Improvement of Wear Resistance of High Strength Brass Alloy by Friction Stir Processing

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The high-strength brass alloys have been widely used in various sliding members such as plane bearings and worm gears. In this study, we have tried to improve the wear resistance of the high-strength brass alloy CAC304C (Cu-Zn-Al-Mn-Fe) by using the Friction Stir Processing (FSP) and evaluated the wear resistance.

Keywords: Friction Stir Process, High-Strength Brass Alloy, Friction Tester, Wear Resistance

1. Introduction

The high-strength brass alloys have been widely used in various sliding members such as plane bearings and worm gears. In order to improve the wear resistance of the high strength brass alloys, various methods such as miniaturization of crystal grains and precipitation of intermetallic compounds have been applied [1]. However, in recent years, further improvement in wear resistance has been required. Therefore, in this study, we have tried to improve the wear resistance by modifying the surface of the high-strength brass alloy CAC304C (The components are shown in Table 1) by the Friction Stir Processing (FSP) and evaluated the wear resistance.

2. Methods

In this study, FSP was performed on the surface of the CAC304C plate of 15 mm thickness, using a pin tool of ϕ4 mm and 1.9 mm length (Fig.1). The tool was made of tungsten carbide. Test pieces with a diameter of 24 mm ×8mm were cut out by machining from the starting material. The tribological characteristics of the test pieces were measured by a Bowden-Leben type friction testing machine. The operating parameters for the sliding tests were , the mating ball; SUJ2 (ϕ=10 mm, about 800 HV), the lubricating oil; 50 µL of oil Shell Tonna S3 M 68 (ISO VG68) , load = 30 N, 5 N (The hertz contact pressure = 1.127 GPa, 0.620 GPa), sliding velocity = 20 mm/s, and total sliding length = 60 min, respectively.

3. Discussion

Figure 2 shows the electronic images of the test pieces cross section and the distribution of Fe observed by SEM-EDS. The black part in the electronic image in Fig. 2 is the precipitate containing Fe, and in the part not subjected to FSP, dendritic precipitates and fine precipitates are dispersed, but in the part subjected to FSP. The size of the precipitate is small. Comparing the presence or absence of FSP, it is considered that the precipitates of the sample were finely dispersed by applying FSP. Figure 3 shows the average values of the friction coefficient and wear amount. Comparing the results, the influence of FSP on the friction coefficient is small. Regarding the amount of wear of the test pieces, when the load was 5 N, the wear decreased by about 30% regardless of the FSP application direction, but when the load was 30 N, the amount of wear increased when FSP was applied compared to the test pieces without FSP. From these results, it is considered that when the load is 5 N, wear is suppressed, and wear resistance is improved due to changes in material properties such as dispersion of precipitates and improvement in hardness due to FSP. When the load is 30 N, the amount of wear increases regardless of the change in material properties due to FSP. It is considered that this is because the load is large and plastic deformation occurs in the sliding test.

4. References

[1] Suwa M., Matsumoto K. “Mn_5Si_3 Dispersed Anti-Wear Copper Alloy” Hitachihyoron, 55, 5, 1973, 607-611.

Table 1 Components of CAC304C (wt%)

Cu	Zn	Pb	Al	Sn	Fe	Mn	Ni	Si
60-65	22-28	0.0-0.2	0.0-0.2	5.0-7.5	2.0-4.0	2.5-5.0	0.0-0.5	0.0-0.1

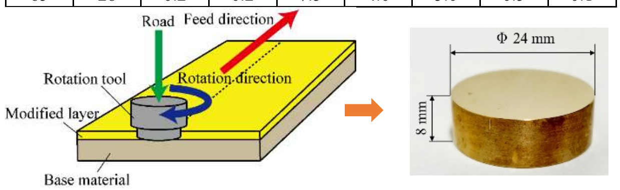

Figure 1: Schematic view of the Friction Stir Processing.

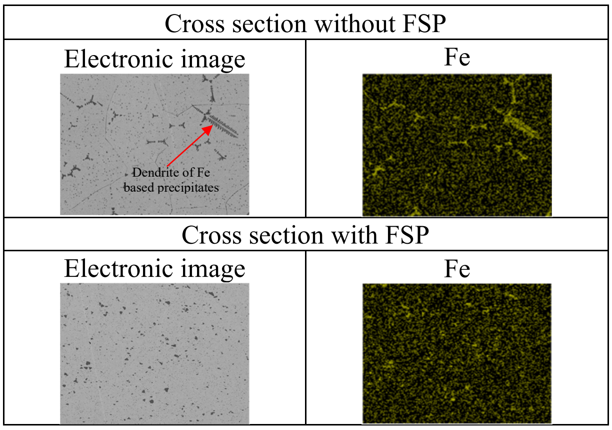

Figure2: SEM-EDS measurement results

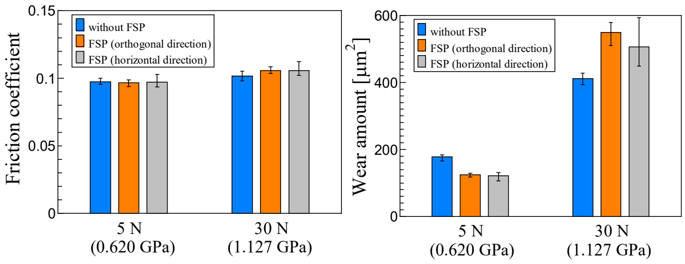

Figure 3: Friction coefficient. And wear amount.