IN-SITU OBSERVATION OF FRICTION AREA OF CNx COATING IN PAO OIL LUBRICATION

Hidenori Nishimura (*), Noritsugu Umehara, Hiyoruki Kousaka, Xingrui Deng
Department of Mechanical Science and Engineering, Nagoya University, Japan
(*Email: nishimura@ume.mech.nagoya-u.ac.jp)

ABSTRACT
Carbon Nitride (CNx) coating shows lower friction coefficient in oil lubrication compared to amorphous carbon (a-C) coating and hydrogenated amorphous carbon (a-C:H) coating. To clarify the reason why CNx coating showed low friction, we observed friction area of CNx coating by in-situ reflectance spectroscopy. As a result, the lubricated condition in this friction test was supposed to be boundary lubrication by the in-situ reflectance spectroscopy.

Keywords: CNx coating, low friction, in-situ observation, reflectance spectroscopy.

INTRODUCTION
Carbon Nitride (CNx) coating is promising for high hardness, low friction property and affordability. Especially, CNx coating shows lower friction coefficient compared to a-C and a-C:H coating in oil lubrication(Sakakibara, 2013), and the reason for the low friction is that friction area is mixed lubrication condition(Ichimura, 2014). However it is reported that the friction area is boundary lubrication condition (Tagami, 2015), therefore there is a contradiction about low friction mechanism of CNx coating. To solve the contradiction, we need to do in-situ observation of friction area. In this paper, we used reflectance spectroscopy which enables us to do in-situ observation at friction area of CNx coating. Then we measured reflectance by reflectance spectroscopy and estimated oil thickness at friction area from the reflectance while sliding.

The CNx coating was deposited on Si(100) substrate by IBAD (Ion Beam Assisted Deposition) method. The thickness of CNx coating was 100 nm. And a schematic illustration of pin-on-disk friction tester with reflectance spectrometer is shown in Fig. 1.

![Fig. 1 - Schematic of pin-on-disk friction tester](image-url)
We used reflectance spectrometer FE-3000 made by Otsuka electric Co. Ltd. The CNx coating was set on a round abyss in the center of a rotatable stage, PAO (Poly Alpha Olefin) 4 oil was filled in the round abyss, and sapphire hemisphere was attached at the end of leaf spring. A normal load was 0.1 N. The sliding speed was set to 9.7 mm/s. And the reflectance spectrometer was set above sapphire hemisphere attached at leaf spring.

RESULTS AND CONCLUSIONS

Figure 2 shows reflectance at friction area. Figure 3 shows the relationship between the friction coefficient (black line) and oil thickness (red line) at friction area of CNx coating sliding against sapphire hemisphere as a function of sliding cycles. From the result, since friction coefficient was around 0.1 during friction test whereas oil thickness increased, it was thought that lubricated condition at friction area was boundary lubrication. Moreover, since lambda ratio at this friction test was calculated to 0.90, this result suggested correctness of results of oil thickness by in-situ reflectance spectroscopy.

We measured reflectance at friction area by reflectance spectroscopy and estimated oil thickness. The result indicated that lubricated condition was boundary lubrication, and suggested measurement feasibility of oil thickness by in-situ reflectance spectroscopy.

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