

【Grant-in-Aid for Scientific Research(S)】
Science and Engineering (Engineering)



Title of Project : Development of Smart Tribosystem with Friction Induced Transformed Thin Layers

Noritsugu Umehara
(Nagoya University, Graduate school of Engineering, Professor)

Research Area : Mechanical Engineering, Machine Design and Tribology

Keyword : Tribology, Mechanical Elements, Ultra low Friction, Transformed Layers

【Purpose and Background of the Research】 1

Carbonaceous hard coatings as DLC and CNx are attracted keen attention to show not only high wear resistance but also ultra low friction that is less than 0.01 of friction coefficient under severe sliding condition that liquid lubricants can not work. Project leader showed that 10 nm thickness transformed layer on those coatings provided ultra low friction. In this research project, we will develop two novel evaluation systems as the evaluation method of transformed layer of carbonaceous hard coatings with a reflective spectroscopy and the evaluation method of surface energy of sliding surface of carbonaceous hard coatings with an Environmental Scanning Spectroscopy ESEM for the establishment of optimum design method of coating systems.

【Research Methods】

1. Development of in-situ evaluation method of transformed layer of carbonaceous hard coatings with reflective spectrometry

Project leader showed that the ultra low friction could be obtained if the ratio of thickness of transformed layer to effective roughness R_{rms}^* of sliding surfaces were more than a critical value. In this project, in-situ evaluation method will be developed in sliding points with a reflect spectroscopy. From the observation results as thickness, roughness and mechanical properties of transformed layer, transformed layer lubrication mechanism as shown in Fig.1 will be established.

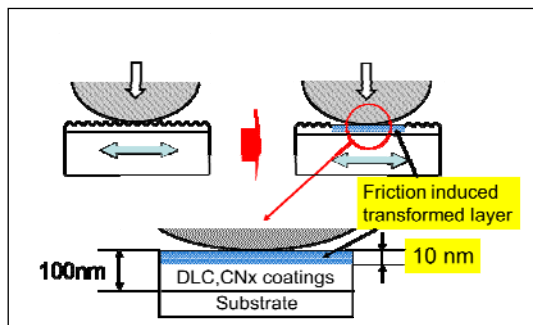


Figure 1 Friction induced ultra low friction transformed layers

2. Development of evaluation method of surface energy of sliding surface with an ESEM

Project leader developed the evaluation method of surface energy on sliding scar with ESEM by the measurement of contact angles of two type liquids droplets on the sliding scar. Optimum coating materials from the view point of low surface energy of sliding scar will be found through these experiments.

3. Propose of practical design method for stable transformed layer on carbonaceous hard coatings

In the practical view points, ultra low friction should be controlled well as stable friction. Necessary material properties and sliding conditions of sliding systems will be proposed for practical design method.

【Expected Research Achievements and Scientific Significance】

Efficient searches of coating systems with ultra low friction will be realized on the basis of the knowledge of in-situ evaluation of sliding points by proposed both evaluation methods with reflective spectroscopy and ESEM.

【Publications Relevant to the Project】

- T. Tokoroyama, M. Kamiya, N. Umehara, et al., Influence of UV irradiation in low frictional performance of CNx coatings, *LUBRICATION SCIENCE*, 24, 3, (2012) 129-139.
- K. Ohara, N. A. Masripan, N. Umehara, H. Kousaka, T. Tokoroyama, et al., Evaluation of transformed layer of DLC after sliding in oil with spectroscopic reflectometry, *Tribology International*, 68, (2013) in press

【Term of Project】 FY2013-2017

【Budget Allocation】 116, 500 Thousand Yen

【Homepage Address and Other Contact Information】

<http://huga.ume.mech.nagoya-u.ac.jp/>
ume@mech.nagoya-u.ac.jp