IDENTIFICATION OF MICRO TRIBOLOGICAL PHENOMENA ON METAL SURFACES BY SPM-AE IN SITU MEASUREMENT

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KEYWORDS
in situ; acoustic emission; wear mode; micro tribology; SPM

ABSTRACT

In situ measurement of acoustic emission (AE) signals of two metals being rubbed on each other on a scanning probe microscope (SPM) was performed in order to examine the relationship between the waveform analysis of the collected AE signals and the microscopic tribological phenomena.

In this study, AE signals from rubbing silicon probe or metal colloid probe and pure iron or copper metal using an SPM on friction force microscope mode were measured similarly like in our previous report [1]. A broadband-type AE sensor was mounted to a metal block specimen. The probe was slid back and forth on a metal specimen only once with a sliding distance of 10 µm and a sliding velocity of 12.5 mm/s. The AE amplification factor was 90dB. And, a band pass filter from 0.5 to 3.0 MHz was used to eliminate noise signals. All experiments were performed under dry conditions at room temperature (20ºC) in air (40% humidity).

Short-time Fourier transform (STFT) is an analysis technique that could transform a short time wave into spectrum that allows us to look into the changes of AE frequency in more detail. The AE signal waveforms detected by friction and wear of Si/Cu, Cu/Cu, Si/Fe and Fe/Fe experiments were analyzed using this method. Figure 1 shows the STFT analysis of the AE signal waveforms detected at rubbing of (a) silicon on copper and (b) copper on copper. STFT was done at every 100 microseconds (frictional distance of 625 nm). Features of the frequency spectrum of the AE signals corresponding to microscopic tribological phenomena are as follows: abrasive friction caused by silicon probe, a low frequency peak at around 0.5 MHz; and adhesive friction caused by metal colloid probe, a high frequency peak at around 1 MHz. Similar to the macroscopic experiments [2], the mode of wear namely abrasive wear and adhesive wear could be identified by looking at the AE frequency. The number of wear elements related to adhesive wear can be evaluated by counting the number of AE frequency peaks from the STFT. Thus, allowing us to understand the elementary process of wear.

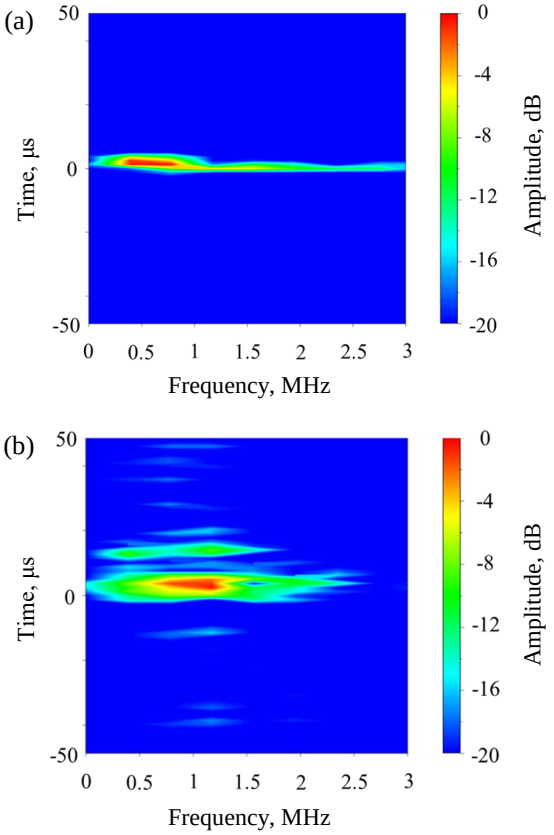

Fig. 1 STFT analysis of the AE signal waveforms detected at rubbing of (a) Si/Cu and (b) Cu/Cu

REFERENCES

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