast alloy and its composites.

Table III Shows the hardness values of As cast A356.0 alloy and its composites. The hardness of A3 (3% Alumina + 5% Graphite) is found to be 58 compared to as cast alloy with hardness 51 indicating 13.73% increase in hardness. A5 (5% Alumina + 5% Graphite) has least value of 39. G10 has hardness of 46.

C: Tension test

Fig.2.9: Tension test specimens

TABLE IV

Alloy Designation	UTS in MPa	% Elongation
As cast A356.0	78.05	1.2
3A	87.99	0.76
5A	79.79	4.08
10A	63.59	1.68
3G	65.74	2.28
10G	62.27	3.32

Table IV gives the ultimate tensile strength (UTS) and ductility of A356.0 and its composites.

Fig 2.9 shows plot of UTS of as cast and its composites. Alloys 3A, 5A have UTS 87.99 M Pa and 79.79 M Pa indicating 12.74% and 2.22% increase respectively compared to as cast alloy with UTS 78.05 MPa. Composites 10A, 3G and 10G have lower strength compared to A356.0.

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D: Damping test

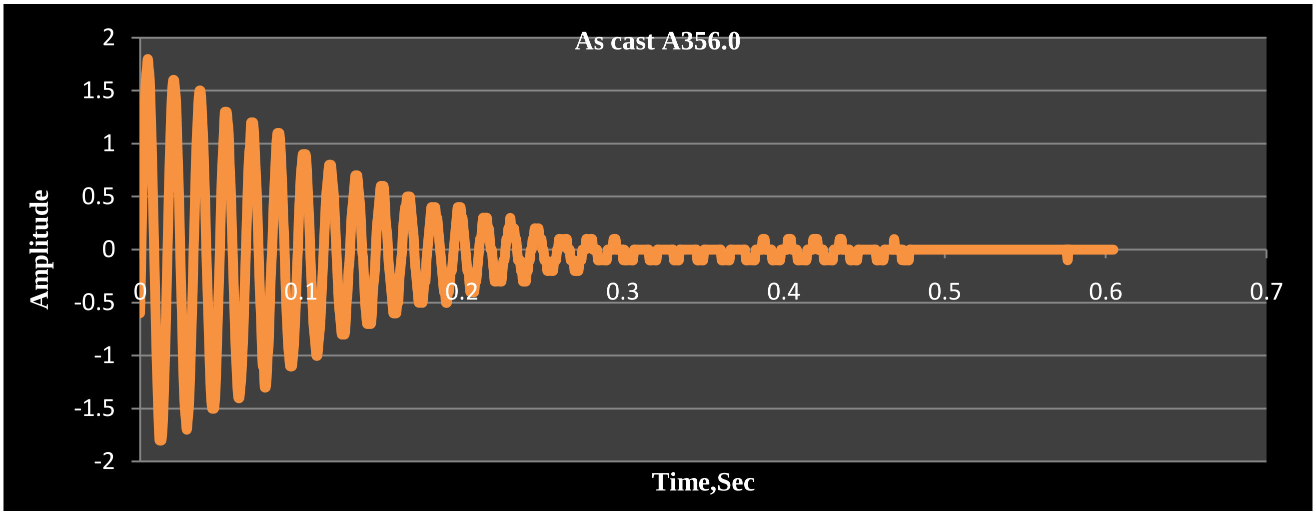

Fig.3.1: Free vibration response of SDOF As-cast alloy.

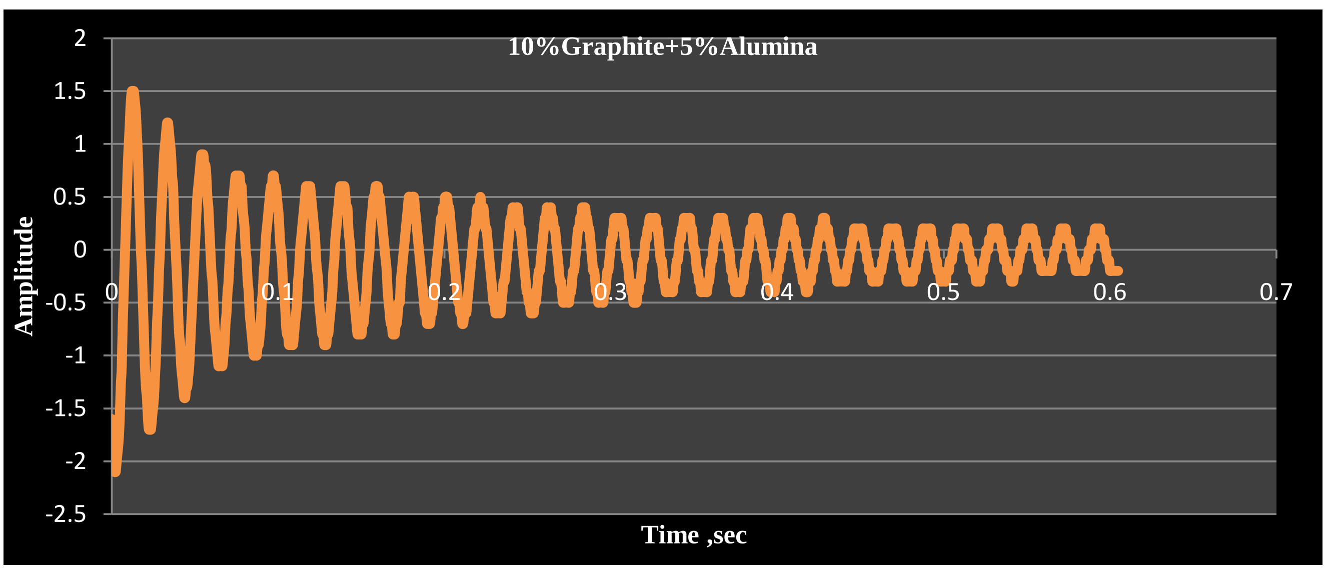

Fig.3.2: Free vibration response of SDOF 10G.

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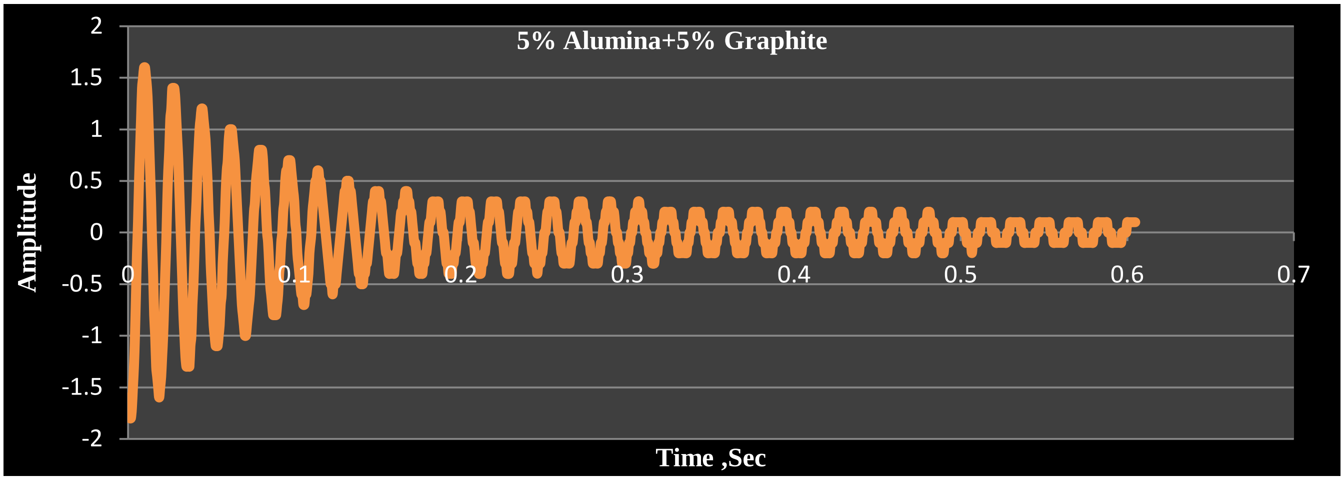

Fig.3.3: Free vibration response of SDOF 5A

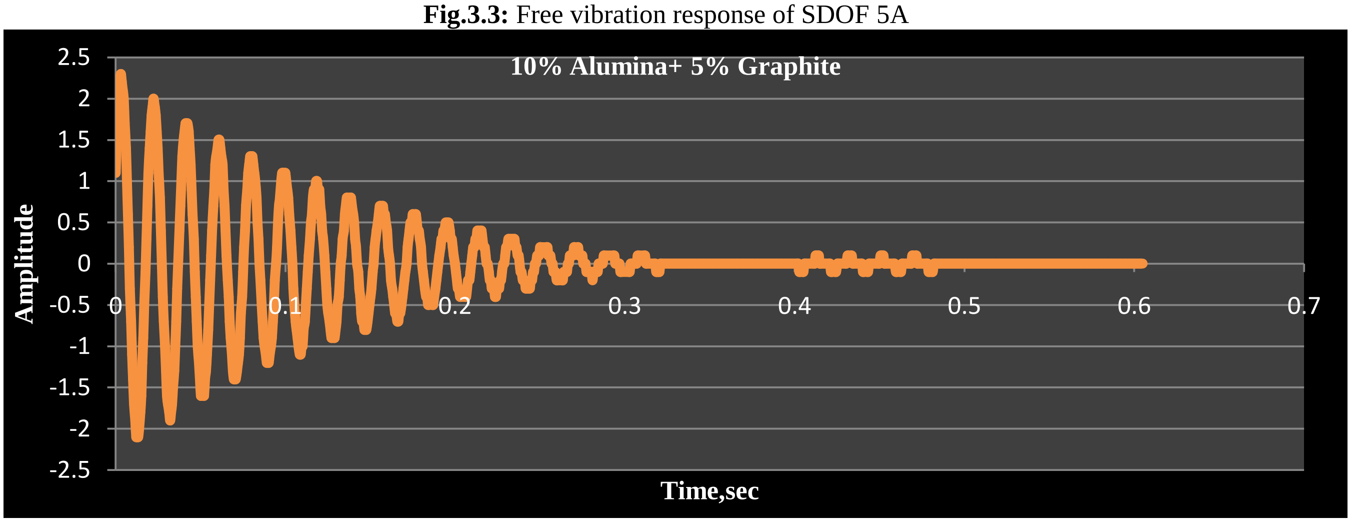

Fig.3.4: Free vibration response of SDOF 10A

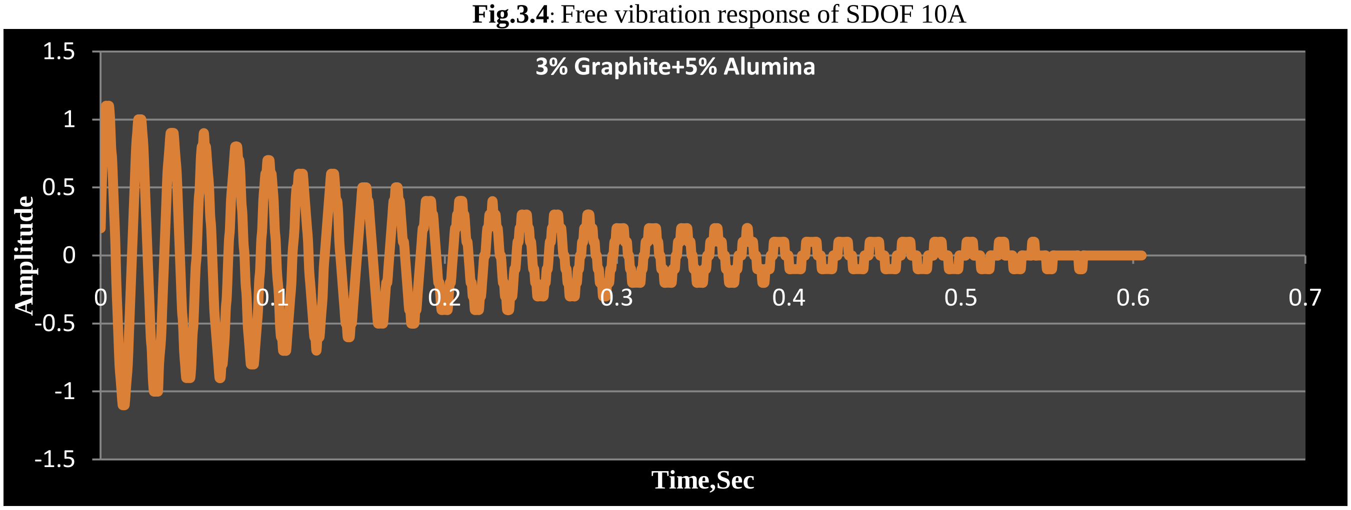

Fig.3.5: Free vibration response of SDOF 3G

Fig 3.1 to 3.5 shows the free vibration response of SDOF of A356.0 reinforced with varied percentage of Alumina and Graphite particulates, where best damping ratio was observed for composite with 10% Graphite +5% Alumina

IV CONCLUSION

Microstructure indicates uniform distribution of ceramics in the matrix resulting in good bonding of the particulates. The composite with 3% Alumina & 5% Graphite has highest hardness and UTS. Composite with equal % of Alumina and Graphite (5%) has highest ductility. The composite with 10% Graphite +5% Alumina showed highest damping ratio and is a good damping material compared to as cast alloy and its Composites. Graphite particles are better reinforcement compared to Alumina reinforced composite.

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REFERENCES

[1]. Feest, E. A., *"Exploitation of the metal matrix composites concept"*. Met.Mater., 1988, 4, 273-278.
[2]. Rohatgi, P., "*Cast aluminum-matrix composites for automotive applications"*. J. Met., 1991, 43, 10-15.
[3]. Saka, N., Pamies-Teixeira, J. J. and Suh, N. P. "*Wear of two-phase metals". Wear*, 1977, 44, 77-86.
[4]. Zhang, Z. F., Zhang, L. C. and Mai, Y.-W., "*Scratch studies of Al-Li alloy reinforced with SIC particles"*. Proc. 4th Int. Tribology Confi (Austrib 94), 5-8 Dec.1994, Perth, Australia, pp. 249-254.
[5]. R.J.Perz, J.Zhang, E.J.Lavernia, "*Strain amplitude dependence of 6061Al/graphite MMC damping*", Computational Materials Science, vol.27, pp.1111-14, (1992).
[6]. S.C.Sharma, A.Ramesh, "*Effect of heat treatment on Mechanical properties of particulate reinforced Al6061 composites, Journal of Materials Engineering and Performance*", vol.9 (3) (2000) pp.344-349.
[7]. S.C. Sharma, B.M. Girish, R. Kamath, & B.M. Satish, "*Fractogrphy, Fluidity, and Tensile Properties of aluminum/Hematite Particle composite"*, Jour. of Mat. Engg. & Perf. vol.8(3), 1999, pp.309-314.
[8]. Joseph E. Bishop and Vikram K.Kinra, "*Analysis of Elasto thermodynamic Damping in Particle-reinforced Metal-matrix composites*" Metall. Trans. vol. 26A (1995) pp.2773-2782.
[9]. G.J.C. Carpenter and SHJ Lo; "*Characterization of graphite-aluminium composites using analytical electron microscopy"*, Jour.Mater. Sci. vol. 27,(1992) pp. 1827-1841
[10]. H.C Lin, S.K Wu, and M.T Yeh, "*Damping Characteristics of TiNi Shpae Memory Alloys"*, Metallurgical Transactions, vol. 24 A (1993), pp. 2189-2782.
[11]. E. Carreno-morelli, N. Chawla, R.Schaller, "*Thermo-mechanical characterization of 2080 Al/SiCp composites by mechanical spectroscopy technique"*, Journal of Materials Science Letter, (2001), vol.20, pp.163-165.
[12]. N Srikanath, d. Saravana, ranganathan, M.Gupta, L.Lu, and M O Lai, "*Modelling and determination of dynamic elastic modulus of magnesium based metal matrix composites*" Material Science and Technology, March 2000, vol.16, pp.309-314.
[13]. J B Shamul, C Hammond, and R F Cochrane, "*Comparative characterisation of damping behaviour of aluminium alloy composites produced by different fabrication techniques"*, Material Science and Technology.
[14]. Hsu-Shen Chu, Kuo-Shung Liu, and Jien-Wei Yeh, "*Damping behavior of in situ Al-(graphite, Al4C3) composites produced by reciprocatingextrusion"*,JournalMaterialResearch,vol.16,no.5(2001) pp.1372-1380

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