# IN-LIQUID AFM OBSERVATION OF RUBBING SURFACE IN CVT FLUID

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***Lubricant additives; Surface topography; Tribofilms; AFM***

## ABSTRACT

In the continuously variable transmission (CVT), the steel belt is stretched over two pulleys to transmit the power. Under the boundary lubrication, a tribofilm generated by tribochemical reactions between two steel surfaces achieves both the high friction coefficient and the wear resistance. In previous report, we revealed the pad-like tribofilm formed on rubbing surfaces of the steel pin increase the friction coefficient at the initial stage of sliding. In this study, we focused on the rubbing surface of steel disk under CVT fluid, and investigated the influence to the friction coefficient.

A carbon tool steel pin and a chromium steel disk were used for test pieces. All tests carried out under an isoparaffin base oil contains following additives; oleylamine, tricresyl phosphate, calcium sulfonate and succinimide. Pin-on-disk reciprocating friction tests and in-liquid AFM observations were carried out by the labo-made equipment as shown in Fig. 1.

We successfully observed the temporal changes in the rubbing surfaces under the additive oil. Figure 2 shows AFM images of the rubbing surface of chromium steel disk after 50 and 350 rounds under different oil temperatures. The microscopy images of rubbing surfaces of carbon tool steel pin after 350 rounds were also shown. Final friction coefficients of 25℃ and 60℃ tests were 0.144 and 0.188, respectively. As shown in Fig. 2, the rubbing surface of pin didn't show specific differences. On the other hand, a large number of particles generated in 25℃ disk surface, but much less in 60℃. Furthermore, as shown in Fig. 3, the rubbing surface of 60℃ disk indicated higher friction force than 25℃ by lateral fore microscopy. The results suggested the rubbing surface of chromium steel disk was covered with thin tribofilm that indicates high friction property. In our previous report, the total area of pad-like tribofilm generated on pin surface mainly affected to friction coefficient [1]. Additionally, we found that also the thin tribofilm formed on disk surface assumed to influence the high friction coefficient.

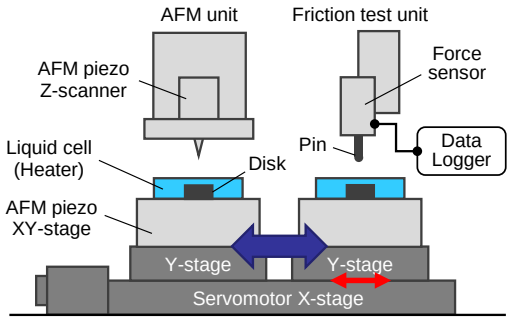


Fig. 1 Illustration of the experimental apparatus

## REFERENCE

[1] Omura, A. and *et al.*, Proc. 45th Leeds-Lyon Sym. on Tribol., Leeds, 2018, Paper 32.3

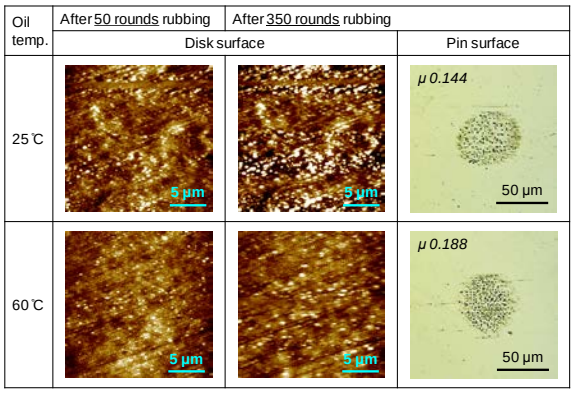


Fig. 2 AFM topography of the rubbing surfaces of chromium steel disk and optical microscope images of carbon tool steel pin tested under the additive oil

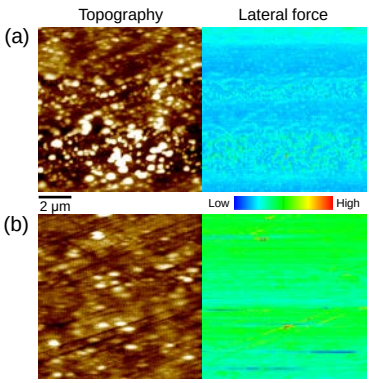


Fig. 3
AFM topography and lateral force images of chromium steel disk tested under the additive oil (a) 25℃, (b) 60℃