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Synergy between tribo-oxidation Mechanically Mixed Layer (MML) and strain rate response on governing the dry sliding wear behavior of Ti-6Al-4V against SS316L

Ashok Raj J[1*], Anindya Deb[1] , Satish V. Kailas[2]

[1]Centre for Product Design & Manufacturing, Indian Institute of Science, Bangalore, India
[2)] Department of Mechanical Engineering, Indian Institute of Science, Bangalore, India
[*]Corresponding author for ashokche@gmail.com

1. Abstract

The motivation behind studying the tribological aspects of titanium alloys was due to its light weight nature and development of better and cheaper metal working techniques in recent times which suites there use in aerospace and automobile industries [1-5]. The dry sliding behavior of Ti-6Al-4V against SS316L was investigated under ambient and vacuum conditions on Vacuum based high temperature Pin on Disk (POD) Tribometer.

The steady state friction and wear properties of test materials were evaluated at various operating conditions. Dry sliding tests were carried out at a constant pressure of 2.8MPa under ambient (25°C, 50% RH) and vacuum condition (1.5X10^{-5}mbar). The normal load was varied from 13.7 to 137.3N and sliding speed varied from 0.01 to 1.5 ms^{-1}. The sliding distance for each test was 2000m. Each test was repeated three times for ensuring consistent behavior. The tribological data presented her are average of the three experiments. The scatter falls within 12% of the mean value.

At ambient conditions, high coefficient of friction and wear rate [Fig.1] were observed for varying normal loads and low sliding speeds because of formation of highly intense adiabatic shear band and lack of thermal oxidation due to very low interface temperature during the dry sliding. As the sliding speed was increased, the interface temperature of dry sliding was high due to which a mechanically mixed layer was formed and thermal oxidation also occurred. Consequently a drop in the coefficient of friction and wear rate was observed [Fig-3] .

At vacuum conditions, wear rate and coefficient of friction was found to increase gradually with respect to an increase in normal load or sliding speed [Fig-2]. At lower sliding speeds, no thermal oxidation was observed which otherwise would played the critical role in protecting the material from further wear. Out of the delamination wear and three body abrasion that were also observed in on the pin surface, the former was found to be more dominant which was responsible to further increase in the interface temperature during the dry sliding. It increased the wear rate compared to the ambient conditions. As the sliding speed increases, the increase in surface and subsurface temperature resulted in heavy plastic deformation which increased the wear rate and coefficient of friction [Fig-4].

The present study shows the relationship between the strain rate response of the material in uniaxial compression, Tribo-oxidation, MML and its subsurface evolution and wear rate.

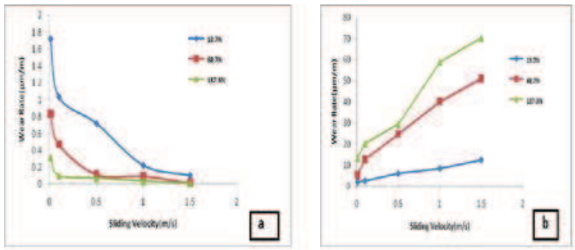

Fig.1 Graphical representation of Coefficient of friction of Ti-6Al-4V against SS316L at different normal loads viz 13.7, 68.7and 137.3N under a) Ambient condition b) Vacuum condition.

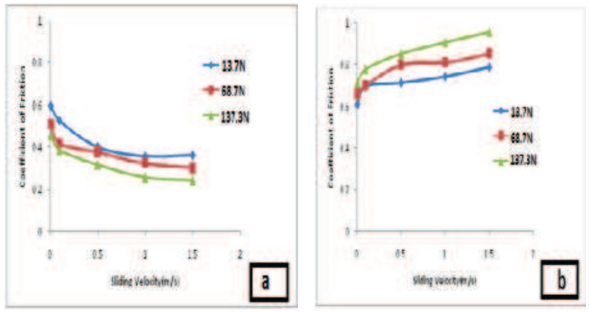

Fig.2 Graphical representation of Coefficient of friction of Ti-6Al-4V against SS316L at different normal loads viz 13.7, 68.7and 137.3N under a) Ambient condition b) Vacuum condition.

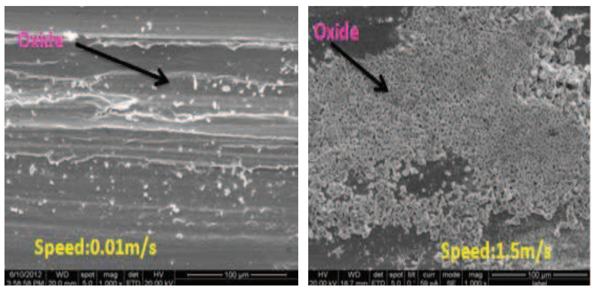

Fig 3. SEM image of Ti-6Al-4V pin at 68.7 N and 137.3N Ambient condition .

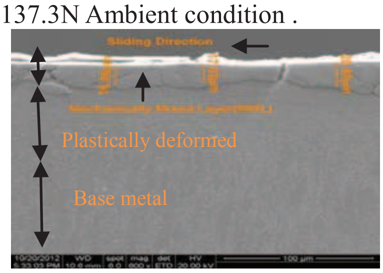

Fig.4 SEM image of MML under ambient condition at 137.3N and 1.5m/s sliding speed.