Proceedings of the 7th International Conference on Mechanics and Materials in Design
Albufeira/Portugal 11-15 June 2017. Editors J.F. Silva Gomes and S.A. Meguid.
Publ. INEGI/FEUP (2017)

PAPER REF: 6517

ACOUSTIC EMISSION ANALYSIS OF FRICTION AND WEAR OF Ni AND Ag RUBBED IN LUBRICANT CONDITIONS

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ABSTRACT

The main goal of this work is the study of the interaction between friction and the AE parameters for materials with different stacking fault energy (SFE)-Ni and Ag. The effects of load on the friction coefficient, wear rate, temperature and AE signals were studied. In order to evaluate a transition from EHL to BL regions, the Stribeck curves were analyzed. Severe plastic deformation of Ag and Ni in the BL region leads to formation of the nanocrystalline structure (grain size, d=33 nm and 143 nm) in comparison to virgin state, d=30 μm. As it can be seen the grain refinement of surface layers in friction is increased with a lowering the SFE.

Keywords: acoustic emission, friction, wear, lubricants.

RESULTS AND CONCLUSIONS

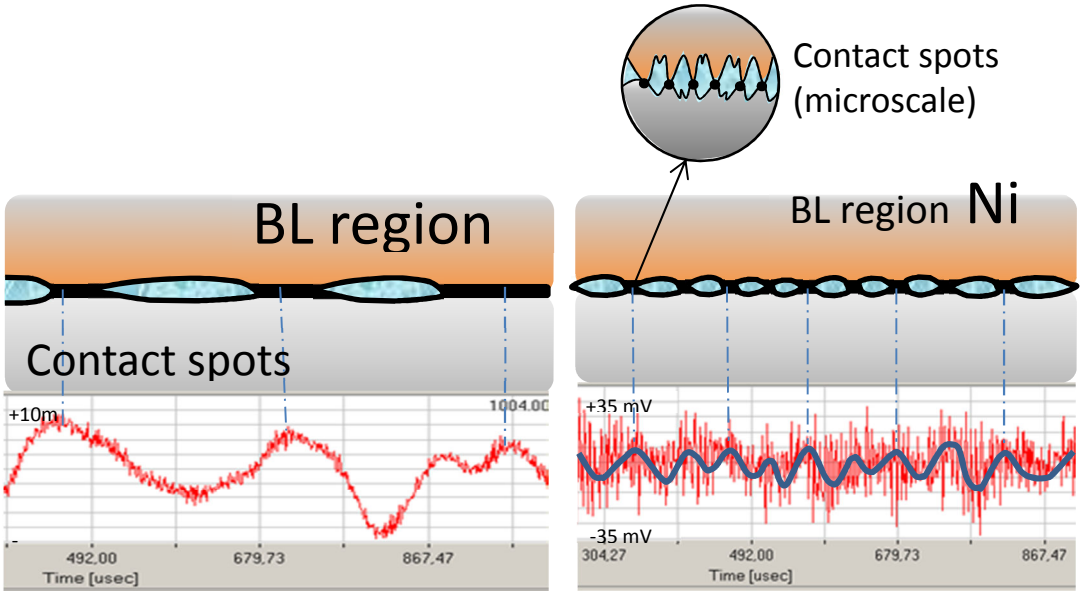
The obtained results in friction are well confirmed by the analysis of the AE waveforms and the annealing of grain refined Ni. A decreasing of the friction coefficient from 0.08 to 0.05 (transition ML region) leads to an appearance of the low frequency wave, characterizing a shearing of relatively small number of contact spots (interaction in macroscale level). The friction coefficient went down immediately to the value, μ=0.02. At this condition, the thickness of lubricant film is increased and therefore the number of contact spots are decreased leading to formation of the waveform similar to that observed in the EHL region. This result confirms the formation of low frequency wave in the EHL region associated with a shearing of relatively small amount of direct contact spots.

With increasing the severity of contact as in the BL region of Ni the amount of contact spots increases significantly and the values of the frequency of low frequency wave is increased. Main difference in the microstructural behavior of Ag in comparison to Ni is the plastic instability associated with the formation of macro-scale shear bands. We can just suggest that large contact spots easy sheared during plastic deformation of Ag in the BL region are responsible for the formation of low-frequency wave in the waveform similar to that observed in the EHL region. An increasing the load in the BL region for Ag just increases a little the frequency of the wave. High level of low frequency signals (8-16 kHz) for Ag in the BL characterize a damage development due to easy shearing of surface layers. At the same time a low level of high frequency signals indicate an easy of process plastic deformation on Ag. Strong damage of Ag in the BL region is confirmed by an increasing the AE energy in transition from the EHL to BL region by high values of low frequency signals, by shearing of surface layers, and by large value of the wear.

In comparison to Ag, the friction of Ni is characterized both by low (8-32 kHz) and high frequency signals (258-512 kHz). It can be suggested that low frequency range is mainly

corresponds to damage development and wear particle formation while high frequency range characterize the plastic deformation including dynamic recovery.

Based on the presented results the model describing the interaction between the AE signals and friction in macro/micro scales is proposed in Fig.1. In the EHL region the number of direct contact interactions is limited and low-frequency wave with relatively large amplitude can be associated with the transitions from direct to lubricant contact. An absent of the high frequency signals indicates on the limited plastic deformation. The material with low SFE (Ag) suffered to easy shearing during the BL region characterized by the low-frequency wave similar to that observed in the EHL region. Low frequency wave in macroscale is just increased from 2.5 kHz for the EHL to 5 kHz in the BL region. If to present the real contact area as the load/hardness value and to assume that the average size of contact spot is close to the size of single wear particles (30μm and 10μm for Ag and Ni, respectively), the number of contact spots is ~ 400 and ~ 8000 for Ag and Ni in the BL region. This demonstrates strong difference in the contact interaction of Ag and Ni in the BL regions.



a) b)

Fig. 1 - The model of the BL region and the corresponding waveform under friction of Ag (a) and Ni (b)

Friction of Ni in the BL region occurs at relatively high loads leading to significantly larger number of the contact spots for Ni in comparison to Ag. It can be seen that the variation of amplitudes, A_m, and A_μ indicates contact spot interaction in the macro/micro scales.

Direct contact interaction of spots in lubricant conditions is a complex problem and the study of this phenomenon by the analysis of plastic deformation, geometry and mechanical properties of contact pair as well as the evaluation of the AE parameters in the transition from EHL to BL region will be continued in our future work.