Influence of Tilt Angle and Grinding Angle of the Plate on Friction and Transfer Layer Formation

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Abstract

In the present investigation, unidirectional grinding marks were attained on the steel plates. Experiments were then conducted using pins of high purity Al, pure Mg and Al-Mg alloys against the prepared steel plates using an inclined pin-on-plate sliding tester. The inclination angle of the plate was varied in the tests and for each inclination angle, the pins were slid both perpendicular and parallel to the unidirectional grinding marks direction under both dry and lubricated conditions. Results showed that the friction, transfer layer formation, and the presence of stick-slip motion significantly depend on the grinding marks direction and tilt angle of the hard surfaces under both dry and lubricated conditions for all the three materials investigated.

1. Introduction

Earlier, experiments were conducted using super purity Al pins slid at 0.3° and 1.0° tilt angles of steel plate¹,². Results showed that the friction did not vary much with normal loads for a given tilt angle. However, a significant variation in friction was observed when the tilt angle of the plate increases. Thus, in the present investigation, attempts have been made to study the influence of tilt angle of the harder plate on friction and transfer layer formation.

2. Experimentation

In this study, unidirectional grinding marks with varying roughness were attained on the steel plates. Experiments were conducted using pins of high purity Al, pure Mg and Al-Mg alloys against the prepared steel plates using an inclined pin-on-plate sliding tester¹. The tilt angle of the plate was held at 0.2°, 0.6°, 1°, 1.4°, 1.8°, 2.2° and 2.6° in the tests. The pins were slid both perpendicular and parallel to the grinding marks direction under both dry and lubricated conditions on each plate at sliding velocity of 2 mm/s in ambient environment. Normal loads were varied from 1N to 30N for 0.2° and 1N to 230 N for 2.6° tilt angle during the test. SEM was used to study the pin damage and morphology of the transfer layer formed on the plates.

3. Results and Discussion

Fig. 1 shows the variation of friction with tilt angle under dry conditions where UPD and UPL represent sliding direction perpendicular and parallel to the unidirectional grinding marks, respectively. It can be seen that the friction significantly varies with tilt angle and grinding marks direction. Similar observations were made under lubricated condition. For a given material pair, it was observed that the transfer layer formation on the plate depends on the coefficient of friction. For the case of Mg, UPD case, stick-slip phenomenon was observed for angles exceeding 0.6° under dry and 1.4° under lubrication conditions, the amplitude of which increases with increasing tilt angle. However, for the UPL case, the stick-slip phenomena was observed for angles exceeding 1° under dry and 2.2° under lubrication conditions, the amplitude of which also increases with increasing tilt angle. For the case of Al, stick-slip phenomenon was observed only under lubricated conditions at tilt angles exceeding 0.6° and 2.2° respectively for UPD and UPL cases. For the case of Al-Mg alloy, stick-slip phenomenon was observed only under lubricated conditions at the highest tilt angle for the UPD case. These variations could be attributed to the extent of plane strain conditions taking place at the asperity level during sliding.

4. Summary

- The coefficient of friction, transfer layer formation and the presence of stick-slip motion depends on both grinding angle and tilt angle of harder counter surfaces.

References