DETECTING OF SCUFFING USING ACOUSTIC EMISSION

J. H. KIM [1], T. W. KIM [2] and Y. J. CHO[3]

[1]Grduate School, Pusan National University
30, Jangjeon-Dong, Kumjung-Ku, Pusan609-735, KOREA
[2]Research Institute of Mechanical Techonlogy, Pusan National University
30, Jangjeon-Dong, Kumjung-Ku, Pusan609-735, KOREA
[3]Department of Mechanical Engineering, Pusan National University
30, Jangjeon-Dong, Kumjung-Ku, Pusan609-735, KOREA

The scuffing failure is a critical problem in modern machine components, especially for the requirement of high efficiency and small size. In this study, scuffing experiments are conducted using Acoustic Emission(AE) measurement by an indirect sensing approach to detect scuffing failure. Using AE signals we con get and indication about the state of the friction processes, about the quality of solid and liquid layers on the contacting surfaces in real time. The FFT(Fast Fourier Transform)analyses of the AE signal are used to understand the interfacial interaction and the relationship between the AE signal and the state of contact is presented.

Keywords : Acoustic Emission, AE RMS, Scuffing, Time domain, Frequency domain

1. INTRODUCTION

Evaluation methods for friction and wear phenomena vary widely. But there is no satisfactory evaluation method as of yet. Monitor system that can be more effective as part of such countermeasure and sense damage state such as defacement damage and scuffing at the sane time method of measurement that can evaluate machine element contact region exactly is required.

Acoustic emission may be defined as transient elastic stress waves, generated at source, by the rapid release of strain energy within a material. These radiating stress waves are detected at a source by a suitable sensor. The resulting AE data may be related to the source mechanisms which can arise from different phenomena such as asperity contact, micro-crack initiation and growth, plastic deformation and flow, etc. these are the mechanisms which are involved in the basic wear processes.

Kannatey-Asibu and Dornfeld have investigated AE in orthogonal metal cutting and in particular its relationship to tool wear.[1] Kholodilov and coworkers studies both friction and wear of polymers sliding on steel using AE measurements. Results showing a linear relation between total AE counts and amount of wear also presented.[2] Lingard and Ng investigated severe metallic wear using AE techniques. They proposed the existence of a correlation between AE total counts and frictional work as well as between AE count rate and the length of the apparent area of contact in the direction of sliding.[3]

This paper is concerned with the measurement and subsequent analysis of the AE signals under the boundary lubricated sliding contacts and will be shown that the AE signals have some relation to the friction behavior and scuffing damage.

2. EXPERIMENTAL METHODS

2.1 Experimental apparatus

The tests were carried out on a ball and plate of plint company's TE67 wear tester. The AE signals were detected by a resonance type(resonance frequency: 300kHz, band pass: 125~750kHz)attached in wear tester. The signals were amplified by and AE preamplifier(60dB gain with frequency range of 100~1000kHz), and channeled to an RMS convert. Fig. 1 shows the detected AE signal processing.

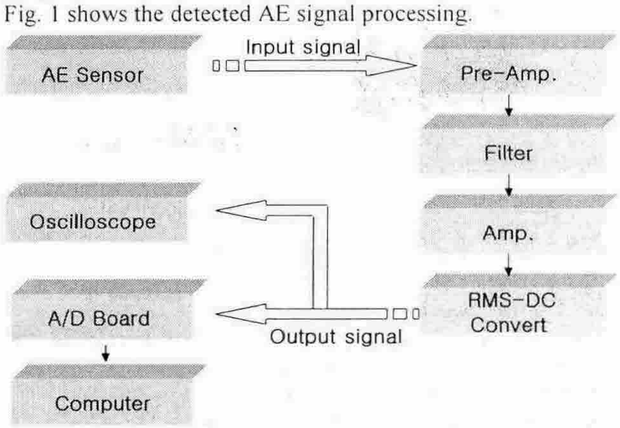


Fig. 1 Block diagram of AE signal

2.2 Experimental methods

All plate is processed identical roughness of Ra=2μm and all samples were ultrasonically cleaned, rinsed in acetone and dried in warm air before begin assembled in the test apparatus. Because considering Kaiser effect, new test specimens were used for each test. This raw signals were sampled at a 1MHz during each of the tests, appeared time domain and frequency domain. Also, RMS signal was detected. Table 1 is displaying experiment conditions.

Table 1 Experimental conditions for sliding tests

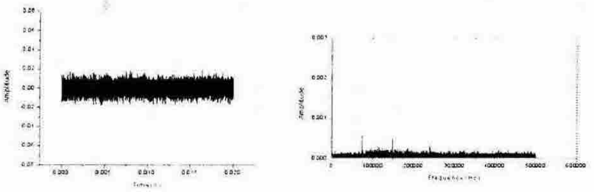
materials	AISI 1040(plate), AISI 52100(Ball)	
Test conditions	Normal load (sliding speed: 1Hz)	50,100,200,300,400[N]
	Sliding speed (normal load: 200N)	1, 1.5, 2, 2.5, 3 [Hz]

3 RESULTS AND DISCUSSION

3.1 Monitor of scuffing failure

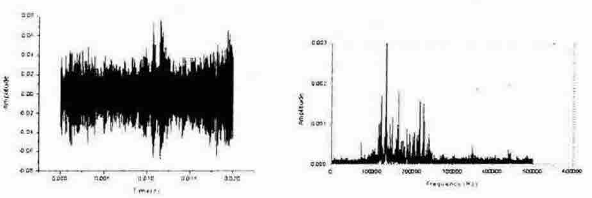
Fig. 2 and Fig. 3 shows the raw signals under experiment condition of sliding speed 1Hz and load 400N. For the steady state(Fig. 2(a)), the signals are continuous type and the FFT analysis results(Fig. 2(b)) of the AE signal show that particular frequency band is not detected.

Whereas, the signals at the scuffing occurrence(Fig. 3(a)) are burst emissions type. Burst emissions are discrete, short term events, typically lasting a fraction of a millisecond and could arise from asperity contact , abrasion and adhesion.



(a) Time domain (b) Frequency domain

Fig. 2 AE raw signal with steady



(a) Time domain (b) Frequency domain

Fig. 3 AE raw signal with scuffing

3.2 Frequency domain

The signals analysed using FFT algorithm. They show large numbers of frequency peaks which reflect the complex nature of the signals. The dominant frequencies seem to occur in emission band between 80kHz and 350kHz. Fig. 4 shows the amplitude variation of AE signal in frequency with time. In the picture, the amplitude can see to increase with time. The signals divide by each band in Fig. 5, which shows the frequency amplitude of the range 100kHz to 200kHz increases rapidly before scuffing. This frequency range may be related to the scuffing damage.

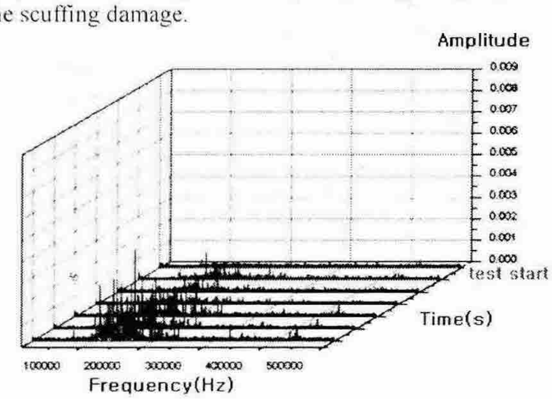


Fig. 4 Variation signal in frequency with time

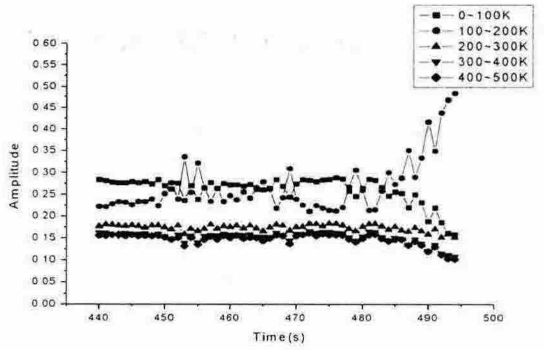


Fig. 5 Variation of each band amplitude

3.3 RMS signals

Typical RMS AE signals for boundary lubricated experiments obtained from the ball-on-plate test rig are illustrated in Fig 6. It was realized that the simple measurement of the RMS of the AE signal contained considerable information concerning the wear mechanisms(running in – smoothing - scuffing)occurring in sliding contacts.

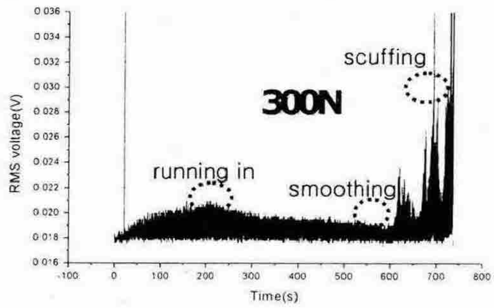


Fig. 6 Variation in RMS signal with time

4. CONCLUSIONS

AE signals provide a valuable tool in the study of wear between sliding contacts. The dominant frequencies seem to occur in emission band between 80kHz and 350kHz. Certain peak frequencies were associated with time.

The time-varying nature of the RMS gives an indication of the wear mechanism occurring.

5. ACKOWLEDGMENT

This work was supported by grant No.(2001-1-30400-005-3) from the Basic Research Program of the Korea Science & Engineering Foundation.

6. REFERENCES

[1] E. Kannatey-Asibu and D. A. Dornfeld, "A study of tool wear using statistical analyse of metal-cutting acoustic emission," WEAR, Vol.76, pp. 247-261, 1982

[2] A. I. Sviridenok and O. V. Kholodivlov, "An acoustic emission study of the real polymer-metal frictional contact area, " Sov. J. Frict. Wear, Vol. 2, pp. 91-94, 1981

[3] S. Lingard and K. K. Ng, "An investigation of acoustic emission in sliding friction and wear of metals. " WEAR, Vol. 130, pp. 367-379, 1989