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Design and Characterisation of Functionally graded Al metal matrix composites reinforced with SiC,$Al_2O_3$and MgO_2

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This thesis aims at the processing of functionally graded materials which are increasing used in the present scenario to replace the conventional composite materials. In our work we mainly focused to prepare compacts of Al metal matrix composites having reinforcing elements SiC,MgO_2& Al_2O_3 adopting powder metallurgy methodology. These green compacts are then sintered at 150 torr and 545^0c to get the desired hardness to the materials. The laminated functional material is then tested for its compressive strength and micro hardness.SEM & XRD analysis is also conducted to determine the compositions of individual elements and also for the calibration of the implemented manufacturing methodology. Attempt is also made to determine the tribological properties of prepares composites at varying sliding speeds and loading conditions.

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***Keywords*:** Graded materials, Compacts, strength, properties.

1. Introduction

Advances in material science have prompted development of new materials having distinctive properties. Graded green compact has a place with this pattern. The design of metal matrix composites can be enhanced by integrating the concept of graded materials to produce engineering materials with tailored contradictory properties that suit multi functioning components. Similarly, graded materials are made from a mixture of metals and ceramics and are characterized in a way that composition of each one and the volume fraction of materials.

A composite material from nature which consists of cellulose in a matrix of lignin. These materials or conventional graded structures will fail under extreme working conditions through a process called delamination (separation of fibers from the matrix) led to damage of component. This can happen for example, in high temperature application where two metals with different coefficient of expansion are used. The case of FGL, gradation is achieved by forming very thin layers of laminates. Graded structures used in structural components so as to optimize the responses of structures undergoing severe loadings, thermal effects due to complex environments

element	Si	Fe	Mn	Mg	Ti	Al
% wt	0.41	0.15	0.023	.38	0.016	Bal

2. SPECIMEN SIZE AND SPECIFICATIONS:

For this purpose of study four sample sizes were considered each of size ø8.5mm and thickness of 14.45mm. For each sample four specimens are fabricated at 324 MPa compaction pressure. Therefore all together sixteen specimens are fabricated. Sample size is 55×8.5mm Specimen size is 14.45×8.5mm

Four Samples have to be fabricated for each composition and totally 16 composites are to be prepared for experiments.

Specimen No.	**Composition Of Specimens**
1	100%Al
2.	90%Al + 10%SiC
3.	90%Al + 5% SiC+5%Mgo_2+Zinc sterate(Binding agent)
4.	85%Al + 5% SiC+10%Mgo_2+Zinc sterate(Binding agent)

In this work, we have fabricated metal matrix briquettes of Silicon carbide with aluminum matrix by powder metallurgy based on cold compaction technique. The mixed powder materials are placed in the mixing chamber. The mixing chamber is rotated with live center of a lathe machine at lowest speed for an half an hour clockwise and in anticlockwise direction for through mixing of powders. Blending powder mixtures were compacted in a cylindrical- diameter compaction dye. Based on the relationship between green density and compaction pressure of the Al alloys, the compaction pressure of the samples was chosen to be 17KN and compacted in compression testing machine (CTM, 100KN) for 60 sec under a uniaxial pressure of 17 KN. After the making of total specimens completed, taken them to finding out the length, diameter and on the digital micrometer. Compacted samples were sintered for 1hr 40 minutes at 545^0C

Fig 1: Compression and ejection block

Fig 2: Compacting guides and followers

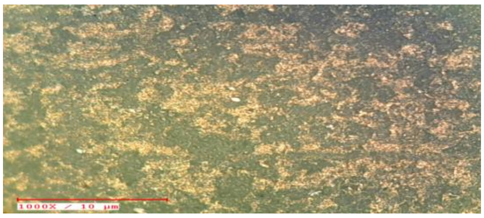
Fig 3: Compaction process

3. Results & Discussions:

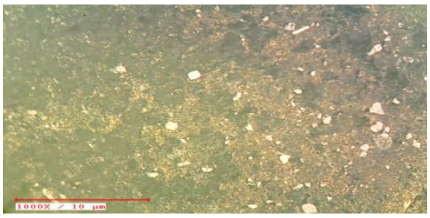
3.1 Hardness of the composites:

S no	Composition	Ball diameter	Impression diameter	VH
1	100%Al	3	1.8	63.69
2	90%Al + 10%SiC	3	1.5	95.084
3	90%Al + 5% SiC+5%Mgo$_2$	3	1.3	128.98
4	85%Al + 5% SiC+10%Mgo$_2$	3	1.2	152.588

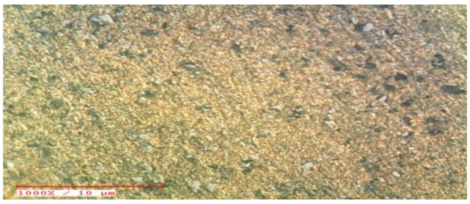
3.2 Microstructure of the composites:



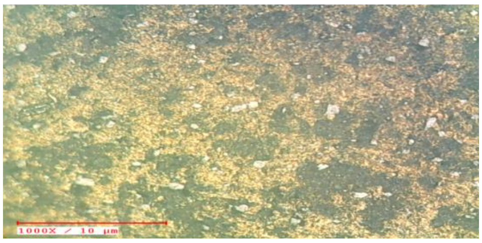
100%Al



90%Al + 10%SiC

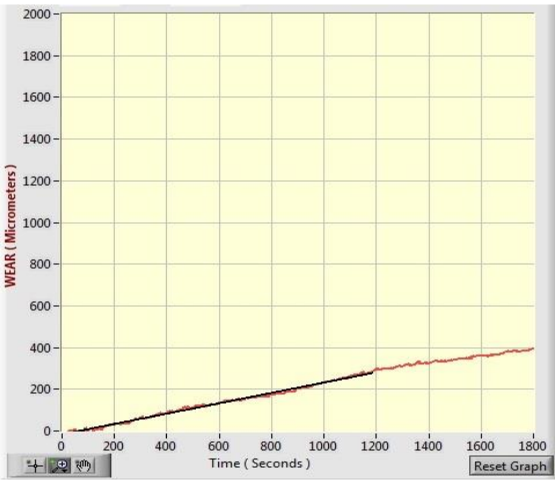


90%Al + 5% SiC+5%Mgo$_2$

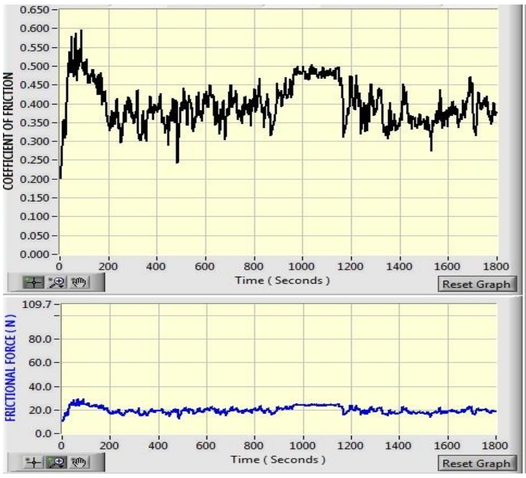


85%Al + 5% SiC+10%Mgo$_2$

3.3 Wear rate of the composites:



Wear rate of 4 layered MMC



variation of coeff of friction & frictional force

4. Conclusion

1. We observed that as the percentage of SiC is increased the hardness of the composite increased but sharp interfaces are formed at the microstructure level.
2. We also observed that as the magnesium is mixed with composite the wear rate of the composite is drastically decreased owing to best optimal results.
3. The combination of SiC and MgO_2 is fabricating the material to closed grain structures and low imperfections at microstuctural level.
4. We also observed that increase in SiC is increasing the compressive strength of the composite.

References

1. Zhai Yan-bo, Liu Chang-ming, Wang Kai, Zou Mao-hua, Xie Yong, “Characteristics of Two Al Based Functionally Gradient Composites Reinforced by Primary Si Particles”, Transactions of Nonferrous Metals Society of China, Vol. 20, Page 361-370, 2010.
2. Bin Shen, Mija Hubler, Glaucio H. Paulino, Leslie J. Struble, “Functionally Graded Fibre Reinforced Cement Composite: Processing, Microstructure and Properties”, Cement & Concrete Composites, Page 663-673, 2008
3. A.C. Vieira, P.D. Sequeira, J.R. Gomes, and L.A. Rocha, “Dry sliding wear of Al alloy/SiCp functionally graded composites: Influence of processing conditions”, Wear 267, 2009, pp. 585–592.
4. Daniel Lin, Qing Li, Wei Li, Shiwei Zhou, and Michael V. Swain, “Design optimization of functionally graded dental implant for bone remodeling”, Composites: Part B 40, 2009, pp.668-675
5. Siddhartha, Amar Patnaik, and Amba D. Bhatt, “Mechanical and dry sliding wear characterization of epoxy–TiO2 particulate filled functionally graded composites materials using Taguchi design of experiment”, Materials and Design 32, 2011, pp. 615– 627.