Tribological behavior of Al hybrid composite for automotive applications

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Introduction

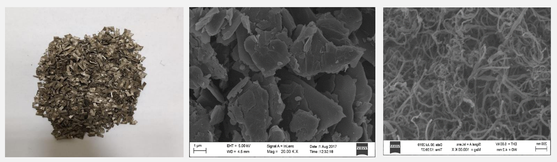
Aluminium metal matrix composites are preferred over conventional metals for the structural parts in automobile and aerospace application due to their high specific strength, high wear and corrosion resistance and light weight. Aluminum MMCs are used in piston, connecting rod, cylinder barrel, brake system. In this work, Aluminium alloy 5052 composites reinforced with TiC fabricated using in-situ reaction synthesis method. Hybrid composites reinforced with CNT will also be fabricated and a comparable study will be carried out. The MMCs will be prepared according to conventional brake disc size where the wear properties will be evaluated. Later, non-regression model will be generated for optimum wear characteristics of the MMCs.

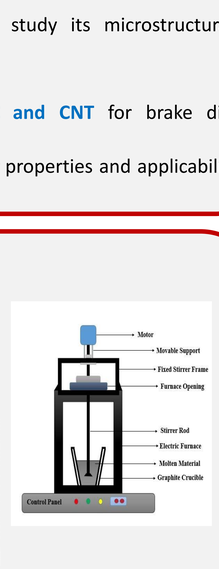
Objectives

- To **fabricate AA5052/TiC metal matrix composites** and study its microstructural, mechanical and wear behavior.
- To **develop fuzzy-logic model** for the wear behavior.
- To **manufacture hybrid composite reinforcing with TiC and CNT** for brake disc application.
- **To Fabricate a miniature model of brake disc** to study wear properties and applicability of the hybrid composite.

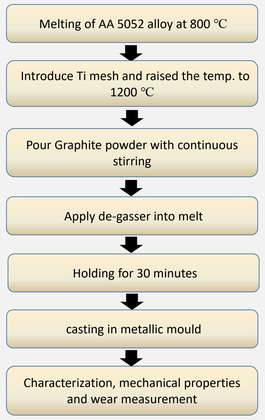
AA 5052 alloy- Primarily alloyed with Mg

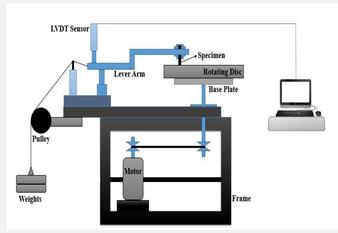
Element	Si	Mg	Cr	Fe	Cu	Al
Wt.%	0.12	**2.61**	0.28	0.22	0.01	Remainder





Experimental Procedure

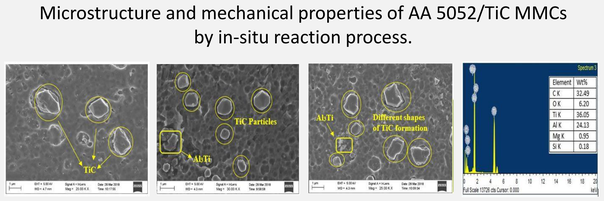




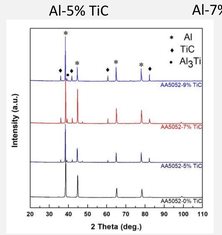
Schematic diagram of wear set up

Results and Discussion

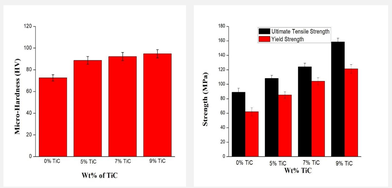
Microstructure and mechanical properties of AA 5052/TiC MMCs by in-situ reaction process.



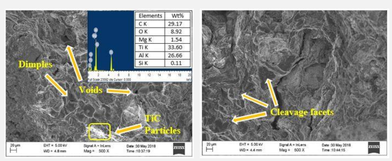
Al-5% TiC Al-7% TiC Al-9% TiC EDX of TiC particle



XRD spectra of Al MMCs



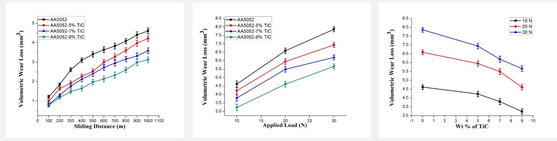
Hardness and Tensile Strength of Al MMCs

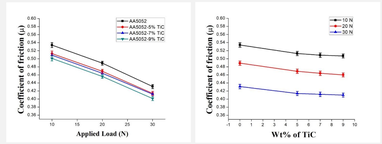


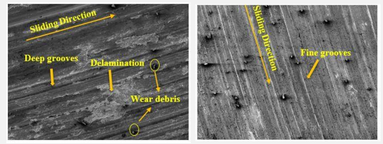
Tensile fracture micrographs of Al MMCs

- Uniform distribution was achieved as a result of in-situ reaction process.
- Perfect Crystalline TiC peak was observed as primary phased in XRD spectrum.
- Micro-hardness was enhanced as by the inclusion hard TiC particles as it resists to the plastic deformation in Aluminum.
- The clear interface with grain refinement of TiC Strengthened the MMCs.
- The fractography shows the formation dimple and cleavage, which indicates the composite exhibited ductile-brittle mixed pattern of fracture.

Sliding Wear Behavior







SEM micrographs of worn surfaces

- When sliding distance increases, the contact surface subjected to rise in temperature. Thus the micro-thermal softening process reduced the bonding, as a result more wear loss was observed.
- Less wear loss contributed to strong interfacial bonding. Also, it indicated the higher hardness. The increase in hardness of the composite allows for lower contact area which needs less energy as compared to the alloy matrix to shear resulting decrease in wear loss.
- Parallel grooves were seen in the worn surfaces indicating the composites exhibiting enhancement of wear resistance by eliminating plastic flow of material.

Summary

- The Aluminum TiC MMCs exhibit better mechanical and wear properties proving its ability to use it in potential tribological application in the automobile sectors.
- Our future work will consist of fabricating hybrid composites with its applicability in brake system.

References

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Publications

- **P. Samal**, Pandu R. Vundavilli, A. Meher and M.M. Mahapatra, "*Influence of TiC on dry sliding wear and mechanical properties of in situ synthesized AA5052 metal matrix composites*", **Journal of Composite Materials**", **(2019)** Vol. 53 (28-30), pp. 4323-4336.
- **P. Samal**, Pandu R. Vundavilli, A. Meher and M.M. Mahapatra, "*Fabrication and mechanical properties of titanium carbide reinforced aluminium composites*", **Material Today: Proceedings, (2019),** Vol. 18 (7), pp. 2653-2661.
- **P. Samal**, Pandu R. Vundavilli, A. Meher and M.M. Mahapatra, "Recent Progress in aluminum metal matrix composites: a review on processing, mechanical and wear properties", Journal of Manufacturing Processes. (Under Review)

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