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Effects of dispersed sulfides in bronze under line contact conditions

T. Sato[1,*], Y. Hirai[1], T. Fukui[1], K. Akiyama[2], H. Usami[2]

[1)] Technology Development Division, Kurimoto, LTD.,
2-8-45, Shibatani, Suminoe-ku, Osaka, 5590021, Osaka, Japan.
[2)] Materials Science and Engineering Department, Meijo University,
1-501 Shiogamaguchi, Tempaku-ku, Nagoya, 4688502, Aichi, Japan.

[*]Corresponding e-mail: ga4d001@gmail.com

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ABSTRACT – A Sintered bronze system is applied to plane bearings with some lubricants. A bronze-based, sulfide-dispersed Cu-alloy was developed via sintering. Sulfides have some functions that reduce friction resistance, thereby preventing scoring and seizures. Effects of the developed sulfide-containing bronze were investigated using a journal-type testing apparatus in wet conditions; results indicate that the developed bronze may have some anti-scoring properties.

1. INTRODUCTION

Copper (Cu)-based alloys usually have higher thermal conductivity and workability than other alloys, and it is possible to control the mechanical properties of such alloys by adjusting their additives and micro structure. Hence, Cu alloys have been applied to bearings operating at higher loads and speeds. To reduce frictional resistance, solid lubricants are dispersed into the alloy surface. Recently, it has been reported that the friction resistance of sintered Cu alloy containing micro-sized sulfide phases was lower than that of lead-dispersed alloy [1] and that the friction resistance of Cu alloys can be further improved by penetrating micro-sized graphite in dry conditions [2]. In this study, a journal type friction test is conducted because numerous mechanical and electrical equipment had journal-type plane bearings made of bronze.

2. METHODOLOGY

2.1 Material

A sintered Cu-based alloy containing a sulfide phase was used as the specimen. An optical microscope image of the alloy is shown in Figure 1. The specimen has micro-sized sulfide phase and pores. The alloy was sintered on a steel surface. After the sintering, the specimen was machined to the disc shape (8 mm in diameter and thickness).

2.2 Testing Apparatus

Figure 2 illustrates a schematic of the testing apparatus. The journal type apparatus consisted of a motor and a spindle. A steel shaft was attached to the top of the spindle. Cu alloy specimens were placed on the table that had an octagonal unit for measuring strain and were lifted up by loading. When shaft and specimen came in contact with applicate poly-α-olefin, from the measuring strain at the octagonal unit, load W and friction force F were calculated. Finally, the coefficient of friction μ was evaluated. Details of the test conditions are indicated in Table 1.

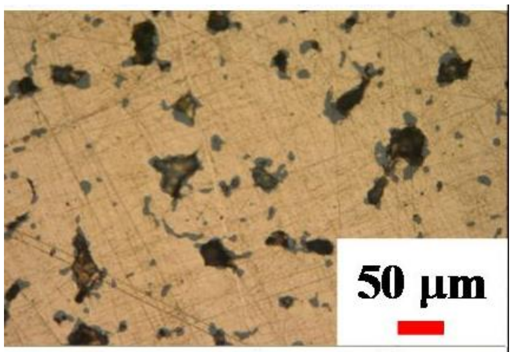


Figure 1 Sulfide dispersed bronze.

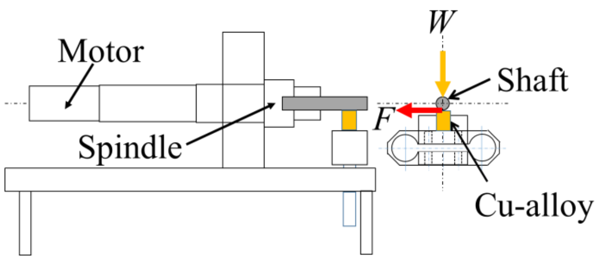


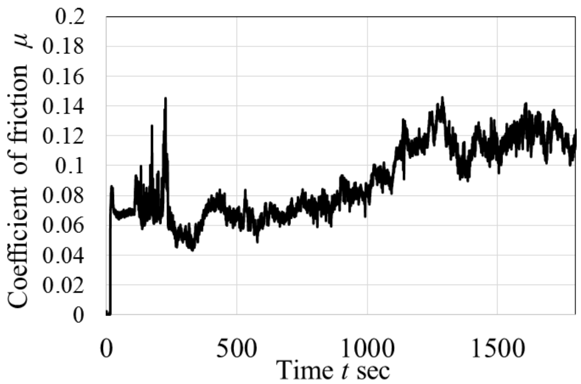
Figure 2 Schematic of the testing apparatus.

Table 1 Conditions of the test.

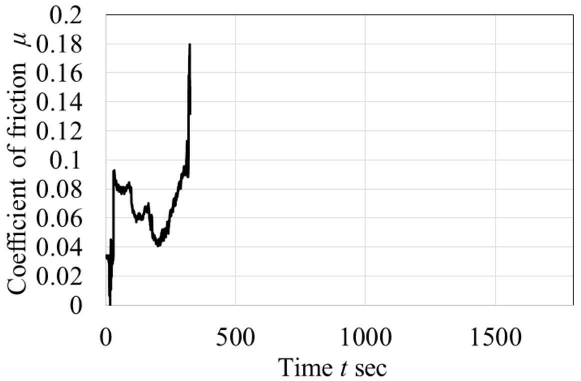
Specimens	System	Load	Speed
A(developed)	Cu-Sn-S-Fe-P	7 N	3.14 m/s
B(comparison)	Cu-Sn-P	7 N	3.14 m/s

3. RESULTS AND DISCUSSION

Figure 3 shows the results of the tests. During the test (which lasted 1,800 s), specimen A(SP-A) experienced no scoring and seizure. For the first 200 s of the test, the coefficient of friction swung up and down. After 200 s until 1000 s into the test, the coefficient of friction was 0.06-0.08. Finally, the coefficient reached approximately 0.12. On the other hand, specimen B(SP-B) showed reduced coefficient of friction until 200 s but experienced a seizure at 320 s. After the tests, specimen surfaces were observed using an optical micro scope, as shown in Figure 4. The top sides of images indicated an anti-spindle side, which indicates that only part of the specimens had contact with the steel shaft, although the line contacts conditions. For the further investigating of the specimen surfaces, steel shafts were observed by secondary electron image (SEI) and energy-dispersive x-ray spectroscopy (EDS), as shown in Figure 5. In Figure 5(a), friction tracks were observed on the steel; the steel friction track shown in Figure 5(b) appears to be the seizure surface; Figure 5(c) shows the addition of Cu and S to the steel. The only iron peak observed was on the steel shaft contacted SP-B(Cu-Sn system).



(a) Results of SP-A



(b) Results of SP-B

Figure 3 Results of the tests.

4. CONCLUSION

As a result of journal type sliding test for sulfide-dispersed bronze, it was found that the sulfides (which consisted of Cu and S) had transferred on the steel shaft, possibility preventing seizures.

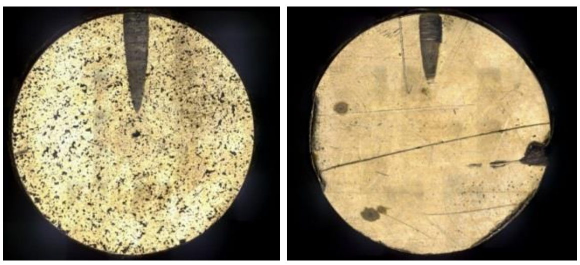
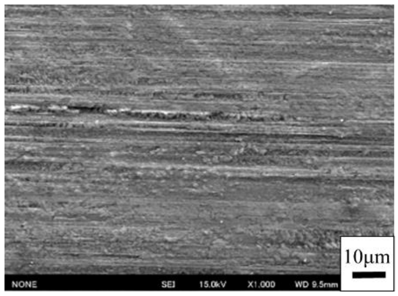
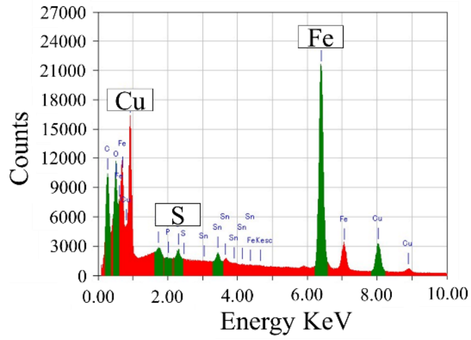

(a) SP-A (b) SP-B

Figure 4 Surfaces after the tests.

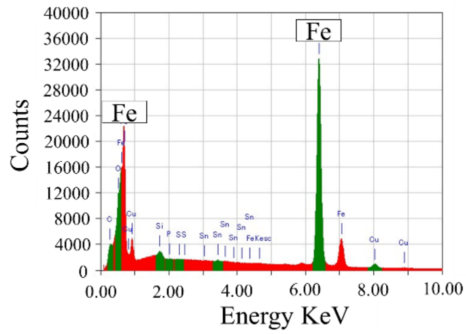


(a) SEI of SP-A

(b) SEI of SP-B



(c) EDS of steel shaft (for SP-A)



(d) EDS of steel shaft (for SP-B)

Figure 5 SEI and EDS results after the tests.

5. REFERENCES

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