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Lightweight Metal Matrix Composites as Bearing Bush Materials for Articulating Revolute Pin Joints

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In this study, magnesium (Mg) and aluminum (Al) metal matrix composites reinforced with 5 wt% WS_2 and 15-20 wt% SiC particles were sintered via powder processing. The composites were over 50% less dense compared with a commercial bearing material, bronze. Tribological behavior of bearing bushes made from these lightweight composites were investigated using a purpose built pin joint test rig. The wear track and tribo-layer generated were investigated by optical profilometry and scanning electron microscopy. The average friction coefficient was found to be 0.11-0.28 compared with 0.28-0.37 for bronze. The lightweight composites exhibited much lower friction coefficient and good wear resistance.

Keywords (from 3 to 5 max): lightweight, metal matrix composites, bearing bush, tribological performance

1. Introduction

Lightweight metal matrix composites (MMC) are candidate materials for tribological components due to their significant potential in weight saving and downsizing [1]. In this study, lightweight Mg and Al composites reinforced with WS_2 and SiC particles were metallurgy sintered and made into bearing bushes. Tribological experiments were designed to study the behavior in a contact between a composite bush and hard chromed 300M steel shaft using a purpose built pin joint test rig. To understand the contact mechanism, the wear track and tribo-layer were investigated and discussed.

2. Methods

2.1. Test rig
Figure 1. shows the purpose-built test rig [2]. The shaft was driven to perform continuous rotation or oscillation (±60°). The driver software was written in LabView, which controls the recording of frictional torque and normal load on the contact.

Figure 1: Test rig, bush sample and contact configuration

2.2. Test specimens
The bearing bushes were machined from sintered composite bar (details in Table 1).

Table 1: Test specimens

Sample designation	Materials
Mg	Magnesium
Mg MMC1	75 wt% Mg, 15 wt % SiC, 10 wt% WS_2
Mg MMC2	70 wt% Mg, 20 wt% SiC, 10 wt% WS_2
Al	Aluminum
Al MMC1	75 wt% Al, 15 wt % SiC, 10 wt% WS_2
Al MMC2	70 wt% Mg, 15 wt% SiC, 15 wt% WS_2

2.3. Contact pressure and friction coefficient
Contact pressure and coefficient of friction (CoF) were calculated from the following two equations.

$$p = \frac{P}{2RL\sin(\alpha/2)} \quad (1)$$

$$\mu = \frac{T}{2PR} \quad (2)$$

P is normal load, R is the shaft radius, L is contact width, T is frictional torque, and α is contact angle.

2.4. Results
The mechanical properties were enhanced by the SiC particles while the friction coefficient was reduced due to the self-lubricating additives, WS_2. The shaft rotation modes, continuous rotation or oscillation didn't affect the friction coefficient for tested composites (Figure 2 (b)). Under the same testing conditions, CoF of the composites was found to be lower than commercial bearing materials (Figure 2 (c)).

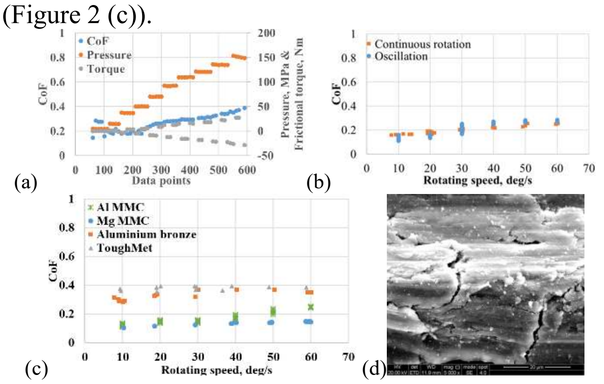

Figure 2: Test results, (a) recorded data, (b) CoF varying against sliding speed for two rotating modes, (c) CoF comparison for varying materials, and (d) SEM image of the Mg MMC worn surface

3. Discussion

The lightweight Mg and Al MMCs, used as bearing bush materials, presented high mechanical strength and lower friction compared with traditional high dense metals, bronze. By understanding their tribological performance, this study shows that Mg and Al MMCs provide competitive advantages for the load bearing applications. The study demonstrates the feasibility of the lightweight composites used for tribological machine elements.

4. References

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