Development of Self-lubricating MoS_2 Dispersed Metal-based Composite Materials Formed by Compression Shearing Method at Room Temperature

S. Takeda[1], H. Miki[2], T. Miyazaki[3], N. Nakayama[4], H. Takeishi[5], and T. Takagi[6]
[1]Graduate School of Engineering, Tohoku University, 6-6 Aramaki aza Aoba, Aoba-ku, Sendai, Miyagi, 980-8579, Japan
[2]FRIS, Tohoku University, 6-3 Aramaki aza Aoba, Aoba-ku, Sendai, Miyagi, 980-8578, Japan
[3]School of Engineering, Tohoku University, 6-6-11 Aramaki aza Aoba, Aoba-ku, Sendai, Miyagi, 980-8579, Japan
[4]Shinshu University, 4-17-1 Wakasato, Nagano, Nagano, 380-8553, Japan
[5]Chiba Institute of Technology, 2-17-1 Tsudanuma, Narashino, Chiba, 275-0016, Japan
[6]Institute of Fluid Science, Tohoku University, 2-1-1 Katahira, Aoba-ku, Sendai, Miyagi, 980-8577, Japan
miki@fris.tohoku.ac.jp

1. Introduction

Today, many slide members of machines are lubricated by lubricant oils, greases or sputtering films of solid lubricant. These lubricants lose lubricating ability by drying up and abrasion with long-term use, so that scheduled maintenance is necessary to keep their performance. However, periodical maintenance is not possible with the extreme environments such as outer space or the vacuum, and the development of maintenance free new lubrication technique is expected. Recently, we have an interest in the composite materials which are dispersed MoS_2 into the host matrix [1]. The composite material is fabricated by the novel powder metallurgy method, which is developed by our research group [2]; compression shearing method at room temperature (COSME-RT). COSME-RT is a method for forming a thin metal plate by applying a shearing strain and a compression stress to a metal powder simultaneously at room temperature and in the atmosphere.

In this study, MoS_2 dispersed Cu-based composite material is fabricated by COSEM-RT, and mechanical and friction properties of the host matrix(Cu) and Cu/MoS_2 composite are investigated.

2. Method

The materials used in this study are powder of 99.9% purity Cu and 98.0% purity MoS_2. The average particle size of the Cu and MoS_2 were 35 and 6 μm, respectively. Cu powder is mixed with different MoS_2 concentration r = 0, 1.0, 3.0, 5.0, 10, and 20 vol.%, and processed by the COSME-RT method (DIP Co., Ltd., DRD-NNK-002). The details are as follows; First, Cu/MoS_2 mixed powder is placed between the base plate and the moving plate, and the compression stress σ_N is applied to the moving plate and kept during the process. Next, shearing strain γ is applied to a mixed powder by displacing the moving plate. In the process, shearing strain is determined from $\gamma = L_S / t_P$, where L_S is the shearing distance (L_S = 5 mm) and t_P is the sample thickness (t_P = 0.25 mm). Processing parameters for the target size 20 × 20 × 0.25 mm^3 are set to σ_N = 1250 MPa, γ = 20, and the shear rate is 5 mm/min. All the samples are fabricated at room temperature and in the atmosphere.

3. Experimental results and discussion

Ball-on-disk friction test was carried out on both Cu/MoS_2 composites and rolled Cu for comparison. In the experiments, normal load, sliding distance, and sliding velocity were programmed to 1 N, 130 m, and 12 mm/s. SUJ2 ball with a diameter of 6 mm was used for the test, and the test was carried out at room temperature and in the atmosphere.

The stable values of the friction coefficient were determined by averaging from sliding distance L = 100 to 130 m in each sample. Fig. 1 shows the relationship between MoS_2 concentration and the average coefficients of friction of the samples. With increasing MoS_2 concentration, the coefficient of friction of the samples was decreased, and that of r = 5 vol.% sample were 0.2. It is suggested that friction properties of the sample is improved by dispersed MoS_2.

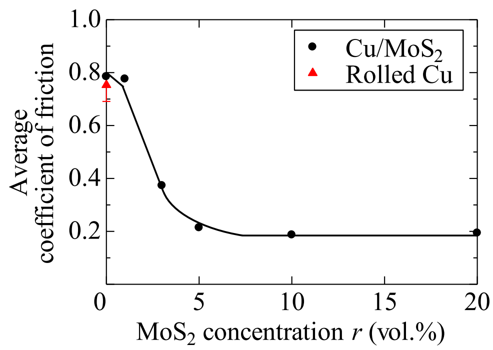

Fig. 1 Relationship between MoS_2 cocentration r and average coefficient of friction of samples.

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References

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