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Seizure property of DLC coated crank journal by engine bearing tester

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In order to further reduce the friction loss in plain bearings, it is necessary to know the phenomenon of friction reduction and the seizure mechanism between the shaft and the bearings. In this study, the change in friction torque with or without DLC coating attached to the shaft side was investigated using a engine bearing tester, however the phenomenon of instantaneous change in friction torque and seizure characteristics were significantly affected by DLC coating. As a result of using AE (Acoustic Emission) to investigate the mechanism, it was found that the phenomenon of adhesive wear does not occur with DLC coating shaft.

Keywords: seizure, reduce friction, Diamond-like carbon, plain bearing, acoustic emission

1. Introduction

In order to further reduce the friction loss of the crankshaft, it is necessary to understand the seizure mechanism. Therefore, this study focused on the crankshaft main bearing and main journal. The seizure was deliberately generated in the bearing tester[1], which can replicate engine like conditions, and the signal at the time of seizure was analyzed using an AE sensor. The aim was to improve seizure resistance by using DLC coated journals, which has a low affinity with the aluminum alloy of the used bearing material.

2. Methods

In the experiment, an aluminum alloy engine main bearing was used, and a steel shaft (SCM420H) simulating a crankshaft and a shaft coated with DLC (a-C: H; Si) were used as the test shaft. The rotation speed was set to 5200rpm, and the load on the journal increased to 99kN at 1.5kN/min. The friction torque was measured with a torque meter, and the torque limiter was set to 27 [Nm]. When the instantaneous torque exceeded this value, it was judged to be seizure, and the bearing tester was stopped instantly by the electromagnetic clutch system.

3. Result

In Fig.1, seizure occurred at 87kN (159MPa) and 69kN (126 MPa) in the SCM420H journal, while no seizure occurred in the DLC-coated journal under loads up to 99kN (181MPa).

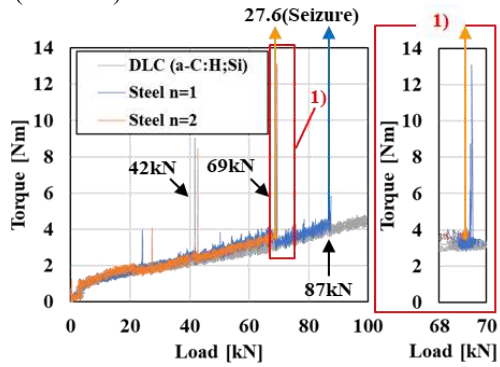

Fig.1 Torque spikes and seizure with or without DLC coating

Fig. 1 also shows the torque trend for each load in each test, while torque spikes occurred in the SCM420H journal at nearly the same load during the two tests, apart from the seizure, no torque spikes appeared in the DLC coated journal.

4. Discussion

Fig. 2 shows the frequency analysis results of the AE signal by using DLC-coated test shaft where torque spikes and seizure do not occur. Bearing loads were 3kN, 48kN, 72kN and 99kN..

Frequencies around 0.1MHz and 0.6MHz were observed with DLC coating at all bearing loads. Although the phenomena of direct contact between the two surfaces and abrasive wear have been confirmed, torque spikes did not occur under any load, so frequencies such as adhesive wear of around 1.4 MHz did not generate. Without DLC coating shaft, the frequency of 1.4 MHz tends to increase when torque spikes occur, and it was possible to understand the phenomenon that the seizure characteristics of the DLC coating can be significantly reduced compared to steel shafts.

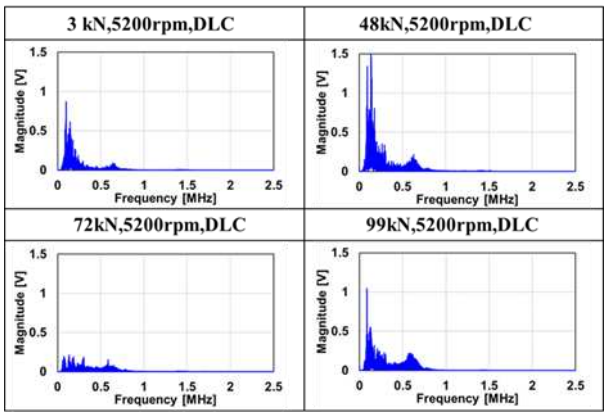

Fig.2 AE analysis results of DLC coating shaft

3. References

[1] Hidemi, O. et al., "Seizure and Friction Properties of the DLC coated Journal and Aluminum Alloy Bearing", Tribology Online, 15,4,2020,241-250.