

ON THE SHAPE OF SURFACE TEXTURE

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ABSTRACT

The research on surface texture for tribological improvements has become a hot topic since the later of 1990s, while Etsion et al. used laser to fabricate circle dimples to decrease friction of mechanical seals. Historically, surface texture is not a new concept. The cross-hatch pattern by honing process has been successfully used for the cylinder liner of combustion engines for more than 80 years. In 1960s, Hamilton et al. indicated that micro-irregularities were able to generate the additional hydrodynamic pressure to increase the load carrying capacity of the surfaces. Later, the pattern of spiral grooves was successfully used for mechanical seals to achieve non-contact sealing performance.

Modern manufacturing technology such as laser or electrolytic etching is capable of producing various shapes of surface texture which provide freedom for surface design for different purposes. The understanding on the mechanisms of the different shapes of surface texture is critical.

As shown in Fig.1, at early stage, it was known that surface texture could generate hydrodynamic pressure, reserve lubricant and trap wear debris. By extensive research, it is gradually understood there could be many other effects such as pumping/obstructing lubricant, generating stress etc. The shape of surface texture plays an important role for those effects.

At first, this article will compare the performance of different texture shapes, including the connected texture like grooves, independent texture like dimples, etc.^[1, 2], and propose our understanding on design strategy for the trib-pairs in different lubrication regime. Then, a shape optimization algorithm for the texture with “free” shape is introduced to maximize the shape effect for specific purpose. Finally, in order to deal with the objectives which may conflict to each other, such as load carrying capacity and leakage rate, a multi-objective optimization approach using the elitist non-dominated sorting genetic algorithm (NSGA-II) is introduced, as shown in Table 1^[3].

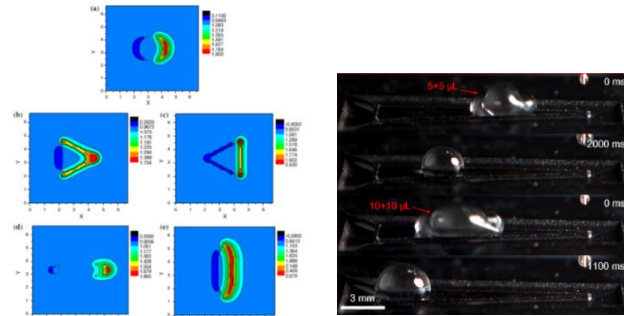


Fig.1 Surface texture for hydrodynamic pressure and liquid transporting

Table 1 Optimal shapes and dimensionless pressure distribution by multi-objective optimization

Solution order	1	2	3	4	5	6	7	Colorbar
Type a								
Type b								

Note: the black line is the profile of dimple and the contour is the dimensionless pressure distribution

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REFERENCES

- [1] H. Yu, X. Wang, F. Zhou, Geometric Shape Effects of Surface Texture on the Generation of Hydrodynamic Pressure between Conformal Contacting Surfaces, *Tribology Letters*, 2010. 37(2): 123-130.
- [2] S. Yuan, W. Huang, X. Wang, Orientation Effects of Micro-Grooves on Sliding Surfaces, *Tribology International*, 2011. 44(9): 1047-1054.
- [3] X. Wang, L. Shi, Q. Dai, W. Huang, X. Wang, Multi-Objective Optimization on Dimple Shapes for Gas Face Seals, *Tribology International*, 2018. 123: 216-223.