

COMPARISON LUBRICITY BEHAVIOUR OF NANOLAMINATED Ti_3SiC_2 AND SOLID LUBRICANTS

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1. General

In this research, the lubricity behavior of Ti_3SiC_2 was investigated by using a pin-on-disc a sliding wear test with a AISI 52100 steel. In the pin-on-disc test, samples show the low friction coefficient (μ), especially in low loads. Microscopic observations show a lubricating layer on samples surfaces that the result of decreasing of μ due to the lubricating behavior. In a high load, samples shows increase in μ ($\approx 200N$) and wear rate in 80 N loads, approximately. The results showed that Ti_3SiC_2 has a lubricity behavior in low loads ($< 80 N$) and can be used as a solid lubricant. Then lubricity behavior of this compound was then evaluated in comparison with graphite and MoS_2 solid lubricant. Likewise lubricity mechanisms are layer structure in compounds, and constituted permanent and lubricant oxide layer on surface of samples.

2. Introduction

The ternary compound, nanolaminated Ti_3SiC_2 is known that has many of the best properties of both metals and ceramics, such This unique combination of properties makes Ti_3SiC_2 a likely candidate for structural applications at elevated temperatures [6, 7], such as turbine blades and stators, heavy duty electric contacts, bearings, etc [4].

A number of useful publications have been written on the use of solid lubricants for space applications. Realistically, the most likely candidates are in the following categories: - Soft metal films: especially Pb, but also Ag and Au, - Lamellar solids: e.g., MoS_2 and WS_2 , and - Polymers: such as PTFE films and glass fiber reinforced composites. Many other candidates could also be considered, but these are the primary choices [3]. Solid lubricants are useful for conditions when conventional lubricants are inadequate [2]. The friction coefficients of solid lubricant materials are of about 0.06 to 0.15 depending upon humidity and sliding conditions [1]. However, currently, reports on the tribological behavior of Ti_3SiC_2 are limited, especially lubricity and wear rate in high load. In the present paper evaluate the tribology behavior (lubricity and wear) of Ti_3SiC_2 ternary compound against 52100 steel pin in low and high loads, then compared with graphite and MoS_2 solid lubricants. The unit cell of Ti_3SiC_2 that compose a nanolayered structure, and graphite and MoS_2 solid lubricants, as shown in Fig. 1.

3. Experimental procedure

The contracted phases of the Ti_3SiC_2 were characterized employing XRD-Philips X'pert-MPD and Microstructure observation by SEM-XL30. The macro-hardness was evaluated by a Vickers diamond indenter at load 50 N using the following formula in Eq. 1. The wear rate (wear coefficient in mm^3/Nm) was calculated under opposite frame: $\Delta m / (p.F.L)$. Then compared with graphite and MoS_2 slid lubricants.

4. Results and discussion

according to XRD analysis, (Fig. 1), As can be seen in the SEM represented at Fig. 3, the product was not uniform, some regions rich in the ternary Ti_3SiC_2 phase, and some being a two-phase mixture of TiC and few amount and Ti–Al binary phases was detected. The results of friction test are listed in Table 1 in various loads, likewise in sliding distance curves, in the pin-on-disc test (Fig 2). It was found that the material undergoes a critically transition stage where the friction coefficient (μ), increases linearly of 0.06 to 0.35 in 200 N load. A change in wear mechanism is initial observed at high load, especially in load over 200 N, that increase (COF and wear rate). The final result show that a low wear rate in 80N load ($< 10^{-6}$) and low COF in low load ($< 200N$) (Fig. 2). Therefore proposed this compound can use as solid lubricant in load lower than 80 N.

Table. (1). Friction coefficient and wear rate for Ti_3SiC_2 sample in various normal load.

Load (N)	10	40	80	120	160	200	240	280
COF (μ)	0.06-0.08	0.06-0.1	0.06-0.1	0.06-0.12	0.06-0.12	0.06-0.12	0.3-0.4	0.35-0.39
$WR \times 10^5$ (mm ³ /Nm)	2	6	12.2	20.3	21.3	25.6	198	182

In table (2) had come friction coefficient of for Ti_3SiC_2 sample in comparison MoS_2 and graphite solid lubricant. The result shows that nanolayered Ti_3SiC_2 has lubricity behavior in higher loads without humid environment, also can use in higher temperature in comparison MoS_2 in low load, because of don't decompose.

Table. (1). Friction coefficient and wear rate for Ti_3SiC_2 sample in various normal load.

Load (N)	10	40	80	120	160	200	240	280
Ti_3SiC_2	0.06-0.08	0.06-0.1	0.06-0.1	0.06-0.12	0.06-0.12	0.06-0.12	0.3-0.4	0.35-0.39
Graphite	0.24	0.16	0.05-0.12	Failure				
MoS_2	0.05-0.15	0.05-0.15	0.05-0.15	0.05-0.15	0.05-0.15	0.05-0.15	0.05-0.15	0.05-0.15

5. Conclusion

In this work, the tribology behavior of Ti_3SiC_2 /steel friction pairs was investigated. This compound showed low COF $\approx 0.06-0.12$ in low load ($<200N$) and a critically behavior in 200 N load, which that change wear mechanism of tribochemical to abrasion. Likewise illustrated low wear rate $\approx < 10^{-6}$ in load lower than 80 N. lubricity mechanisms in low load was composed permanent oxide layer (tribochemical mechanism) and layered structure, but in high load has abrasion mechanism and plastic deformation. Therefore nanolaminated Ti_3SiC_2 can be used as a solid lubricant in low load, and high temperature due to constituted a passive layer in high loads. In comparison if that MoS_2 has lubricity behaviour in high loads but in high temperature decomposed. Also in comparison graphite has lubricity behavior without a humid environment.

6. References

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