Chapter 5
Texturing for Technological Surfaces

ABSTRACT

This chapter explores methods of engineering the elements of the roughness of a tribological surface and the effect of that process on performance. Texture and topography have a crucial influence on the tribological performance of surfaces. The presentation focuses on the dominant technology of laser texturing. The authors review the principles of the texturing process, its effects on friction and wear, and then discuss existing technical difficulties. It is shown that despite being practiced for a long time, and being promising, laser texturing still lacks standardization. To date, there is no agreement on a standardized design methodology that yields optimized textural features that meet the requirements of a prespecified application.

INTRODUCTION

Texture and topography have a crucial influence on the tribological performance of surfaces. The previous chapters detailed the classification and characterization of topography. It was shown that the roughness and texture of the surface, along with their distribution, are directly linked to the surface loadbearing capacity. This has been pointed out by Abbott and Firestone (Abbott and Firestone 1933) in the classic work. Such an influence is to be expected on physical basis since texture is at the forefront of any contact or sliding taking place between two complying solids.

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The connection between roughness distribution and loadbearing, as detailed in chapter 3, formed the basis of the so-called areal performance parameters (i.e. the so-called Sk-family). These parameters are supposed to predict the suitability of the surface for tribological events (including anticipation of weigh-in and lubricant retention). The relation between roughness distribution, and its geometry, to loadbearing and friction performance, however, is more rooted in friction laws as formulated by Amonotons-Coloumb and others (Amontons 1699, Bélidor, 1782, Coulomb, 1801).

When two surfaces are brought into contact under the influence of the normal force, the roughness asperities on both bodies will deform. This deformation is proportional to the portion of the load befalling each of the asperities on each surface. The low share of asperities, in turn, is proportional to the height of the individual roughness features. The longest asperity establishes contact first, shorter ones follow, and the process continues until the normal load is totally supported by the roughness. Accordingly, the true area of contact would be a small fraction of the apparent (nominal) area, and the formation of the asperities will be either elastic, the elasto-plastic, or totally plastic (see chapter 2). At this point, it is instructive to recall the friction laws of Amonotons. The two simple laws imply that control of friction may be attempted through two approaches. The first is to control the normal active load which causes initial compliance contacting monies and maintain their contact. Whereas the second, is to control the real area of contact that develops due to asperity interaction (i.e. to control roughness distribution and geometry). It is seen, therefore, that although the state of roughness of the surface is not a direct factor in these two laws, roughness (distribution and topography) indirectly contributes to the evolution of the friction process. Roughness and texture features additionally are subject to wear. Wear, in turn, changes the distribution of heights of individual features. Change of heights in turn affects friction. In particular it affects the dynamic load bearing and the instantaneous true area of contact. Wear effects are dynamic and require active control.

The evolution of the real area of contact in relation to the geometry and texture contacting couple have been the subject of numerous works in tribology literature. Modern models have the roots in 17th and 18th century literature. Inspired by the sketches of da Vinci, Amontons (Amontons 1699) conducted several friction tests in the course of designing his heat engine “moulin s feu”. The observations of his experiments were formulated into the friction rules described earlier. Amonotons further remarked that the friction force developing between two sliding bodies depends on the complex relationship