ELECTRICAL IMPEDANCE METHOD FOR MEASURING OIL FILM THICKNESS AND METALLIC CONTACT RATIO IN EHD CONTACTS

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KEYWORDS

Elastohydrodynamic lubrication (EHL); Oil film thickness; Metallic contact ratio

INTRODUCTION

To measure oil film thickness in EHD (elastohydrodynamic) contacts, optical interferometry methods have been used for a long time. However, it is difficult to apply them to measurements for practical bearings because visible lights cannot be transmitted through metal bodies. In this study, a novel method for measuring oil film thickness in EHD contacts has been developed by improving an electrical impedance method [1], which has a possibility to be applied to practical bearings.

EXPERIMENTAL DETAILS

A ball-on-disc-type apparatus was used for measuring oil film thickness in EHD contacts. A poly-α-olefin (viscosity: 30 mm^2/s at 40 °C) was used as a test lubricant. The ball (diameter: 25.4 mm) was made of 52100 steel. The disc (diameter: 100 mm, thickness: 10 mm) was made of BK7 glass. A Cr film and an ITO (indium tin oxide) film were coated on the disc surface as the semi-reflective layer and the spacer layer, respectively.

The central oil film thickness was measured using an optical method (i.e., ultrathin film interferometry [2]) and the developed electrical method (i.e., electrical impedance method) simultaneously. For the latter method, a sinusoidal voltage (RMS amplitude: 1 V and frequency: 1 MHz) was applied between the ball and the ITO film. The accuracy of the developed method was evaluated by comparing it with the optical method and the Hamrock-Dowson theory. Besides, the metallic contact ratio was obtained from the developed method.

RESULTS AND DISCUSSION

Figure 1 shows the measured central oil film thickness (h) as a function of the entrainment speed (U) at a normal load of 9 N. It was found that the h values measured by the electrical method agreed well with those by the optical method, which were located around the broken line predicted by the Hamrock-Dowson theory. The metallic contact ratio (α), which was simultaneously measured using the electrical method, was increased with decrease in U, which means that the experiments at lower speeds (e.g., less than 0.1 m/s) were conducted in the mixed lubrication regime.

CONCLUSION

From the above, we can conclude that the developed electrical impedance method can measure oil film thickness in EHD contacts with a high accuracy. Besides, by using it, metallic contact ratio can be quantified simultaneously. It is hoped that this method will be applied to practical bearings, to understand the invisible behaviors of oil films.

REFERENCES

[1] K. Nakano, Y. Akiyama, *Tribol. Lett.*, **22**, 127 (2006).
[2] G.J. Johnston, R. Wayte, H.A. Spikes, *Tribol. Trans.*, **34**, 187 (1991).

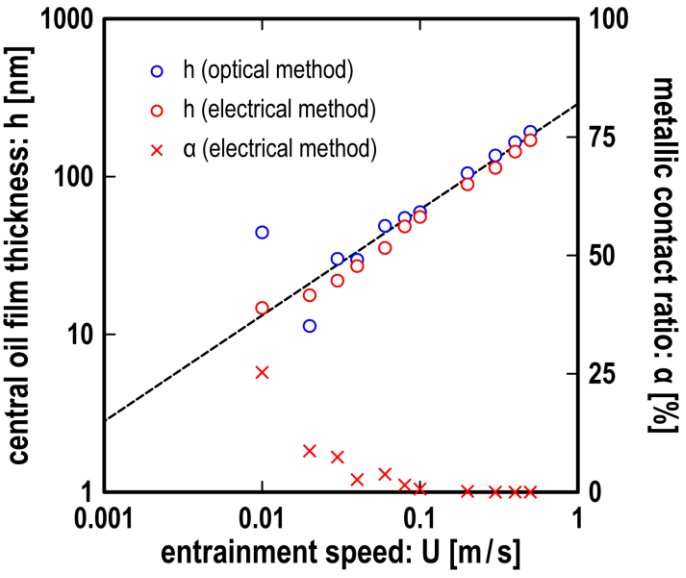

Fig. 1 Measured central oil film thickness h and metallic contact ratio α in EHD contacts; broken line: theory by Hamrock-Dowson.