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WEAR BEHAVIOUR OF ALUMINIUM BASED MMC USED IN BRAKE DISCS

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ABSTRACT

The wear behaviour of aluminium metal matrix composite sliding against automobile friction material was compared with the conventional grey cast iron. The wear tests were carried out on a pin on disc machine, using pin as brake shoe lining material and discs as Al - MMC and cast iron materials. Microstructural evidence of the wear behaviour of the composites was studied in order to come to a validation of the experimental data produced. The worn surfaces and subsurfaces of specimens tested were also examined by using Scanning Electron Microscopy (SEM) and Infinite Focus Microscopy (IFM). Infrared (IR) thermography was also used to measure thermal profiles of the material surfaces during wear testing.

Keywords: metal matrix composites (MMC), wear, SEM, IR imaging.

INTRODUCTION

Metal Matrix Composites are now used in braking in most top-level motorsport worldwide, reducing unsprung weight, giving better frictional performance and improved structural properties at high temperatures, compared to cast iron. MMC brakes can withstand temperatures that would make conventional cast iron discs bendable. The attractive key property of Aluminium based composites reinforced with ceramic particles is the combination of the physical as well as chemical properties such as the mechanical strength, stiffness, thermal expansion coefficient, weight, corrosion resistant, high heat tolerance and at an affordable cost. Past investigations show that the MMCs have considerable higher wear resistance than conventional cast iron while sliding against automobile friction material under identical conditions [R.L. Deuis et al, 1997, N. Natarajan et al, 2006]. The main aim of the study is to compare the wear behaviour and the heat dissipation characteristics of different formulations based aluminium composites reinforced with two different types of ceramic particles, SiC and Al_2O_3. Cast iron material will be tested for comparison. The technique that will be used to test the wear behaviour of the materials is the pin on disc test. This test basically involves spinning the disc and applying the pin to its surface to wear it. This is the most common test for research based around wear behaviour in brake discs (Kaczmar & Naplocha, 2010). This particular test suits brake discs because it matches the real situation of wear in a spinning situation. It is also easy to control and change several variables in this test method.

RESULTS AND CONCLUSIONS

Pin-on-Disc wear tester was used for evaluating sliding wear characteristics. A pin-on-disc type setup was used for the wear test in which commercial phenolic pad pin pressed against a horizontal rotating disc made from Al-MMC (Fig.1). Tests were conducted for a total duration of 80min at 100rpm with a load of 8kg for each of the samples.

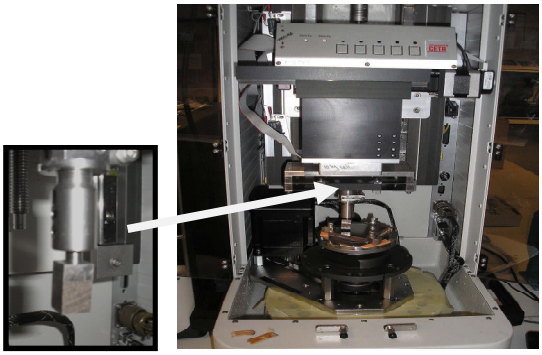

Fig. 1 - Experimental setup of Pin on Disc machine

The surface roughness of MMC and cast iron were compared using IFM microscopy and the results are shown in Fig.2. In comparison to the wear scar for the cast iron sample, this sample of MMC appears much smoother, indicated minimum wear. In Table 1 wear scar depth measurements taken by IFM reveals the advanced performance of the MMCs in comparison to conventional Cast iron discs.

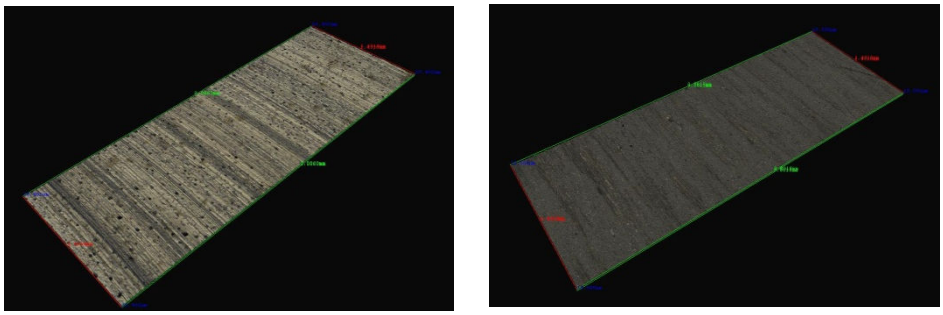

Fig. 2 - IFM image of worn section of a) Cast iron sample b) MMC sample

Table 1 - Wear depths for Cast Iron vs. MMC sample

Wear scar depth measurements	Maximum scar depth 1 (µm)	Maximum scar depth 2 (µm)	Maximum scar depth 3 (µm)	Average	Standard Deviation
Cast Iron	8.87	9.28	8.22	8.79	0.53
MMC	3.25	4.62	3.44	3.77	0.74

The study showed that Al-MMCs offer much more desirable wear characteristics on the disk itself, but on the brake pad as well. The Al-MMC sample disk had a maximum wear scar depth that was less than half as deep as the cast iron sample. The Aluminium MMCs profile roughness post testing was three times smoother than the cast iron sample.

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