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Time Effect on the Wear of Iron

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The effect of non-friction time (interval time between frictional contacts) on the wear of iron is discussed with special reference to severe-mild wear transition. Using twin-ring tribometer, the number of frictional contacts needed for the transition was determined by the displacement of the centers of the two rings. Non-friction time increased the necessary number for the transition at low temperature. On the contrary, at high temperature, it decreased the number for the transition. These complex phenomena could be due to the non-friction time that enhanced the humidity effect on the wear of iron.

Keywords: transient process, severe-mild wear transition, non-friction time, humidity, iron

1. Introduction

The effect of time on tribological processes has been one of the most important subjects since "Transient Processes in Tribology" was highlighted in the 30th Leeds-Lyon Symposium on Tribology in 2003 [1]. The authors have studied the time factor during wear of iron in terms of "non-friction time" when sliding is paused and the specimens are exposed to the atmosphere. Regarding the time effect on wear, the mechanisms of severe-mild wear transition will be discussed, focusing on the non-friction time and the interactions of the surface with surrounding gases such as oxygen and water vapor.

2. Methods

The twin-ring type wear test rig was employed, where the peripheries of two identical rings were slid against each other with the same rotational speed. The two rings were stopped after every rotation, allowing the desired non-friction time. Humidity and temperature of the surrounding air were modified, while adjusting the non-friction time [2]. In some tests, the concentrations of oxygen and water vapor were individually controlled. The displacement between the centers of the rings were continuously monitored as illustrated in Figure 1. As the wear mode shifts from severe to mild, the slope changes from steep to gentle. The inflection point corresponds to the number of frictional contacts needed for the severe-mild wear transition.

3. Results

The effect of non-friction time on the number of frictional contacts for severe-mild wear transition is summarized in Table 1 for the temperature range of 40 ºC to 120 ºC with absolute humidity of 0 to 20 g/m^3. Three characteristics are apparent.

1) At zero absolute humidity, the number of frictional contacts less than 200 is needed to trigger severe-mild wear transition. As humidity climbs, the number for the transition is increased and reaches a peak at 5 to 15 g/m^3 of absolute humidity except at 120 ºC.

2) At the temperature below 60 ºC, the number for the transition is increased as the non-friction time is prolonged, i.e., the wear transition is retarded with the increase of the interval time between sliding contacts.

3) On the contrary, at the temperature range of 80 ºC to 100 ºC, the necessary number for the wear transition is decreased as the non-friction time is increased.

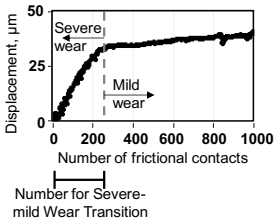

Figure 1: Displacement curve to determine the number of frictional contacts for severe-mild wear transition

4. Discussion

Non-friction time oppositely affects the number of frictional contacts for the transition, depending on the temperature range. These complex time effects can be due to the characteristics of the wear of iron influenced by the humidity increase, which enhances wear at low humidity range while reduces it at high humidity. Extension of non-friction time would further enhance the humidity effects because the number of water molecules interacting with the surface is increased by prolonged non-friction time. The effect of temperature can also be explained by the enhancement of the interactions between surface and water molecules.

5. References

[1] G. Dalmaz, A.A. Lubrecht, D. Dowson, M. Priest, Ed., Transient Processes in Tribology, Elsevier, 43 (2003) pp.3-872.

[2] K. Hiratsuka, M. Inagaki, Trib. Intern., 49 (2012) pp.39-43.

Table 1: Effect of non-friction time on the number of frictional contacts for severe-mild wear transition