

# Modeling and Analysis of Dimpled Textured Surfaces on Rolling Pairs

Vigneshwaran.S, M.srinivasan

PG scholar, Department of Mechanical Engineering, Jay Shriram Group of Institution, Anna University, Chennai, India

Associate Professor, Department of Mechanical Engineering, Jay Shriram Group of Institution, Anna University  
Chennai, India

**ABSTRACT:** Dimple Texture forming in the friction pairs is one of the wear reduction techniques like lubrication. The shape, geometry and density of the patterned micro texture features (dimples) play a key role in the frictional properties of rolling pairs.

In this work, thus, the frictional properties of the rolling pairs with three kinds of textured surface (Smooth, Circular arrays of circular & elliptical dimples) with various geometry and density were calculated using pin on disk tribometer. This work investigates the effect of micro-dimples on the frictional properties of a brass disk mated with brass pin. Results also indicated that the circular patterning, reduces the coefficient of friction by 14.5 % under normal and sliding conditions with zero

Lubrication and circular shape patterning outperforms the elliptical shape patterning with regard to the reduction in the friction coefficient.

**KEYWORDS:** Friction, Lst Patterning, Dimple Texture, Tribometer, Coefficient of Friction

## I. INTRODUCTION

Friction is involved in thousands of applications in our daily lives. In some applications high friction is desirable, as in vehicles' tires on the roadways, brakes, clutches, and frictional power transmission systems. In other applications, friction reduction is a constant demand, which reflects on energy efficiency, component durability, and system reliability. Researchers have been found out surface texturing, as an effective means to improve the frictional properties. Wakuda et al. 2003 [1] stated that Dimples produced by the AJM process had a spherical morphology, while the LBM process led to rather angular dimples. Friction coefficients value was approximately 20% lower than that of the non-dimpled sample. Texturing with 40  $\mu\text{m}$  dimples had no beneficial effect on friction reduction under the above test conditions, whilst lower friction coefficients were obtained for the larger dimples. Kangmei Li et al. 2014 [2] verified that LPT is an effective technology to fabricate controlled micro-dimple array on specimen surface and Surface with texture density of 13% shows the best friction and wear performance in this study. Compared with the untextured surface, it could reduce friction coefficient up to about 1/2 under the test conditions in his research. Wang et al. 2003 [6] concluded that dimple shape had a good effect on lubricating condition, from the point of view of both pressure and oil film thickness. Minimum oil film thickness is totally dependent on the dimple where is located at the inlet of the oil flow in the contact region. The dimple texturing may bring about increase of fatigue of life and of wear resistance of machine element. Zhao et al. 1999 [7] studied the effects of micro-pores as lubricant reservoirs for a highly-loaded, boundary lubrication condition. This research developed a finite element model of a rigid cylinder in contact with an elastic and elastic-plastic half space with lubricant filled micro-pockets. The results showed a reduction in the volume of these micro pores with loading, therefore if those pockets are filled with lubricant, the squeezed lubricant will partially support the applied load. This reduces the surface-to-surface contact between the rigid cylinder and the textured surface. Comparing the empty micro-pore with the micro-pore filled with lubricant, the pressure spikes and the sub-surface stresses of the filled micro pore are lower than in the empty one. Etsion et al. 1999 [10] developed another analytical model to simulate the piston ring-cylinder liner system. The ring and liner were modeled as two parallel flat

# International Journal of Innovative Research in Science, Engineering and Technology

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Vol. 6, Issue 3, March 2017

surfaces where only the ring surface was dimpled, and a reduction of 30% in friction was obtained. The optimal diameter to depth ratio was found to be between 0.1 and 0.18, and areal texture densities varied from 5% to 20% which contradicted with the values found by Stephen. This analytical study showed a similar trend to the experimental test, however, the exact values differed due to the adjustment in the lubricant viscosity assumed in the analytical study.

## II. METHODOLOGY

### A. PROBLEM DEFINITION

The rolling pairs in most of the machines suffer from moderate to severe energy losses due to friction. The surfaces of the rolling pairs experience a high liberation of heat. Due to this there is an increase in the rate of thermal stresses and strains which leads to a low fatigue life of the component.

### B. METHODOLOGY IDENTIFIED

In this work, the control of the friction of dry sliding contact through micro surface texturing is the main objective. To accomplish this objective, a thorough analysis of the mechanisms involved in dry sliding conditions is made. In order to reduce the sliding wear of the friction pairs, the surfaces of friction pairs were textured with the morphology of dimples. Finally, the optimal range of the significant surface texture parameters that minimize friction is sought.

### C. SOLUTION TECHNIQUE

First, Design and Modeling of a dimple texture surface topography is created by using modeling software with appropriate shape and size. Second, various textured surfaces in contact with a Laser Surface Texturing are Analysed by using ansys software in order to investigate texturing parameters that significantly contribute to the frictional forces, and eventually the friction coefficient, to prove that a minimum overall coefficient of friction exists.

The effects of different texture parameters, such as texture size, density, shape, and anisotropy on contact pressure are addressed, and the most significant surface texture parameters at which the wear rate is minimum are determined by ansys by which the optimal parameters been checked and the results has been compared

## III. MODELING AND ANALYSING OF DIMPLE TEXTURED SURFACES

In this chapter, three dimensional and three models of engineered textured surfaces were developed using ansys software. These models are used to investigate the effects of the pattern geometry, density, and shape on the friction coefficients. The following table I shows the material property for Brass plate with engineering textured surfaces.

TABLE I. MATERIAL PROPERTY

Property	Value
Young's Modulus	100000 N/mm <sup>2</sup>
Poisson's Ratio	0.37
Shear Modulus	4e10 N/mm <sup>2</sup>
Density	8900 kg/m <sup>3</sup>
Tensile Strength	3`4438e008 pa
Yield Strength	2.5865e008 pa
Hardness	190-200 BHN

### A. SURFACE TOPOGRAPHY

Fig. 1 shows the three dimensional model of untextured and dimple textured surface of Brass plate with different shapes. A principal application of dimples is preservation of lubricant and trapping wear fragments, which significantly reduces the tendency of infuriating and scoring in the rolling pairs.

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Vol. 6, Issue 3, March 2017

## B ANALYSIS

Plate without dimples

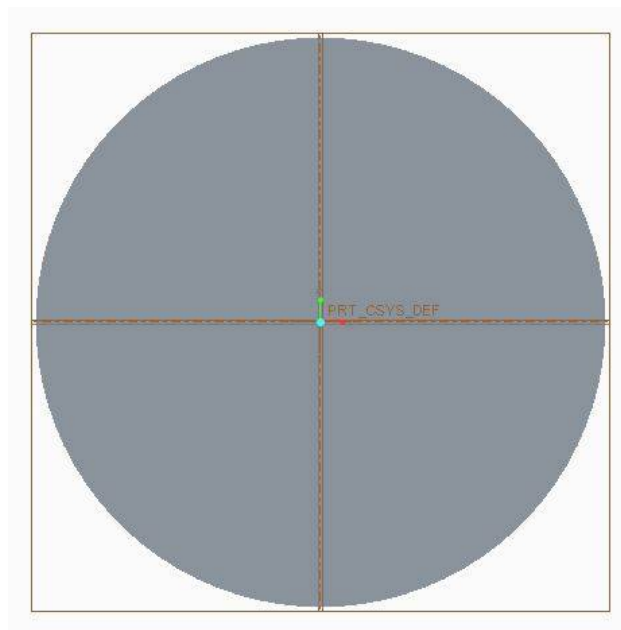
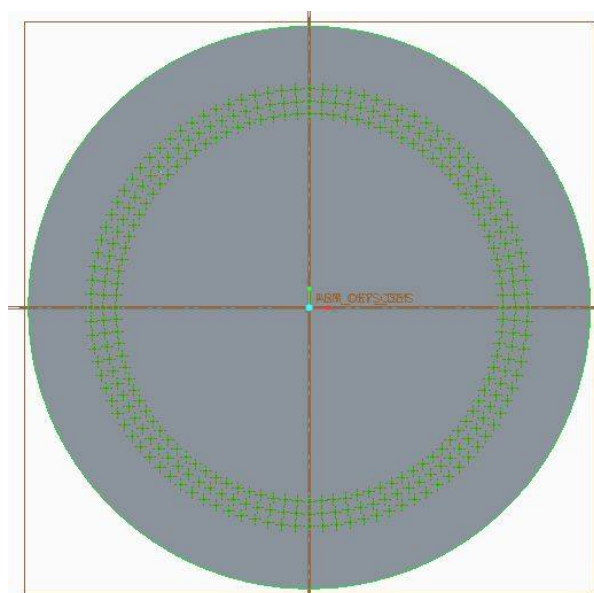


Plate with dimples



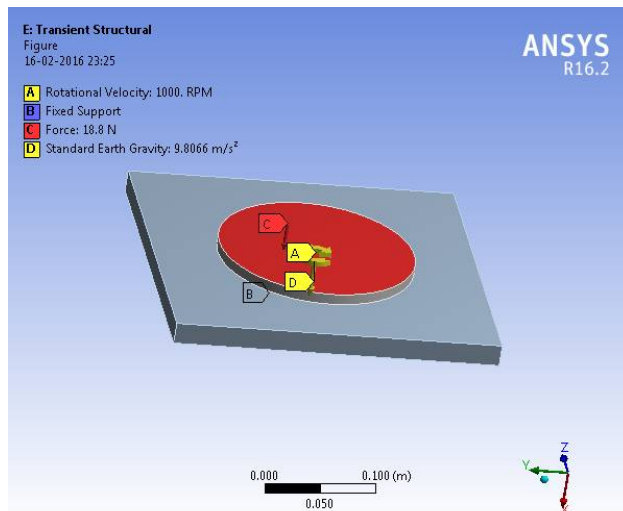
Loading conditions for untextured plate

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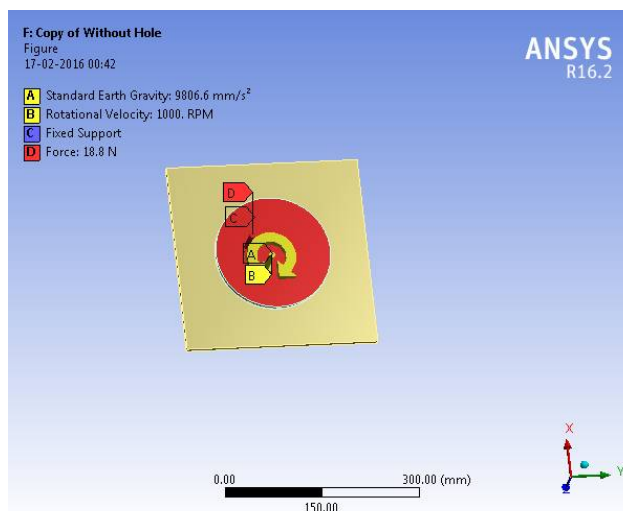
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Vol. 6, Issue 3, March 2017

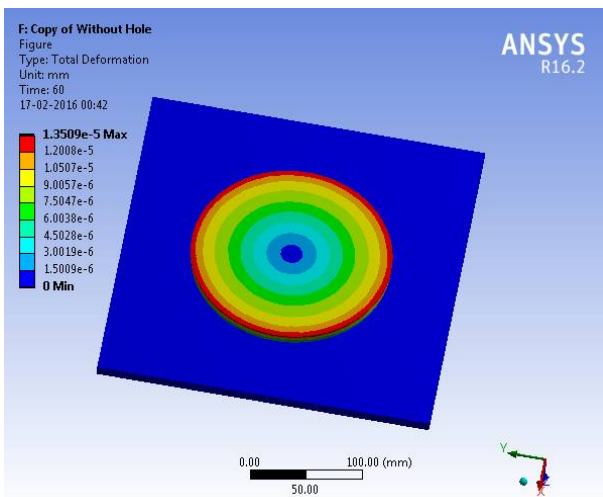


Loading conditions for textured plate

Loading conditions for textured plate

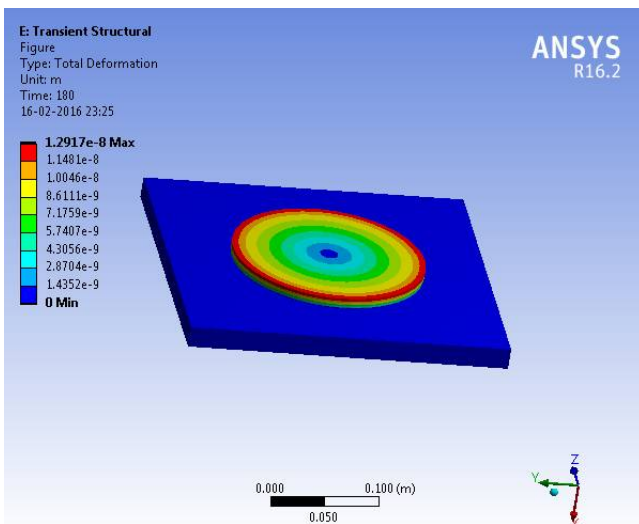


### Total deformation of Plate without dimples



Time	Minimum (mm)	Maximum (mm)
20	0	1.3509e-005
40		
60		

### Total deformation of Plate with dimples



Time	Minimum (mm)	Maximum (mm)
20	0.	1.2917e-008
40		
60		

### B. Conclusion

The major findings drawn from each chapter of this work are summarized in this chapter.

The literature survey showed that micro surface texturing has proven to be an effective means of enhancing tribological performance. Most of the studies investigated the effects of micro surface texturing in wet conditions with a very limited number of studies tackling the dry sliding condition. Most of the studies concluded that texturing with 40 μm dimples had no beneficial effect on friction reduction under the above test conditions, whilst lower friction coefficients were obtained for the larger dimples.

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Vol. 6, Issue 3, March 2017

Larger holes give the lower frictional coefficient and the values are mentioned in the below table.

Applied Force (N)	Size of the hole (mm)	Output Force (N)	Frictional Force (N)	Coefficient of Friction
40	-	30.918	9.082	0.227
	2	32.251	7.749	0.194
	3	34.987	5.013	0.125
	4	35.368	4.632	0.116

The following is a summary of findings which have been mentioned earlier, and they would add to the current state of the art:

1. Micro surface texturing does reduce the coefficient of friction if appropriate surface texturing parameters are identified and optimized.
2. The dimensionless quantity, spatial texture density (D/L), is the most significant texture parameter because it incorporates the size of the texturing features, and the density as well.
3. The minimum coefficient of friction falls between 2 and 4 mm of the circular shape texture.
4. With the circular patterning, a reduction of 40 % in the coefficient of friction is obtained under normal and sliding conditions with zero lubrication.

### REFERENCES

- [1] Manabu Wakuda, Yukihiro Yamauchi, Shuzo Kanzaki, & Yoshiteru Yasuda, Effect of surface texturing on friction reduction between ceramic and steel materials under lubricated sliding contact, 2003, Wear [ELSEVIER].
- [2] Kangmei Li, Zhenqiang Yao, Yongxiang Hu & Weibin Gu, Friction and Wear Performance of Laser Peen Textured Surface under Starved Lubrication, 2014, Tribology International [ELSEVIER]
- [3] Liguang Qin, Ping Lin, Yali Zhang & Guangneng Dong, Influence of surface wettability on the tribological properties of laser textured Co–Cr–Mo alloy in aqueous bovine serum albumin solution, 2013, Applied Surface Science [ELSEVIER].
- [4] Yuki Kuroiwa, Auezhan Amanov, Ryo Tsuboib, Shinya Sasakib, & Shinji Katoc, Influence of surface wettability on the tribological properties of laser textured Co–Cr–Mo alloy in aqueous bovine serum albumin solution, 2013, Applied Surface Science [ELSEVIER].
- [5] Yuki Kuroiwa, Auezhan Amanov, Ryo Tsuboib, Shinya Sasakib, & Shinji Katoc, Effectiveness of surface texturing for improving the anti-seizure property of copper alloy, 2011, Procedia Engineering [ELSEVIER]
- [6] Wang, X., K. Kato, K. Adachi and K. Aizawa, Loads carrying capacity map for the surface texture design of SiC thrust bearing sliding in water. Tribology International, 2003. 36(3): p. 189-197.
- [7] Zhao, J., F. Sadeghi and H.M. Nixon. A finite element analysis of surface pocket effects in Hertzian line contact. Journal of Tribology, 1999. 122(1): p47-54.