44th Leeds-Lyon Symposium on Tribology - September 4-6, 2017, Lyon, France

WEAR ACCELERATION MECHANISM OF DLC FILMS UNDER BOUNDARY LUBRICANTIN IN THE PRECENCE OF MO-CONTAINING LUBRICANT ADDITIVES

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KEYWORDS
DLC; MoDTC; Wear mechanism;

ABSTRACT
Diamond-like carbon (DLC) films are most successful coatings in tribological fields in recent years because they can provide much lower friction and wear rate than other sliding materials under various sliding conditions. Especially, many recent works have shown that DLC films can exhibit the good tribological performance under boundary lubrication with the presences of friction modifiers and anti-wear additives. There are a large number of studies which have reported that the tribochemical reaction between DLC films and lubricant additives produces tribofilms on the sliding surface, which lead to the positive effects on the tribological performance such as low friction and high wear resistance. On the other hand, it is well known that the combination of DLC films and molybdenum dithiocarbamate (MoDTC) triggers the negative effects: "wear acceleration" [1-4].

In previous works, the wear acceleration mechanism has been suggested by several research groups [1-4]. Shinyoshi et al. suggested that the wear acceleration could be caused by the oxidation–reduction reaction between carbon atoms and molybdenum (Mo) oxide molecules [1]. Jia et al. also suggested that Mo-oxides derived from MoDTC caused the abrasive wear of DLC films because of its sharp edge crystalline solid structure [2]. Moreover, new insights of wear acceleration have been suggested recently [3,4]. De Feo et al. have suggested the new wear mechanism of DLC films lubricated with MoDTC solution by systematic analytical results [3]. From their results, the tribochemical reaction between the dangling bond of DLC films and Mo atoms formed the Mo-carbides and the reaction led to the wear acceleration [3]. Moreover, we have suggested that the specific structural transformation of DLC films was observed by in-situ Raman analytical method, and the specific structural transformation could be explained by the formation of Mo-carbides, which could lead to the abrasive and chemical wear of DLC films [4]. From these new insights [3,4], the formation of Mo-carbides strongly relates the wear acceleration of DLC films under lubrication with MoDTC solution. However, the details have not been clarified yet.

In this study, the following points were discussed to reveal the wear acceleration mechanism completely:

I. Effects of the types of DLC films [hydrogenated amorphous carbon (a-C:H) and tetrahedral amorphous carbon (ta-C)] on the wear acceleration under lubrication with MoDTC solution.

II. Effects of the chemical structure of Mo-containing lubricant additives on the wear acceleration.

III. Effects of the presence of zinc dialkyldithiophosphate (ZDDP) on the wear acceleration

All friction tests were conducted on the in-situ Ramn tribometer as reported in [4] to monitor the structural transformation of DLC films and tribological properties. Wear tracks were evaluated by leaser scanning microscopy(LSM), Raman spectroscopy and X-ray photoelectron spectroscopy (XPS).

ACKNOWLEDGMENTS
This work was supported by JSPS Grant-in-Aid for JSPS Research Fellow Grant Number JP16J090430.

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