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Wear mode transition process of Al-Sn-Si Alloy for sliding bearing material and the effects of boundary film

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Al-Sn-Si alloys are used for sliding bearings in automotive internal combustion engines. However, the wear progression is expected to be accelerated by the increase of solid contact due to measures to reduce fuel consumption, and material design criteria for the wear of Al-Sn-Si alloy base materials are still in the process of being explored. To predict the wear characteristics of Al-Sn-Si alloys and to establish a standard that can be used in actual material design, it is necessary to understand the transition process and mechanism of wear morphology in detail under additive lubrication. This study focuses on the effect of the boundary film and the transition of wear morphology due to lubricant additives and discusses the wear transition process based on wear surface observation and various sensor data. Wear tests were conducted using the block-on-ring method of line contact. Al-Sn-Si alloy was used for the block and S55C for the ring. Oil-A is an actual lubricant, to which MoDTC and ZnDTP are added. After the friction and wear tests, the sliding surfaces of the specimens were observed and analyzed. The results of the load increase test with sliding distance in Fig. 1 showed no high peaks in the friction coefficient and specimen temperature except at each load increase. It can be inferred that under this velocity condition, no seizure accompanied by an increase in the coefficient of friction and temperature occurred. Fig. 2 shows images of the wear surfaces of the block and ring obtained after stopping the test at arbitrary points. At point A, a black deposit, presumably a boundary film, was observed on a portion of the block specimen. At points B and C, black deposits were observed on both the block and ring specimens, and at point B, a portion of the black deposit was observed to have detachment. Fig. 3 shows the process of the boundary film from running-in to increasing load. At running-in, the boundary film thickens while repeatedly forming and detachment due to friction, protecting the substrate and leading to running. As the load increases, solid contact occurs between the boundary films, and when the shear stress due to friction beyonds the critical shear stress of the boundary film, detachment of the boundary film and the exposure of the substrate occurs. The boundary film is then formed again by the supply of lubricant. However, exposure of the base material may lead to a seizure.

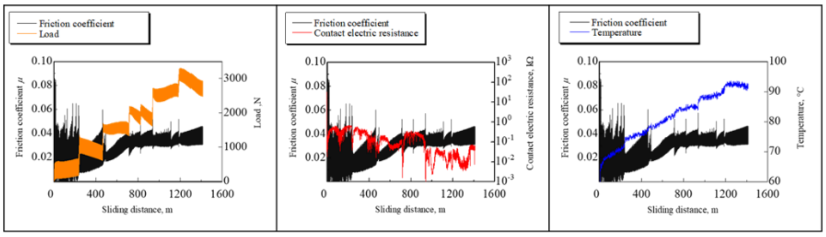

Fig.1 Variation of friction coefficient, load, contact electric resistance and specimen temperature as a function of sliding distance in Oil A

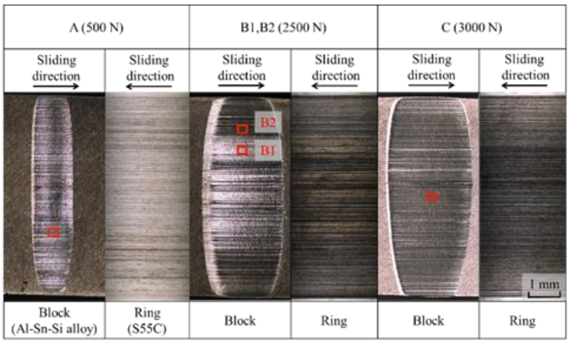

Fig.2 LM images of Al-Sn-Si alloy and S55C

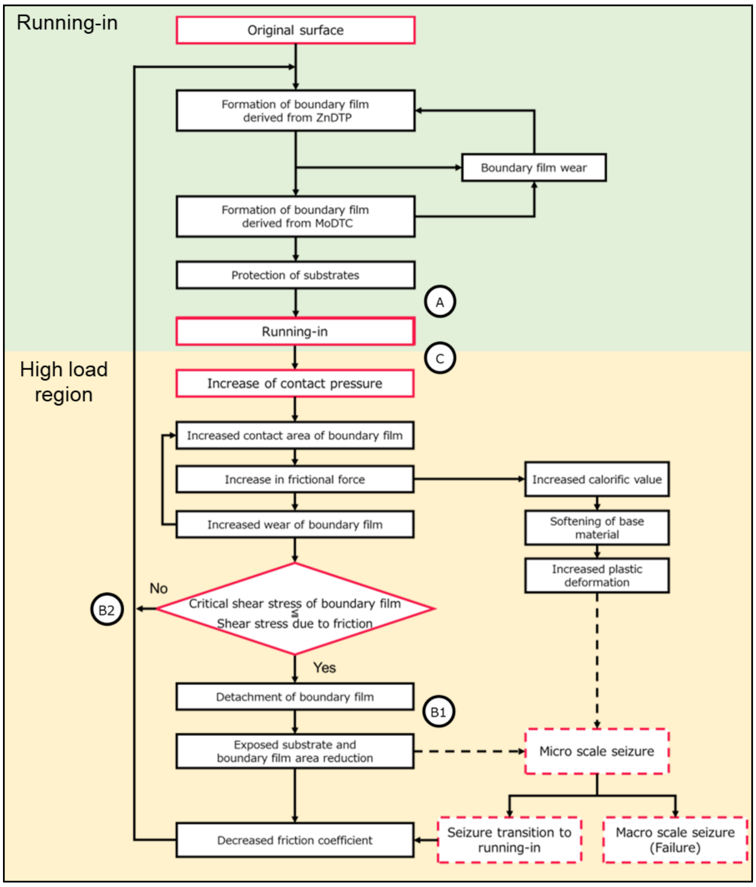

Fig.3 Wear mode transition process include wear of boundary film