Selected Methods and Applications of Anti-Friction and Anti-Wear Surface Texturing

Slawomir Wos, Waldemar Koszela and Pawel Pawlus • Rzeszow University of Technology

The following is an edited version of the paper. The complete paper is available in the library at www.shotpeener.com.

Abstract: The constant development of environmental protection causes the necessity to increase the efficiency of machines. By increasing the efficiency of machines, energy losses can be limited, leading to lower energy consumption. Friction reduction leads to an increase in efficiency and a decrease in wear. In this paper, selected surface texturing methods, such as burnishing and abrasive jet machining, with their limitations are presented. Thanks to those processes, various surface textures can be obtained. Examples of applications of these methods for friction and wear reduction are shown.

Introduction

Surface texturing, due to the creation of dimples acting as reservoirs of lubricant in the contact zone, leads to an increase in wear resistance and to a change in friction from dry or boundary to mixed or full film lubrication. Dimples manufactured on frictional surfaces can also act as traps for wear debris, reducing wear. With special-shaped oil pockets and a sufficient amount of lubricant, surface texturing can cause the generation of a hydrodynamic lift, leading to a decrease in the coefficient of friction. By the proper selection of texture parameters such as oil pocket shape and depth, oil consumption, and pit-area ratio, a friction reduction effect can be obtained [1–6].

There are many texturing techniques [7]. Laser surface texturing [2,8–10] is the most common method of dimple creation. This technique is precise and allows for the easy creation of dimples. However, surface heating by the laser beam can lead to the creation of a heat-affected zone. In some cases, this disadvantage is unacceptable, especially for coated sliding elements. In most cases, after laser texturing, burrs occur around oil pockets and additional operation is required to remove them. Other techniques, such as burnishing (embossing) [11], mechanical polishing, milling [12], etching [13], abrasive jet machining [14] or a combination of these methods [15], can be used for dimple creation. It is not difficult to create oil pockets of comparatively large dimensions, applied, for example, in the sleeves of slide bearings, contrary to micro-dimples formed on thin-walled or coated elements.

In this work, two methods of dimple creation by burnishing and abrasive jet machining developed by the authors will be presented. In the surface layer after burnishing and abrasive jet machining, compressive residual stresses are created. They have positive effects on wear resistance and fatigue strength. These methods are supplements to laser surface texturing. They can be used for critical elements affecting the safety of construction where laser treatment was not approved. There can be problems with the creation of deep dimples by the burnishing of thin-walled elements, in contrast to abrasive jet machining. The selected tribological applications of these techniques will be given.

Conclusions

1. Burnishing changes the treated surface by plastic deformation. Dimple size and shape are the result of the shape of the tool. The burnishing process is fast. The zone near the dimples is not affected by heat. The positioning of the tool with regard to the treated surface needs high precision. Therefore, special devices for surface texturing by the burnishing process should be developed.

2. Abrasive jet machining is an interesting alternative to laser texturing. The erosion process caused by speeded abrasive particles was used. Abrasive jet machining can be applied for all types of materials. Similar to burnishing, this process is fast and the zone around the oil pockets is not influenced by heat. In addition, burrs around dimples were not created and multiple usages of masks and abrasives are possible. However, precision in the positioning of the masks is needed.

3. Surface texturing by burnishing of the block from bronze caused a decrease in the total linear wear of ring-on-block assembly up to four times. The beneficial effect of surface texturing was related to an increase in running-in time. This effect depends on the oil capacity. Dimples were traps for wear debris, leading to wear reduction.

The dimensions of the dimples should be selected taking the operating conditions into consideration.

4. Disc surface texturing of the steel disc caused a decrease in the coefficient of friction of the pin-on-disc pair in unidirectional sliding up to five times. This beneficial effect was larger for higher speeds and smaller normal load. In addition, surface texturing led to lower variations of the coefficients of friction, especially for high sliding speeds.