

# Research Status and Prospect of Surface Textured Rolling Bearings

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**Abstract.** Surface texture refers to the process of creating a series of microstructures with a specific distribution pattern and size on the surface of mechanical components using machining equipment. This technique improves the lubrication, friction, and wear performance of contact surfaces. Researchers have conducted extensive optimization of surface texture geometric features and operating conditions to study the mechanisms and applications of surface texture technology. This paper reviews the development and processing methods of surface texture technology, as well as the main research achievements in controlling rolling bearing friction in recent years. It discusses the latest advances in improving the tribological performance of material surfaces from two aspects: the geometric features of surface texture and practical operating conditions. The geometric features include the shape, diameter, depth, areal density, and arrangement of the surface texture. Practical operating conditions depend on the type of friction and operational conditions. An analysis and summary of the parameters and conditions that improve surface tribological performance are presented. The paper also reveals the mechanism of laser surface texture's effect on the friction and wear performance of rolling bearings. Future research will need to extend the test duration, optimize texture parameters (such as external profile, size, bottom shape, and laser parameters), and apply artificial intelligence algorithms like deep learning and neural networks. These areas will be the focus of future research.

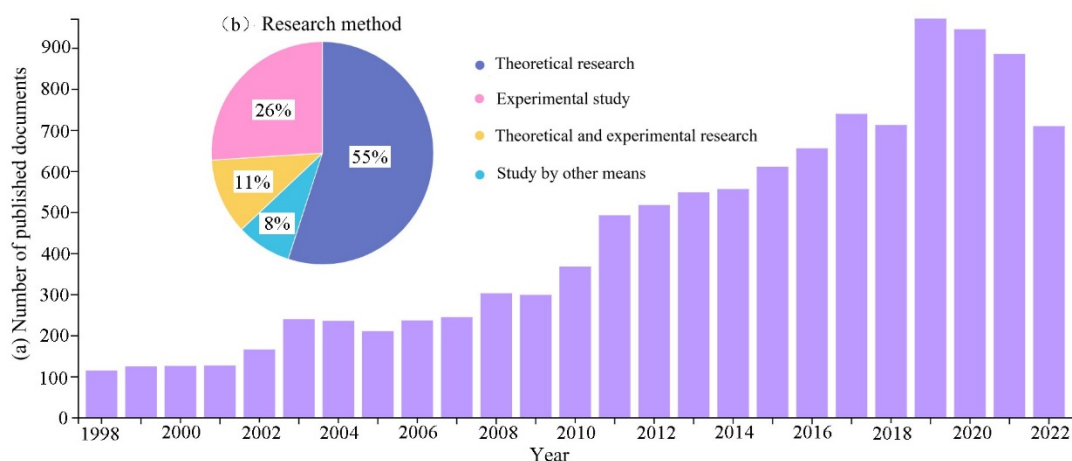
**Keywords:** Rolling Bearings; Surface Texture; Status and Prospect.

## 1. Introduction

Rolling bearings are among the most widely used mechanical components (second only to nuts and bolts), with origins dating back to ancient times. The bearing support platforms on Roman ships used rolling elements made of bronze and wood. Modern rolling bearings are precision, low-friction mechanical components, typically produced in large quantities. They are widely used in rotating machinery such as aerospace equipment, machine tools, coal mining machines, excavators, and wind turbines. Rolling bearings play roles in power transmission and motion transfer. Their friction, wear performance, mechanical properties, and operational status directly affect the reliability and service life of equipment. In real-world operations, it is difficult for friction contact surfaces to consistently maintain lubrication. For example, under harsh operating conditions such as high-speed, high-load, high-temperature, startup, and reverse motion, or when rolling bearings are lubricated with grease, lubrication inadequacy may occur. To ensure the normal operation of rolling bearings under these severe conditions and to extend their service life, improving the lubrication performance of rolling bearings can alter their friction and wear conditions. The core issue lies in addressing the challenges between lubrication, friction, and wear. Currently, one method to improve the friction and wear condition of rolling bearings is to enhance the precision of the working surface. Traditional tribology theory suggests that a contact surface with low friction and wear must be smooth.

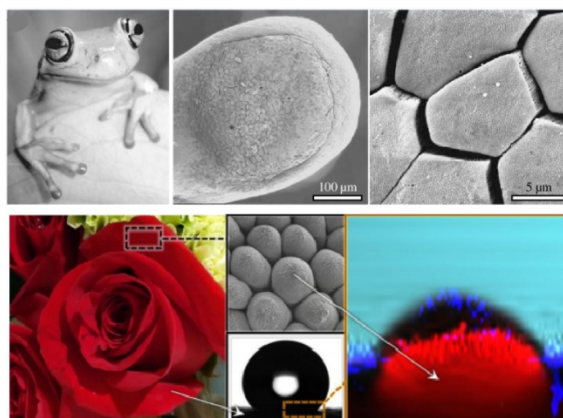
In nature, many animal groups, such as ants, crocodiles, and sharks [3, 4], as well as plant groups, such as lotus leaves [5], have developed specialized microstructures that give their skin friction-reducing and wear-resistant properties. Inspired by these biological phenomena, surface engineering

in mechanics has opened new avenues for reducing inherent friction and enhancing lubrication. Numerous theoretical and experimental studies based on biomimetic tribology principles have led to new discoveries, such as how microstructures on contact surfaces reduce the friction coefficient and improve wear resistance [6, 7]. By creating specific geometric micro-pits or micro-grooves on frictional contact surfaces, lubrication conditions can be significantly improved, and the friction performance of contact surfaces can be enhanced [8-10]. A statistical analysis of literature on surface texture components improving the friction and wear performance of contact surfaces, published between 1998 and 2022 in the Web of Science database (Surface Texture & Friction), shows that research primarily focuses on theoretical studies (as shown in Figure 1).



**Figure 1.** Statistics of the number of literatures on surface texture improving tribological properties

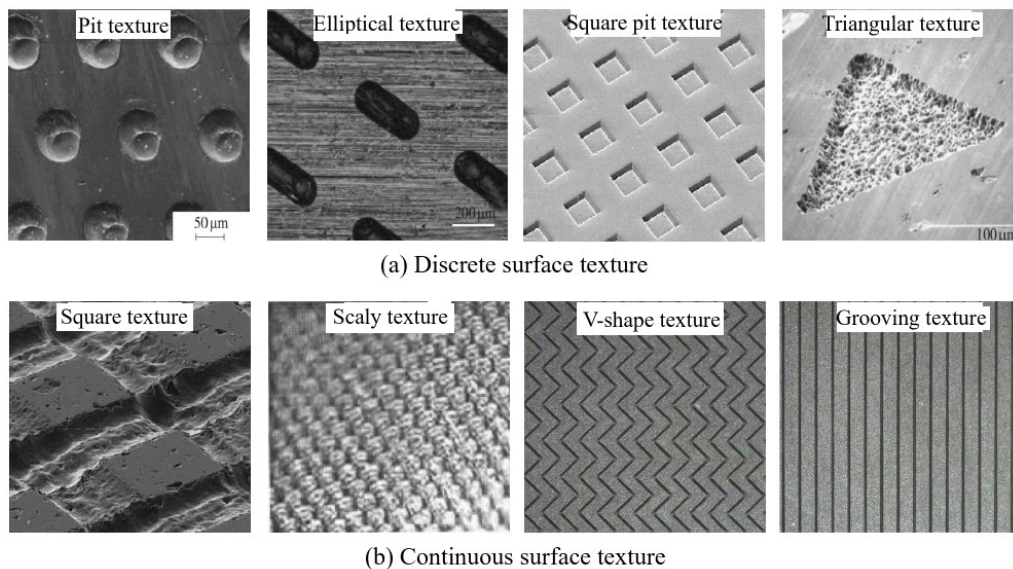
Surface texture refers to the creation of a series of microstructures with a defined distribution pattern and size on the surface of mechanical components using processing equipment, aimed at improving lubrication, friction, and wear performance of the contact surfaces. Inspired by nature, experts and scholars utilize surface texture to enhance lubrication conditions, as shown in Figure 2. The remarkable feature of tree frogs is their ability to attach to smooth surfaces using their large webbed feet. The webbed feet of tree frogs are characterized by nail-like hexagonal cells, with deep channels opened by mucus glands separating them. The pads are fully saturated with a water-like mucus, and the adhesive force is significantly enhanced through the close contact and boundary friction between the pad epithelium and the substrate. The highly regular microstructure of the pads contributes to the improvement of adhesion. The surface structure of rose petals provides unique wettability characteristics. Experimental and modeling results reveal the wetting behavior of water on the layered surface structure of rose petals, explaining the macroscopic wetting behavior of rose petals.



**Figure 2.** Surface texture feature [11, 12]

In order to better adapt to the natural environment, organisms have evolved diverse surface morphologies, which inspire scholars to create various types of surface textures. Currently, surface textures can be divided into two main categories (as shown in Figure 3): discrete surface textures and continuous surface textures. Among the numerous types of surface textures, cylindrical pits are the most widely applied. They are characterized by large oil storage capacity, simple processing, single-step formation, and isotropy, which have garnered significant attention from researchers both domestically and internationally.

Cylindrical pit surface textures play a role in reducing friction and improving lubrication in various types of friction pair contact surfaces. Many processing methods have been proposed by researchers, such as electrolytic machining technology [13], embossing technology [14], deposition technology [15], and laser surface texture technology [16-18]. Laser surface texture technology (LST) has become one of the most successful surface texture technologies due to its advantages of flexibility, environmental friendliness, and cost-effectiveness. Currently and for the foreseeable future, this technology is gaining considerable attention from researchers both domestically and internationally. By utilizing advanced laser processing technology to create micro-pit arrays on the surface of mechanical components, specific geometrical shapes can be achieved, which effectively improves the microstructural properties, anti-friction performance, and wear resistance of the friction pair contact surface.



**Figure 3.** Surface texture morphology[1]

## 2. Research Status of Laser Surface Texture

### 2.1 Development of Surface Texture

The development of surface texture can be roughly divided into three stages:

Stage 1: Emergence of Surface Texture

In 1966, Hamilton et al. [19] discovered that "microirregularities" on sliding contact surfaces, which were similar to hydrodynamic sliding bearings, could generate additional fluid dynamic pressure and provide a certain load-bearing capacity. This improvement in the friction and wear performance of friction pairs marked the first appearance of the concept of "surface texture" in the literature.

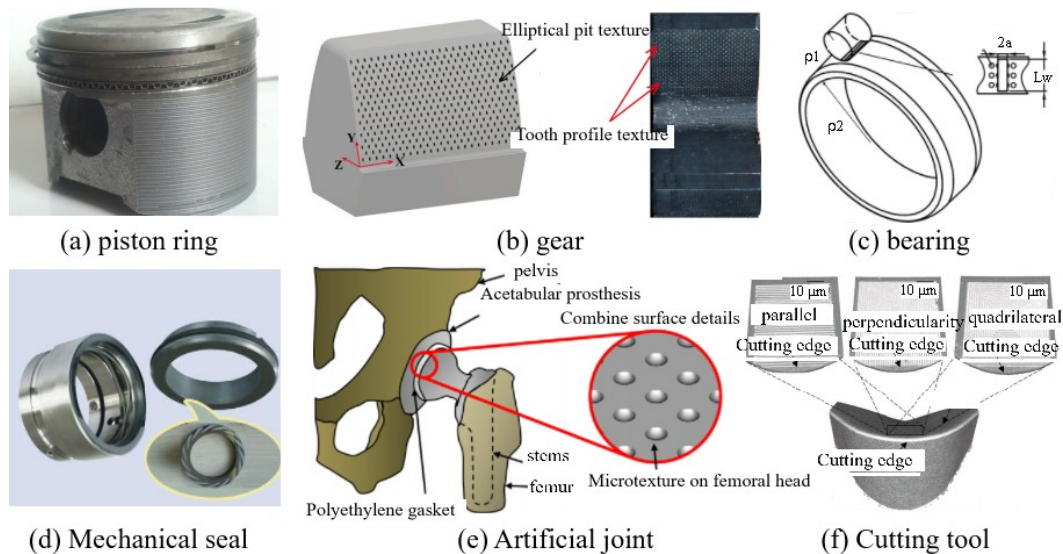
Stage 2: Formation of Surface Texture

In 1999, Etsion et al. [20] applied the concept of "microirregularities" to mechanical seals and achieved excellent results. Etsion and colleagues referred to these "microirregularities" as "surface texture," marking the formalization of the surface texture concept. The advantages of surface texture

in improving the friction and wear performance of contact surfaces in friction pairs gained attention from international researchers. However, it did not attract much interest from domestic scholars until 2003. Currently, domestic universities engaged in the manufacturing and research of surface texture for improving the friction and wear performance of friction pair contact surfaces include Tsinghua University, Jilin University, China University of Mining and Technology, Nanjing University of Aeronautics and Astronautics, and Jiangsu University, among others.

### Stage 3: Rapid Development of Surface Texture

Since 2009, surface texture has entered a stage of rapid development. The impact of different surface texture morphologies on the tribological performance of contact surfaces in friction pairs varies. Among the many surface texture morphologies, micro-dimple textures are the most common [21-24], and different types of surface textures require various processing methods. Generally, surface texture is primarily used to improve the tribological performance of friction pair contact surfaces by reducing friction, decreasing wear, improving lubrication conditions, and increasing the bearing capacity of the contact surface. Numerous surface texture research results have been applied in various fields, such as cylinder liner-piston rings [25, 26], gears [27, 28], bearings [29-31], artificial joints [32, 33], mechanical seals [34, 35], and cutting tools [36-38], as shown in Figure 4.

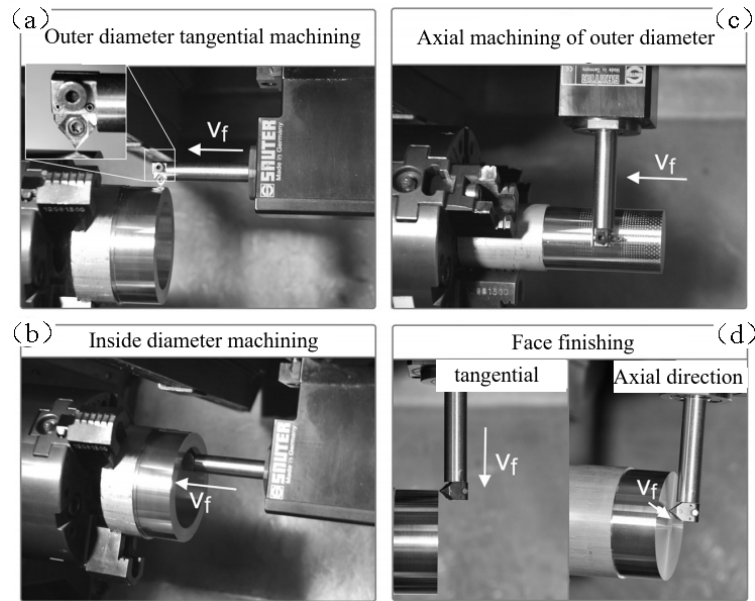


**Figure 4.** Common application of surface texture

## 2.2 Research Status of Surface Texture Manufacturing Methods

Advanced manufacturing technologies and machining processes have been exploring surface textures to create various types of structures on a range of engineering surfaces [37, 39, 40]. The diverse surface texture morphologies have prompted researchers to develop various methods for manufacturing surface textures, which can be briefly summarized as follows:

**Fly-cutting Kinematics:** Novel axial parallel and orthogonal turning-milling processes can effectively generate micro-dimples on cylindrical parts [41]. The machining operation conducted on a certain CNC lathe is shown in Figure 5. The rotary milling cutter is supported by the driven tool post and superimposed on the surface of the rotating component. The geometry of the notch cross-section is directly determined by the geometry of the tool tip. By determining the feed rate and speed ratio, non-overlapping micro-dimples can be continuously processed. The average dimensions of the micro-dimples are as follows: length 1 mm to 2 mm, width 50  $\mu\text{m}$  to 100  $\mu\text{m}$ , and depth 5  $\mu\text{m}$  to 30  $\mu\text{m}$ . The advantage of this method is the flexibility in the arrangement of micro-dimples. However, the drawback is that surface texture processing requires the use of tool heads, and prolonged use of the tool head can lead to contact fatigue, resulting in wear that ultimately affects the quality of surface texture manufacturing.



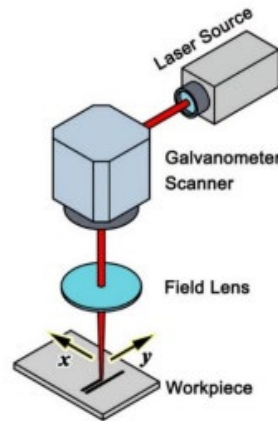
**Figure 5.** Cylindrical parts axial parallel and orthogonal machining pits[41]

Abrasive jet machining (AJM) uses fine abrasive particles for shot blasting and is an attractive micro-machining method for ceramic materials [42]. The abrasive jet machining process requires the assistance of a mask. Compared to conventional large-scale particle erosion, the surface processed by abrasive jet machining does not experience strength degradation, indicating that radial cracks do not extend downward due to particle impacts. However, when using this technology for surface texturing, drawbacks such as noise pollution, dust particle dispersion, and retention of abrasive particles may occur.

Maskless micro-patterning employs photolithography to directly print the initial planar micro-pattern on the surface of diamond-like materials [43]. In this process, photolithographic exposure is conducted using specified positioning control based on CAD data. The maskless micro-patterning process consists of three steps: maskless exposure controlled by a beam, removal of platinum deposition through milling, and the removal of nano-carbon resin via reactive ion etching. The spatial resolution of the micro-patterning process is limited to 1  $\mu\text{m}$ . This method offers high processing precision but has a complex procedure.

Micro-ultrasonic machining removes material through the abrasive action of a particle-laden slurry between the workpiece and the tool, with the slurry vibrating at low amplitude and high frequency (typically 16–25 kHz) [44]. The micro-ultrasonic machining system consists of an ultrasonic generator, ultrasonic transducer, ultrasonic horn, tool, workbench, power supply, and control unit. The high-power amplifier ultrasonic generator uses integrated circuits, and ultrasonic vibrations are generated by a digital piezoelectric transducer. The system features automatic frequency tracking and can maintain resonance through automatic control. The input power range is 0–150 W, with a frequency of  $20 \pm 4$  kHz (the resonance frequency of the vibrator). The workpiece is fixed on the workbench. Due to the small machining area and depth, manual replenishment of abrasives is required, limiting large-scale application.

Laser surface texture is a technique used to improve the performance of components by modifying the surface structure of a material through laser processing [45]. The processing principle is shown in Figure 6 [46]. It is currently one of the most common non-contact, high-efficiency, and high-speed processing technologies. Both microscopic and macroscopic objects can be processed using laser technology. The accumulated dynamic pressure effect of the surface texture can effectively improve the friction and wear performance of the contact surface in friction pairs.



**Figure 6.** Schematic of laser surface texturing[46]

Many methods for manufacturing surface textures have been proposed by researchers [47, 48]. Each method has its advantages and disadvantages, as shown in Table 1. To achieve the desired geometric parameters and cost, selecting the appropriate texture manufacturing technology for a given application is particularly important.

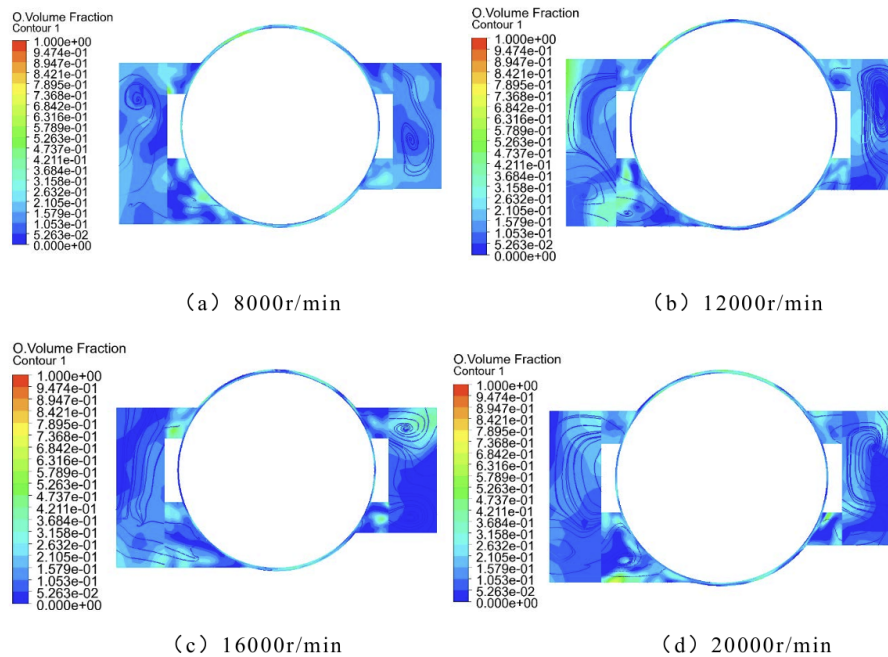
**Table 1.** Advantages and limitation of various texture manufacturing techniques

Texture technology	Advantages	Disadvantages
Laser surface texture	Wide application range High precision, precise size No contact force	Heat affected zone Low texture speed Higher equipment cost
Numerical control machining	Don't use high energy No chemical waste is produced	Burr Control system expensive
Chemical etching	Suitable for processing brittle materials Easy to weave in various shapes	Environmental pollution Waste disposal costs are high
Electrochemical machining	Fast processing speed Flexible control	High surface roughness Poor fatigue performance
Fine grinding	Contact with the tool Simple and cheap process	Tool aspect ratio is very low No deep narrow cavities
Microcasting	Large-scale commercial Low requirements for further processing	Difficult to cure after forming Bubble-prone
Micro-discharge machining	Complex geometric textures Low machining force	Texture size uncertainty Low material removal rate

### 2.3 Research Status of Laser Surface Texture Tribology

As mentioned previously, laser surface texture technology is considered one of the most promising technologies in the field of surface texture manufacturing. Laser surface texture is a non-contact processing method. By adjusting process parameters such as laser beam energy and movement speed, it is possible to process various materials (metals, non-metals, high hardness and brittle materials, transparent materials). The laser beam has a high energy density and performs localized processing on the object's surface, with a small heat-affected zone and minimal impact on non-processed surfaces. The laser beam also has excellent directionality, allowing for transformations in various directions through focusing.

Current Research Status in China: Wu Yan [49], based on point contact elasto-hydrodynamic lubrication theory and fluid dynamics theory, analyzed the influence of optimal surface texture shape parameters on the oil phase volume fraction in bearing chambers and the effect of surface texture on the lubrication performance of angular contact ball bearings (see Figure 7). Zhang Di [50] established an elasto-hydrodynamic lubrication model for needle roller/outer ring rolling bearings and explored the lubrication effects of surface textures at different rotational speeds. Jin Zhihao et al. [51], taking the 81107-TN thrust cylindrical roller bearing as the research object, extensively studied the impact of pit textures on the friction and wear performance of the "outer ring-cage-rolling elements-inner ring" rolling bearing system. The results indicated that when the pit diameter is 300  $\mu\text{m}$  and the depth is 8  $\mu\text{m}$ , compared to bearings without texture, the textured bearings show a 61.57% reduction in wear loss, exhibiting excellent wear resistance. Long et al. [52, 53] studied the tribological performance of laser surface pit-textured rolling bearings under variable load and starved lubrication conditions, as well as the performance of groove textures under starved lubrication. The tests showed that compared to smooth bearings, both pit and groove textures significantly reduced the coefficient of friction and wear loss, demonstrating good anti-friction and wear resistance properties. Lu Ji [54] developed a quasi-static model for high-speed rolling bearings and solved it using the Newton-Raphson iterative method to investigate the effect of surface micro-pits on the bearing performance. The study revealed that the selection of pit parameters has a significant impact on the post-test surface morphology of the raceway. Xing Guoxi [55] conducted an in-depth study on the factors influencing the oil film lubrication characteristics of surface-textured inner ring flanges, obtaining regularities regarding the influence of surface texture type, geometric parameters, distribution patterns, and the number of pits on the bearing capacity and frictional characteristics of the inner ring flange oil film. Zhang Kexin [56] carried out experimental research on the lubrication performance of guide surface-textured rolling bearings. The results showed that when the speed exceeds 900 r/min, surface textures can effectively reduce the frictional torque (up to a maximum of 70%), proving that surface textures can significantly improve lubrication performance under starved lubrication conditions.



**Figure 7.** Bearing chamber section flow diagram[49]

Bhardwaj et al. [57] studied the texture of circumferential micro-grooves on the inner race of thrust ball bearings and operated the bearings under light loads ( $\text{PH} = 0.4$  and  $0.6$  GPa, the minimum required load) and speeds ranging from  $1.8$  to  $4.0$   $\text{m}\cdot\text{s}^{-1}$ . The experimental results indicate that, compared to conventional bearings, micro-groove bearings significantly reduce the friction torque

(by 14% to 21%), overall temperature rise of the raceway (by 14% to 26%), and vibration amplitude (by 7% to 34%). Baharin et al. [58] reviewed the extensive application of surface texturing in improving the surface properties of materials. Surface texturing helps to reduce friction and wear, and a higher texturing density can enhance the wear resistance of surfaces. Currently, most surface texturing is carried out using laser surface texturing technology. Kovalchenko et al. [59] investigated the effect of Laser Surface Texturing (LST) on the transition of lubrication states. Frictional tests were conducted using a pin-on-disc apparatus within a sliding speed range of 0.015 to 0.75 m/s and a nominal contact pressure range of 0.16 to 1.6 MPa. Two oils with different viscosities (54.8 and 124.7 cSt at 40°C) were used as lubricants. The results show that laser texturing improves the contact parameters related to load and speed in hydrodynamic lubrication. The beneficial effects of laser surface texturing are more pronounced at higher speeds, loads, and higher viscosity oils. Laki et al. [60] reviewed 80 studies related to the empirical methods and latest research findings on laser surface texturing technology, noting that surface texturing with appropriate manufacturing parameters can enhance lubrication and reduce friction in both sliding and rolling contacts. The review focuses on the use of surface texturing in the engine field to reduce friction. Li et al. [61] pointed out that the poor friction performance of water-lubricated bearings under low-speed and heavy-load conditions severely limits the widespread application of water-lubricated bearings. They noted that the natural low friction and wear phenomena have attracted significant scientific interest, leading to extensive research from mechanism analysis to bionic applications. The development of materials for water-lubricated bearings and typical examples of friction reduction and resistance in nature were introduced, providing guidance and analytical basis for the bionic design and theoretical research on the anti-friction and anti-wear properties of water-lubricated bearings.

As can be seen from the above, the advantages of laser surface texturing technology include high flexibility, fast processing speed, high efficiency, the ability to fabricate complex textures, and a wide range of applications. The disadvantages include the formation of molten burrs during the processing, which can be easily removed by simple polishing and ultrasonic cleaning after the processing.

### **3. Research Status of Friction and Wear of Rolling Bearings**

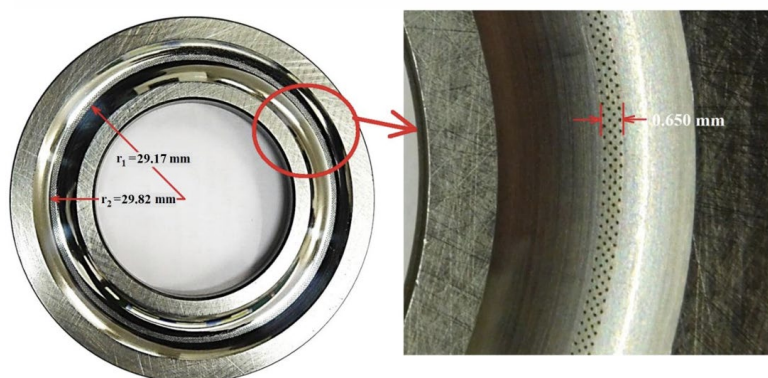
As mentioned previously, tribology is the study of friction, wear, and lubrication between the friction pairs of components and their interrelationships. Wear is an inevitable result of friction, and it refers to the process of material removal that occurs when two contact surfaces undergo relative motion. Insufficient lubrication results in the inability of the rolling elements in rolling bearings to maintain a complete oil film between the inner and outer races (shaft race and seat race) as under full elastohydrodynamic lubrication conditions. Intermittent lubrication leads to direct contact between the rolling elements and the races, causing wear in the areas of mutual contact. In recent decades, the lubrication, friction, and wear performance of rolling bearings have attracted the attention of many experts and scholars. The surface contact analysis of rolling bearings is fundamental to the study of bearing friction and wear. The key factor influencing contact fatigue and friction wear is the contact stress.

The contact between the rolling elements and the inner and outer races of deep groove ball bearings is a point contact, which is prone to wear. This wear can affect the geometric accuracy and support precision of the bearing. When wear becomes severe, it results in the deterioration of the stress distribution, thereby impacting the reliability and service life of the rolling bearing. In the ideal state of theoretical design, the relative motion between the rolling elements and the inner and outer races of the deep groove ball bearing is pure rolling. However, in actual operation, under the influence of speed, load, and friction, a certain degree of relative sliding inevitably occurs in the contact area between the rolling elements and the inner and outer raceways, which ultimately leads to friction and wear between the rolling elements and the raceways. In recent years, many domestic and international experts and scholars have conducted comprehensive and systematic in-depth research on the friction and wear performance of rolling bearings.

Olofsson et al. [62, 63] conducted detailed friction and wear tests on thrust spherical roller bearings under boundary lubrication conditions, focusing on slight wear that may be caused by sliding. The experimental results show that mixed wear occurs in the contact sliding area, leading to significant changes in the raceway morphology. Based on Archard's wear theory, the wear amount of spherical thrust roller bearings was analyzed using numerical simulation methods, showing good consistency with the experimental results.

Shi et al. [64] established a numerical simulation model for the wear of cylindrical roller bearings. Aiming to predict the wear state of cylindrical roller bearings, they proposed a wear algorithm based on the discrete theory of rolling bearings, computer technology, and dynamics theory. The results indicate that the numerical method can simulate the complex wear process of cylindrical roller bearings.

Bhardwaj et al. [65] tested the temperature rise, frictional torque, and vibration performance of conventional and textured inner ring thrust ball bearings. The results show that, compared to conventional raceway bearings, textured raceways can reduce the bearing's frictional torque. The surface texture effectively retains lubricant, improving contact damping and reducing bearing vibration. At low speeds (1.8 m/s), the lubricated textured ball bearings significantly reduce frictional torque (by up to 33%) and vibration amplitude (by up to 50%)(see Figure 8).



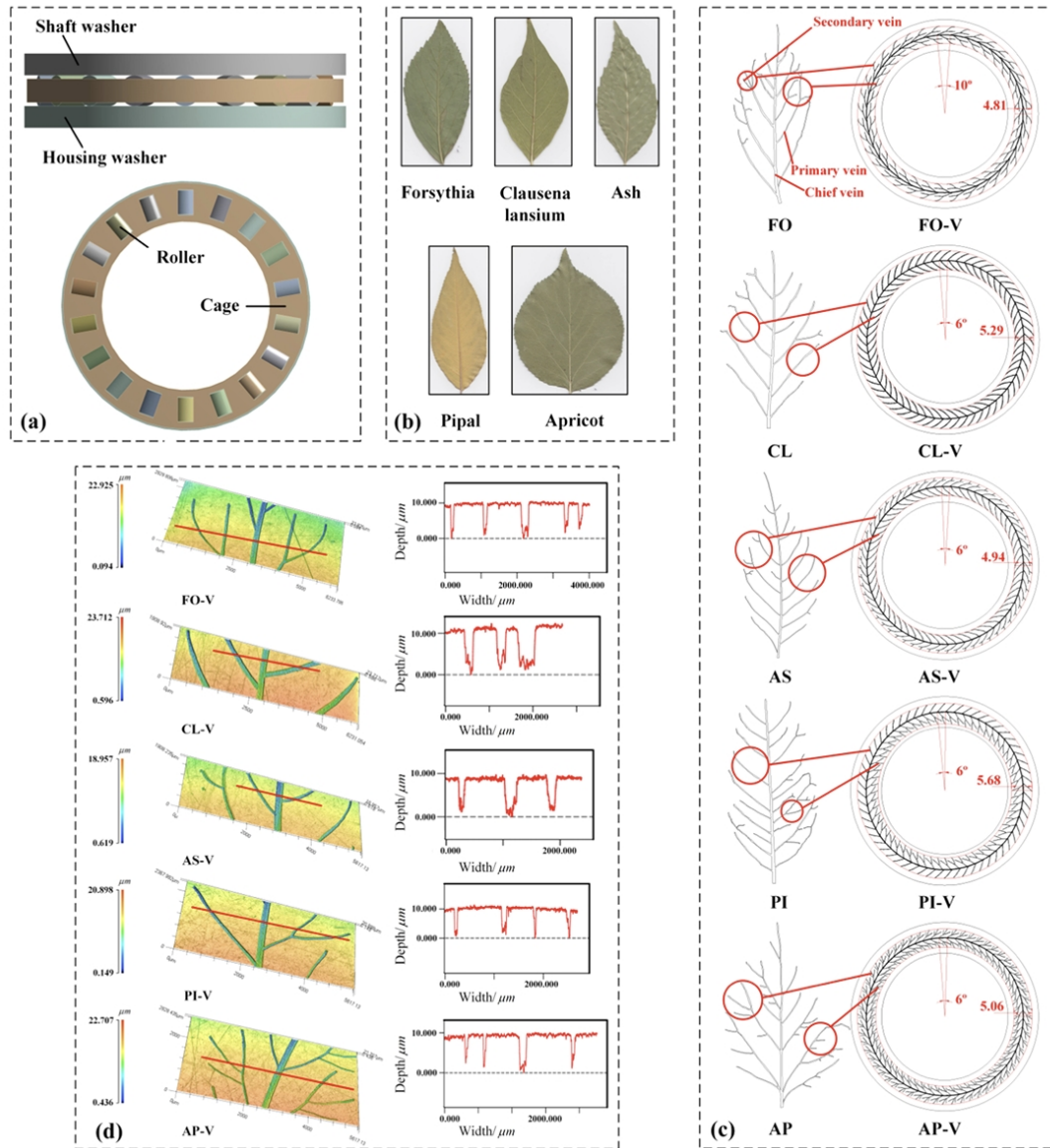
**Figure 8.** Photographic view of textured race of a test bearing[65]

Vidyasagar et al. [66] applied nanosecond pulsed laser surface texturing to the inner rings of deep groove ball bearings. Using an internally developed test rig, they measured frictional torque and vibration parameters at different speeds and light loads (around  $0.01C$ , where  $C$  is the dynamic load rating of the radial ball bearing). The experiments show that under light loads, the frictional torque and vibration significantly decrease, and the wear condition of the bearing raceway improves. Compared to conventional bearings, bearings with textured surfaces exhibit a notable reduction in frictional torque (by 15% to 47%) and a substantial decrease in vibration amplitude (by 25% to 46%). A 15% pit area density results in better tribological performance. TEM micrographs reveal that, compared to conventional bearings, the soap fiber damage in textured bearings is smaller.

Hsu et al. [67] created a series of shallow ( $0.9/1.1 \mu\text{m}$ ) textured patterns on the raceway of thrust rolling bearings under boundary lubrication conditions, demonstrating that the textured pits promote the formation of anti-wear friction films. Fatigue life assessment results also show that surface texturing has a positive impact on the bearing's service life, with the fatigue life of thrust rolling bearings increasing by a factor of three. The textured patterns ensure adequate lubrication under high-load conditions, improve the rolling-sliding contact mode between rolling elements and raceways, and reduce wear in roller bearings, thereby enhancing bearing performance.

Zhao et al. [68] investigated the tribological performance of thrust cylindrical roller bearings with six different types of vein surface textures under boundary lubrication conditions. The study found that the symmetry of the biomimetic texture and the number of secondary veins significantly affect the tribological properties. Compared to the smooth group, the biomimetic textured bearings

exhibited lower friction coefficients and wear loss. Among all the bearing groups, the leaf vein pattern of the white wax tree leaf demonstrated the best tribological performance, with wear loss and friction coefficient reduced by 16.23% and 15.79%, respectively (see Figure9).



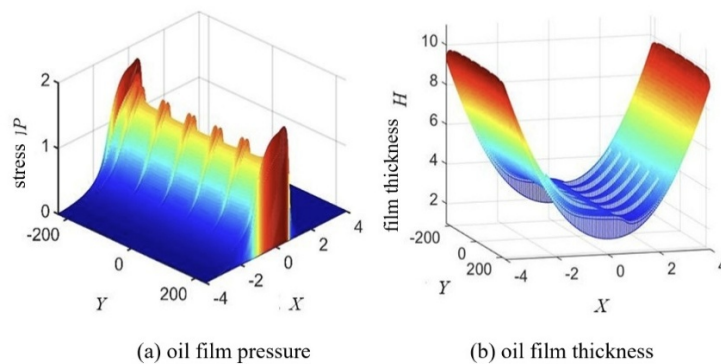
**Figure 9.** 3D sketch of the CRTB (a), image of leaves (b), contour diagram of leaves and the corresponding V-texture patterns (c), 3D surface topographies and cross-curves of patterns (d) [68]

Wang et al. [69, 70] studied single and composite textured SiC thrust bearings sliding in water. It was reported that the generation of additional dynamic water pressure to increase the bearing capacity was considered the most significant effect of surface texturing. To enhance the generation of dynamic water pressure and improve the running-in process, a surface texturing pattern combining large pits (circular pits with a diameter of 350 μm) and small pits (rectangular pits with a length of 40 μm) was designed, maximizing the impact of the texture on the bearing capacity of SiC surfaces in water.

Grützmaier et al. [71, 72] experimentally studied the effects of single-scale and multi-scale surface textures on the friction performance of sliding bearings. All textured patterns significantly reduce the friction coefficient. For multi-scale surfaces, better distribution of the lubricant in the contact area results in less cavitation. Under hydrodynamic lubrication conditions, the reduction of cavitation leads to increased load-carrying capacity, thereby decreasing the friction coefficient. The study also explored the effect of multi-scale textures on the wear behavior of steel-alumina composite materials under lubrication conditions. It was reported that multi-scale surfaces demonstrated good

performance, showing stable and lower friction coefficients. For deep micro-casting patterns, additional laser texturing helps reduce cavitation, enhances lubrication in the contact area of the surface, and improves tribological performance.

Qi H [73] used FLUENT software to simulate the hydrodynamic effects of textured rolling tracks and studied the influence of texture shape, size, and area density on the friction coefficient and load-carrying capacity of the lubricant film in rolling element-raceway interactions. The research investigated the friction-reducing performance and relevant mechanisms of textured rolling bearings. The experimental results indicated that, compared to bearings without texture, the textured bearings showed a significant reduction in friction coefficient and an increase in load-carrying capacity, with improved lubrication performance. At low speeds, the texture depth had a significant impact; at high speeds, the texture diameter more notably reduced the friction torque in rolling bearings. The rolling bearings with a texture density of 2.748% along the axial direction and 3.583% along the rolling direction on the inner raceway showed the most significant reduction in friction torque(see Figure10).



**Figure 10.** Oil film pressure and thickness of textured bearings[73]

## 4. Conclusion

This paper mainly reviews the generation, development, and manufacturing methods of surface textures, as well as the research history and progress in the field of tribology of rolling bearings. It summarizes and concludes some key research findings and discoveries. Future research on surface-textured rolling bearings should focus on the following aspects:

**Experimental Aspects:** There is a lack of research on complex geometric-shaped textures and high-speed rolling bearings, especially in high-precision bearing-rotor systems and high-speed spindle systems. When the number of textures is large, it becomes a highly challenging task in terms of theory, experiments, and texture manufacturing preparation.

**Theoretical and Experimental Research on Surface Textures of Rolling Bearings:** There is a shortage of theoretical and experimental studies on surface textures of rolling bearings, particularly in high-speed operating systems. Researching the impact of surface textures on system dynamics, and revealing the mechanism and laws of surface textures in suppressing system vibrations, is of significant importance.

**Impact Mechanism of Laser Surface Textures:** The mechanism of laser surface textures on the friction, wear performance, and friction-induced vibration and noise of rolling bearings needs further exploration. This requires increasing experimental load, extending test duration, optimizing texture parameters (such as outer contour, size, base shape, and laser parameters), and applying artificial intelligence algorithms like deep learning and neural networks. These will be important directions for future research.

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