Understanding of scuffing process by in-situ observation techniques

Kazuyuki YAGI

Department of Mechanical Engineering, Faculty of Engineering, Kyushu University
Advanced Energy Materials Thrust, International Institute for Carbon-Neutral Energy Research (WPI-I^2CNER), Kyushu University

Scuffing is one of the most important catastrophic failures for the research field of tribology, which is the science and engineering for interacting surfaces in relative motion and includes the study of the principles of friction, lubrication, and wear. Scuffing occurs in sliding contacts found in gears, sliding bearings, cam-tappet systems, and piston-skirt systems. When scuffing occurs, dramatic increases in friction, wear, vibrations, and temperature appear, resulting in shutdown of machinery. The scuffing process involves many complex phenomena based on mechanical, chemical, and material behaviour, which influence each other. In recently, there is much growing interest in the scuffing phenomenon because lubrication conditions get more severe and more severe in accordance with requirements of the use of low viscosity lubricant oil. A better understanding of the scuffing mechanism has been required to improve the reliability of machinery.

Our research group has focused on material behaviours of the contact surface as the final stage of the scuffing process. We have developed in-situ observation techniques for a better understanding the material behaviour in the scuffing phenomenon. They include a fast-capturing system using multiple visible cameras for observing plastic flow [1], an infrared camera for capturing instantaneous heat generation [2], and a synchrotron X-ray diffraction technique for analysing in-situ the structure of crystal grains of the surface [3]. Specialised simple friction test rigs are designed for in-situ observation, in which a contact area is created between a rotating sapphire surface and a stationary steel surface. Variations in the steel surface are captured over the sapphire surface. It was found that instantaneous plastic flow occurred with high heat generation, resulting phase transformation of crystal grains of the surface. In this presentation, the scuffing mechanism will be discussed based on several interesting phenomena found by the in-situ observation systems.

References

[1] Y. Matsuzaki, K. Yagi, J. Sugimura, Wear, 386 (2017) 165–172.
[2] Y. Matsuzaki, K. Yagi, J. Sugimura, Tribology Letters, 66 (2018) 142.
[3] K. Yagi, T. Izumi, J. Koyamachi et al., Tribology Letters, 68 (2020) 115.