

TOF-SIMS ANALYSIS OF DEUTERIUM DISSOLVED INTO BEARING STEEL DURING LUBRICATION TEST -EFFECT OF ADDITIVE-

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KEYWORDS

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ABSTRACT

The effect of additives on a fatigue flaking life under EHL condition was investigated using a four ball tester[1] as shown in Fig. 1. The conditions of lubrication test were also shown in Fig.1. Fatigue flaking was accelerated by the effect of hydrogen in atmosphere. Lubrication tests were carried out with lubricant oil of PAO (poly- α -olefin, kinematic viscosity: 394 mm²/s) under the atmosphere of deuterium gas which was used as a tracer for detection of D dissolved in steel by TOF-SIMS(Time of Flight-Secondary Ion Mass Spectrometry). A shorter fatigue life was observed under D₂ atmosphere. After lubrication tests deuterium was detected on the friction track of the lubricated upper-ball by TOF-SIMS[2]. It was found by TOF-SIMS analysis of the cross-section of the upper-steel ball that deuterium diffused into steel even at 300 μ m underneath of friction track, when lubricant oil without additive was used for the test.

analysis of the cross section of the tested ball with the lubricant containing NaNO₂ under D₂ atmosphere revealed that no deuterium was detected in steel. This suggests that NaNO₂ can prevent dissolution of deuterium into steel during the lubrication test even under D₂ atmosphere. It can be concluded that TOF-SIMS analysis with D₂ as a tracer can be a powerful method to investigate the effect of hydrogen and the effect of additives on fatigue life of steel.

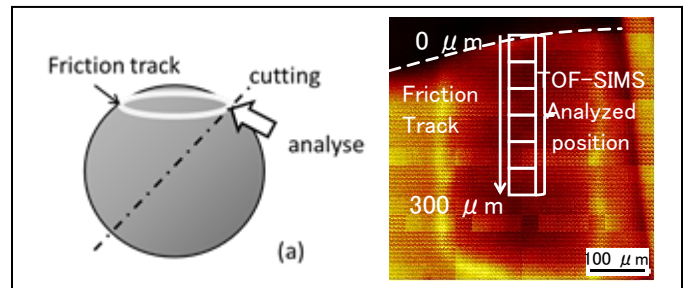


Fig.2 Sample preparation(a) and the analyzed position and region of TOF-SIMS analysis(b)

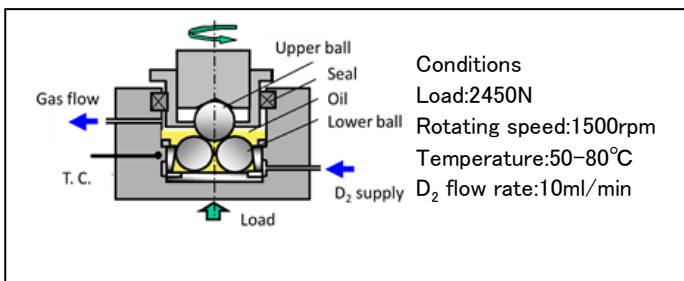


Fig.1 Four ball tester under D₂ atmosphere

Longer fatigue life was observed even under H₂ atmosphere when NaNO₂ was used as an additive[3]. TOF-SIMS

REFERENCES

- [1] Imai, Y. Endo, T. Dong, D. and Yamamoto, Y., "Study on Rolling Contact Fatigue in Hydrogen Environment at a Contact Pressure below Basic Static Load Capacity," Tribology.Trans., 53, 2010, 764.
- [2] Nanao, H. Okada, Y. Mori, S.Nakazawa, S.and Imai, J., "TOF-SIMS analysis of deuterium dissolved into bearing steel during lubrication test," J.Jap.Soc.Tribol., submitted.
- [3] Evans ,M. H., Richardson ,A.D.; Wang ,L., Wood ,R.J.K., "Effect of hydrogen on butterfly and white etching crack(WEC) formation under rolling contact fatigue(RCF)," Wear, 306(2013)226.