Impact Of Dimple Density On Tribological Performance Of PTFE Composite

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Abstract

Surface texturing has emerged in the last decade as a viable option of surface engineering resulting in significant improvement in tribological properties like wear resistance, friction coefficient, load capacity etc. of mechanical components. In the present investigation the effect of surface texturing on tribological properties of PTFE (PTFE+40% Bronze) composite material considering various texture patterns so as to observe the comparative friction and wear behavior of PTFE composite with & without surface texturing on mating surface at dry & wet lubrication by using a pin-on-disc Tribometer. The results shows that the coefficient of friction varies considerably with surface texture patterns, some texture patterns shows a higher load carrying capacity & due to that negative coefficient of friction was observed. Wear of the some textured surface is higher compared with non textured surface. Scanning Electron Micrographs shows that wear of some textured surfaces was reduced compared with the non textured surface at both the lubricating conditions.

Keywords: Surface Texturing, Dimples, Tribometer.

I. INTRODUCTION

"Surface Engineering" is a novel expression that named the sub-discipline of material science dealing with the optimization of solid surface phase in order to functionalize the items during their interaction with the environment and the surrounding systems. From the technological point of view, Surface Engineering is meant to be considered an attractive instrument for tribological challenges: several solutions involving chemical, structural and morphological modification by means of adding material or reshaping surface topography, can be adopted with the aim of improving performances, reducing friction and wear, and/or increasing hardness and toughness.

Surface texturing involves modifications of surface topography, creating a uniform micro relief with regularly shaped asperities or depressions. Nowadays, surface texturing delineates a scientific and technological open-frontier where the area of micro-fabrication converge to surface science committed to study and demonstrate the various mechanisms of integrated micro-effects resulting in a macro-benefit that optimizes performances.

II. EXPERIMENTAL METHODOLOGY

Experimental set up of a pin-on-disc Tribometer (TR-20LE) was used for the readings of wear and frictional force.

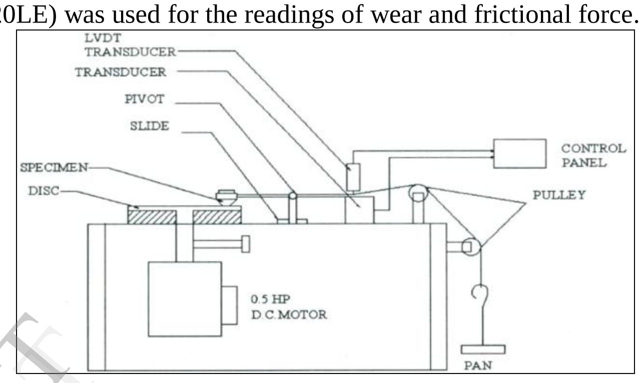

Fig. No. 1. Experimental setup of Pin on Disc Tribometer

The TR-20LE Pin on disc wear testing is advanced regarding the simplicity and convenience of operation, ease of specimen clamping and accuracy of measurements, both of wear and frictional force along with lubrication and environmental facility.

The machine is designed to apply loads up to 20 kg and is intended both for dry and lubricated test conditions. It facilitates study of friction and wear characteristics in sliding contacts under desired test conditions within machine specifications. Sliding occurs between the stationary pin and a rotating disc. Normal load, rotational speed and wear track diameter can be varied to suit the test conditions. Tangential frictional force and wear are monitored with electronic sensors and recorded on PC. These parameters are available as a function of load and speed.

III. PREPARATION OF SPECIMEN

PTFE composite material is in the form of cylindrical rod with dimentions 6 mm diameter and 105 mm length. The test specimens (pins) of 6 mm diameter and 30 mm length are cut. The disc of materal AISI SS 304 stainless steel plate of the surface roughness Ra for counter surface i.e. for disc is The surface texture patterns were made on the SS 304 plate by the Lasers. The size of the dimple is taken 300 Micron &

densities of the dimples are varied as 10%, 20%, 30%. The no. of dimples for the 3 tracks is as follows:

Track No.1: Non Textured Surface
Track No.2: 300(μm) Diameter & Density (10%)
Track No.3: 300(μm) Diameter & Density (20%)
Track No.4: 300(μm) Diameter & Density (30%)

Table.1: Typical properties of 40 % Bronze filled PTFE composites

Sr. No.	Property	Unit	40 % Bronze filled PTFE
1.	Density	gm / cc	3.1-3.2
2.	Tensile Strength	kgf / cm^2	125-150
3.	Elongation	%	100-175
4.	Compressive Strength	kgf / cm^2	85-100
5.	Flexural Strength	kgf / cm^2	85
6.	Flexural Modulus	kgf / cm^2	14000
7.	Hardness	Shore	70-75
8.	Dielectric Strength	kv / mm	Conductive

Experimental Parameters:
Sliding velocity- 0.12 m/sec,
Time- 60 min,
Load- 12 Kg,
Lubricant- Watmans Watol S. R. Bearing oil 3 during the wet test conditions.

IV. OBSERVATION TABLE

Table No. 2- Experimental data of Track No. 1

S.N	Time (min)	Wear (μ)		F.F (N)		C.O.F	
		Dry	Wet	Dry	Wet	Dry	Wet
1	0	0	0	36.7	1.4	0.3076	0.0117
2	5	0	0	36.8	1.8	0.3084	0.0151
3	10	0	0	37.4	1.7	0.3134	0.0142
4	15	0	0	37.9	1.6	0.3176	0.0134
5	20	0	0	38.2	1.6	0.3201	0.0134
6	25	0	0	38.3	1.6	0.3210	0.0134
7	30	1	0	38.6	1.6	0.3235	0.0134
8	35	1	0	38.8	1.6	0.3251	0.0134
9	40	1	1	39.1	1.6	0.3277	0.0134
10	45	1	1	39.2	1.5	0.3285	0.0126
11	50	1	1	39.3	1.4	0.3293	0.0117
12	55	1	1	39.4	1.4	0.3302	0.0117
13	60	1	1	39.4	1.5	0.3302	0.0126

Table No.3 - Experimental data of Track No.2

S.N	Time Min	Wear (μ)		F. F (N)		C.O.F	
		Dry	Wet	Dry	Wet	Dry	Wet
1	0	0	0	36.2	18.6	0.3034	0.1559
2	5	0	0	37.3	19.6	0.3126	0.1643
3	10	0	0	37.6	20.6	0.3151	0.1726
4	15	0	0	38	20.1	0.3184	0.1684
5	20	1	0	38.2	19.6	0.3201	0.1643
6	25	1	0	38.4	19	0.3218	0.1592
7	30	1	0	38.8	18.5	0.3251	0.1550
8	35	2	0	38.8	18.9	0.3251	0.1584
9	40	2	0	38.9	18.5	0.3260	0.1550
10	45	2	2	39.3	18.9	0.3293	0.1584
11	50	2	3	39.4	16.5	0.3302	0.1383
12	55	2	3	39.6	9.6	0.3319	0.0804
13	60	2	3	39.7	9.6	0.3327	0.0804

Table No. 4 - Experimental data of Track No.3

Sr No	Time Min	Wear (μ)		F.F (N)		C.O.F	
		Dry	Wet	Dry	Wet	Dry	Wet
1	0	0	0	47.2	20.4	0.3955	0.1710
2	5	0	0	48.3	18.4	0.4048	0.1542
3	10	0	0	49.1	21.6	0.4115	0.1810
4	15	0	0	51.5	22.3	0.4316	0.1869
5	20	0	0	52.7	21.2	0.4416	0.1777
6	25	0	0	53.5	20.7	0.4483	0.1735
7	30	-1	0	53.9	18.8	0.4517	0.1575
8	35	-1	0	54	15.2	0.4525	0.1274
9	40	-1	3	54.2	0.5	0.4542	0.0042
10	45	-1	3	54.4	0.4	0.4559	0.0034
11	50	-1	3	54.4	0.3	0.4559	0.0025
12	55	-1	3	54.5	0.3	0.4567	0.0025
13	60	-1	3	54.8	0.3	0.4592	0.0025

Table No. 5 - Experimental data of Track No. 4

S.N	Time Min	Wear (μ)		F.F (N)		C.O.F	
		Dry	Wet	Dry	Wet	Dry	Wet
1	0	0	0	38.1	22.3	0.3193	0.1869
2	5	0	0	39.5	22.2	0.3310	0.1860
3	10	0	0	40.8	21.8	0.3419	0.1827
4	15	0	0	41.6	21	0.3486	0.1760
5	20	0	0	42.4	20	0.3553	0.1676
6	25	0	0	42.8	18.8	0.3587	0.1575
7	30	0	0	43.6	18	0.3654	0.1508
8	35	1	1	44.8	16.9	0.3754	0.1416
9	40	1	3	45.7	4.7	0.3830	0.0394
10	45	1	3	46.2	-0.3	0.3872	-0.002
11	50	1	3	47.3	-0.3	0.3964	-0.002
12	55	1	3	48.2	-0.3	0.4039	-0.002
13	60	1	3	48.3	-0.3	0.4048	-0.002

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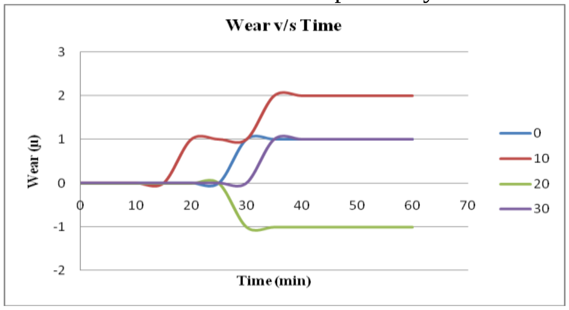
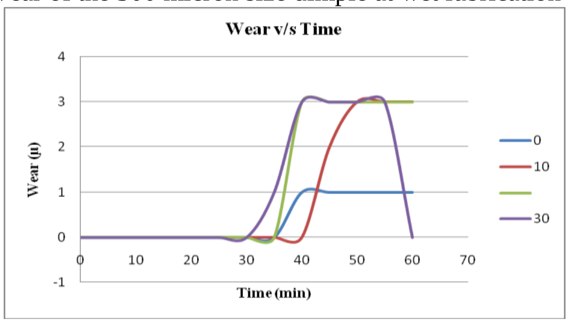
V. RESULTS

a. Wear of the 300 micron size dimple at dry lubrication



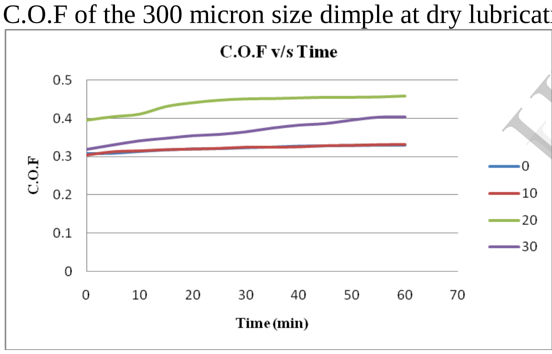
Graph No. 1: Wear v/s Time plot when density of the dimples increases at dry lubrication

b. Wear of the 300 micron size dimple at wet lubrication



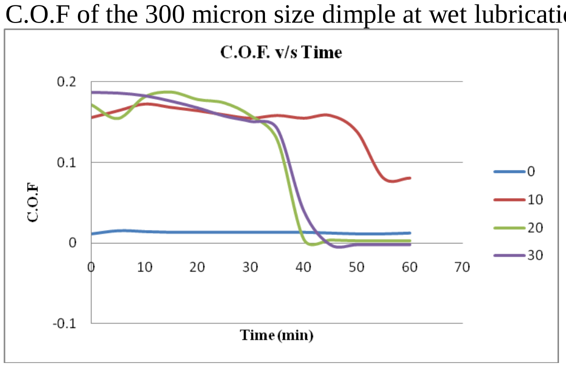
Graph No. 2: Wear v/s Time plot when density of the dimples increases at wet lubrication

c. C.O.F of the 300 micron size dimple at dry lubrication



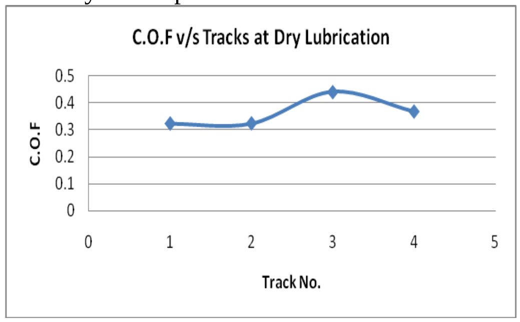
Graph No. 3: C.O.F v/s Time plot when density of the dimples increases at dry lubrication

d. C.O.F of the 300 micron size dimple at wet lubrication



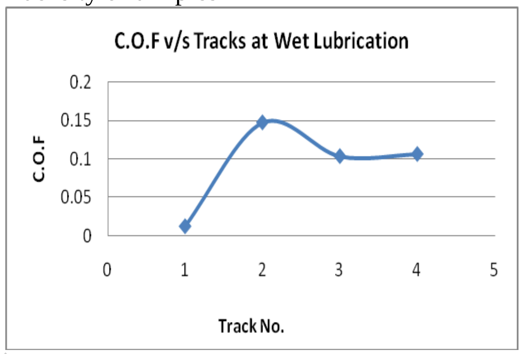
Graph No. 4: C.O.F v/s Time plot when density of the dimples increases at Wet lubrication

e. C.O.F at dry lubrication changes w.r.t change in density of dimples



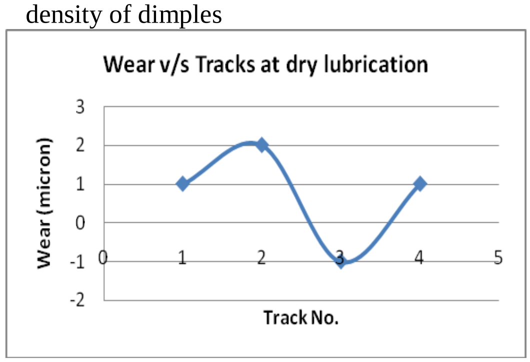
Graph No. 5: C.O.F v/s Tracks at dry lubrication

f. C.O.F at wet lubrication changes w.r.t change in density of dimples



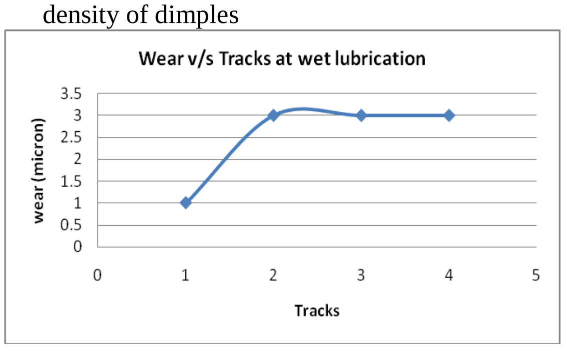
Graph No. 6: C.O.F v/s Tracks at wet lubrication

g. C.O.F at wet lubrication changes w.r.t change in density of dimples



Graph No. 7: Wear v/s Tracks at dry lubrication

h. C.O.F at wet lubrication changes w.r.t change in density of dimples



Graph No.8: Wear v/s Tracks at wet lubrication

VI. DISCUSSION

From the above oservations & calculations it can be shown that at dry lubrication condition the coefficient of friction increases as the texturing density increases & wear remains constant for all the texturing densities. The Frictional force goes on increasing when the density of the dimples are increased beyond the 10% & wear during the experimentation varies at very smaller values comparison with each other texturing patterns.

VII. SEM ANALYSIS

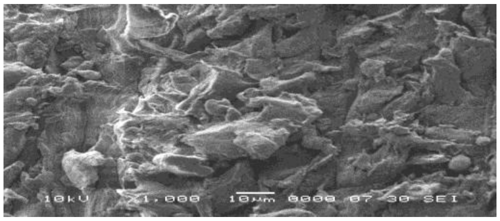
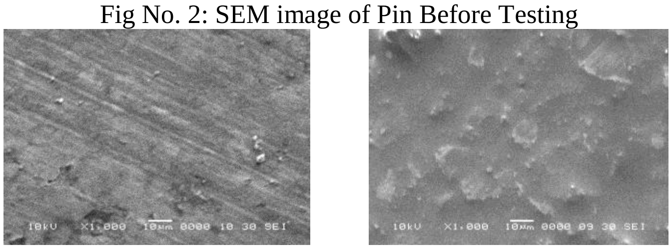
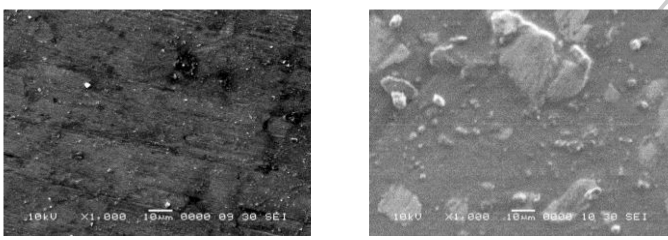


Fig No. 2: SEM image of Pin Before Testing



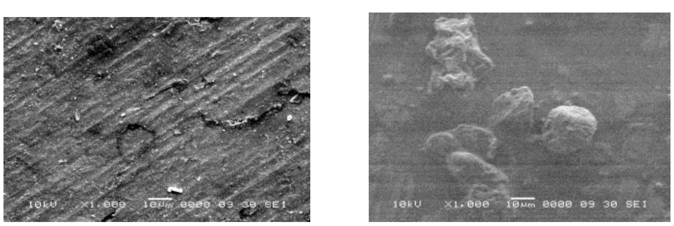
Dry Wet

Fig No. 3: SEM image of Pin After Testing on Track No.1



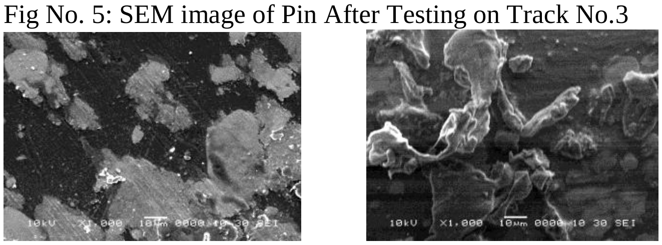
Dry Wet

Fig No. 4: SEM image of Pin After Testing on Track no.2



Dry Wet

Fig No. 5: SEM image of Pin After Testing on Track No.3



Dry Wet

Fig No. 6: SEM image of Pin After Testing on Track No.4

VIII. CONCLUSIONS

- C.O.F increases with the density of the dimples.
- SEM images shows that the wear of textured surface is low compared with non textured surface in both dry & wet lubrication conditions.
- Load carrying capacity of textured surface is increased in higher dimple density track due to that it shows negative C.O.F in wet lubrication.
- It improves the mechanical efficiency & bearing life.

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