The development of friction tester in pressurized hot water at 30 MPa and 300 °C

Y. Yagi[1]*, T. Tokoroyama[1], N. Umehara[1], N. Inayoshi[2] and K. Sasaki[2]

[1)] Nagoya Univ. Dept. of Mechanical Engineering, Furo-cho, Chikusa-ku, Nagoya, 464-8603 Japan
[2)] DENSO CORPORATION, Showa-cho, Kariya, 448-8661 Japan

*Corresponding author for yagi@ume.mech.nagoya-u.ac.jp

1. Introduction

The realization of low friction and high wear proof in high temperature and pressure under water or lubrication is demanded to achieve high power with low energy consumption. There are several studies reporting the development of tribological materials such as ceramics, DLC (Diamond-Like Carbon) under high temperature and pressure with the maximum experimental condition of temperature 300°C and pressure 8.53 MPa [1-4]. For such a demand, DLC film attracts attention in automotive industry, but the wear mechanism under high temperature and high pressure environment is not clear. The focus of this study will be the effect of high temperature and high pressure atmosphere on the friction and wear of DLC films in dry or water lubricated conditions. A new pin on disk type friction tester with autoclave system will be built for the evaluation of tribological properties of DLC films. Friction test in such a severe environment is conducted by reciprocation which moves like pendulum. As an evaluation method, we measured sliding angle and sliding time by electric signal, and calculate friction coefficient.

2. Experimental

The schematic figure of reciprocating friction tester with an autoclave device is shown in Fig. 1. The slider with three pins (SCM420) with 1 mm curvature radius which top was coated by DLC and SUS316 stainless steel plate as counter material were prepared for mating friction pair. Guides were composed of SUS316 and ceramics. The autoclave can heat to maximum 300°C and pressurize to maximum 30 MPa under atmosphere, water, or lubricant. For the initial experiment, wear volume of DLC was measured in friction test under pressurized hot water at 30 MPa and 300°C in order to check the friction test in high temperature and high pressure is possible. Normal load of one DLC pin was 0.056 N and sliding distance was 200 m of 2600 cycles.

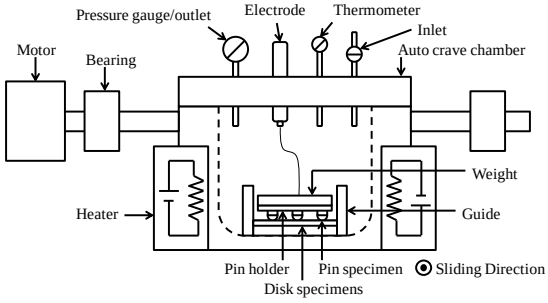

Fig.1 Friction tester with an autoclave device

3. Results and Discussion

The wear volume of DLC under water in atmosphere and at 30 MPa and 300°C was shown in Fig. 2. It was clear that the wear volume under water at 30 MPa and 300°C had more 30 times than that under water in atmosphere. It was assumed that the wear volume became remarkable because the generation of the oxidation film of DLC was promoted by high temperature and high pressure. DLC didn't break away and wear particle did not stick from the observation of the wear trace. There was not the damage of the guide composed of SUS316 and ceramics by the high temperature and high pressure water when friction test time was for 2 hours and sliding distance was 200 m.

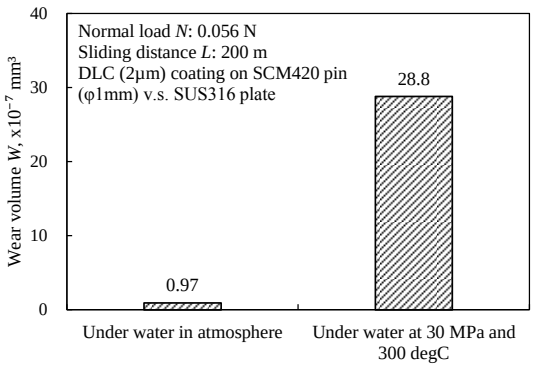

Fig.2 Wear volume of DLC under water in atmosphere and at 30 MPa and 300°C

4. Conclusion

A new reciprocating friction tester with autoclave system was built for evaluation of tribological properties under high temperature and pressure, and wear volume of DLC was measured in friction test under pressurized hot water at 30 MPa and 300°C. As a result, it was clear that the wear volume under water at 30 MPa and 300°C had more 30 times than that under water in atmosphere.

5. References

[1] S. Kitaoka, T. Tsuji, T. Katoh, Y. Yamaguchi, K. Kashiwagi, J. Am. Ceram. Soc., 77, 7, (1994), 1851.
[2] S. Kitaoka, T. Tsuji, Y. Yamaguchi, K. Kashiwagi, Wear, 205, (1997), 40.
[3] A. Erdemir, C. Donnet, J. Phys. D: Appl. Phys. 39, (2006), R513.
[4] P.L. Dickrell, N. Argibay, O.L. Eryilmaz, A. Erdemir, J. Tribology, 131, (2009), 032102-1.