SEM Observation Study for Recognition of Wear Mechanism Using AE Technique

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1. Introduction

Real-time measuring of amount of wear and recognizing the mechanism of wear would be possible through an acoustic emission (AE) technique. We found from our previous study that the feature of the frequency distribution of the AE signals was different according to wear mechanisms [1]. In order to recognize wear mechanisms more accurately, further study is needed on the relationship between wear processes and AE signals. The aim of this study is to verify the relationship between wear processes and AE signals using a scanning electron microscope (SEM).

2. Experiments

Figure 1 shows a schematic diagram of the experimental setup. A pin-on-disk type friction system was installed in a SEM vacuum chamber. The AE signals were detected using an AE sensor mounted on the side face of the stationary part of the pin specimen. The AE signals were amplified to 70-80 dB through a high-pass filter of 100 kHz. Two main wear mechanisms of adhesive wear and abrasive wear were reproduced by different tip shapes of the pin specimen. The experiments were performed with a sliding velocity of 0.9 mm/s and normal loads of 1.5 and 10 N under dry condition in a vacuum of 7×10^{-4} Pa.

3. Results and discussion

Figure 2 shows the SEM observation images of each reproduced wear mechanism: (a) adhesive wear and (b) abrasive wear. In adhesive wear, flake-like wear particles were formed through the mutual transfer and accumulation of wear elements. In abrasive wear, on the other hand, chip-like wear debris were formed onto the rake face of the pin specimen.

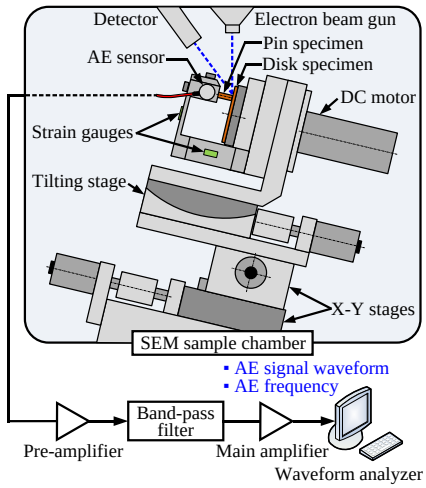

Fig.1 Schematic diagram of the experimental setup

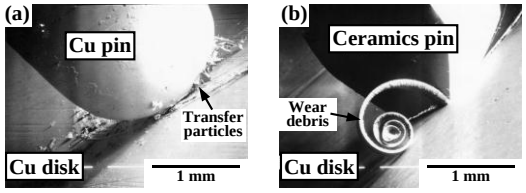

Fig.2 SEM observation images in adhesive wear (a) and abrasive wear (b) experiments

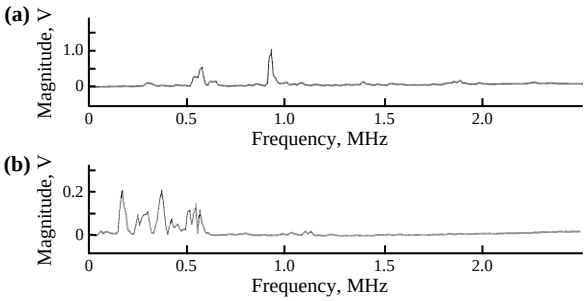

Fig.3 Typical frequency spectra in adhesive wear (a) and abrasive wear (b) experiments

The typical frequency spectra of the AE signal waveforms detected in each wear mechanism are shown in Fig. 3. In adhesive wear, the frequency component distributed between 0.4 to 1.6 MHz, and large frequency peaks occurred at around 1.0 MHz. In abrasive wear, the frequency component distributed between 0.2 to 0.7 MHz, and large frequency peaks occurred at around 0.5 MHz. These features of frequency spectra are caused by the difference in fracture morphology which is similar to our previous study [1].

4. Summary

The results obtained from this SEM observation study support the results from our previous study. The recognition and evaluation of wear mechanisms in real-time is possible by measuring and analyzing the AE signal waveforms.

5. References

[1] Hase, A., Mishina, H., and Wada, M., "Correlation between Features of Acoustic Emission Signals and Mechanical Wear Mechanisms," Wear, 292-293, 2012, 144-150.