Chapter 8
Examples of Implemented Technological Bio-Inspired Surfaces

ABSTRACT

This chapter examines the multi-scale nature of biological materials. It is shown that this characteristic motivated several design attempts within the field of tribological surfaces. These designs were not easy to implement because of a lack of technological means. Until the push for nanoscale material manipulation, many designs, although conceived and conceptually verified, were not technologically possible. The leap in technologies that matured within the past decade resurrected efforts to manufacture many discarded designs on a commercial scale. The material within this chapter presents samples of existing bio-inspired tribological surfaces. The examples are either a direct replica of the bio-analogue or represent a modification of the surface through a combination of chemical and geometrical changes.

INTRODUCTION

Intense probing of surface phenomena has accelerated towards the 1980s. As a result, our current understanding of surface interactions and functional requirements and different applications has improved dramatically. Currently, our level of comprehension of the functional surfaces, and their interactions with their environment, permits accurate determination of technical needs

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in a given application. Such an advanced knowledge has encouraged efforts for customization of surface features i.e. the so-called surfaces-by-design. There are many customization lists for surfaces in optics, energy, informatics, and of course tribology. The list of enabling technologies, have also grown larger, and many techniques that enable manipulation of matter at almost any scale are currently available.

Advances in technical understanding and availability of material manipulation techniques induced rush for miniaturization. Miniaturization, many would argue, is a necessity condition for materializing efficient functionalization of surfaces. That is, implementing the so-called surfaces-by-design doctrine. However, despite the availability of techniques and advanced understanding of nature of surface function, many technical problems still exist. These problems, as detailed in earlier chapters, mainly pertain to developing suitable design paradigms. As mentioned before, also, the major obstacle is conceiving surface design paradigms capable of producing through multi-functional surfaces. That is materializing of the surface construct of which performance is an integral part of its enclosed system, and in the same time caters to the multiple needs of that system. Such a requirement was expressed in chapter 1, in terms of ability of the surface to change, and respond to, the various information with its surroundings. Within the realm of tribology, these requirements add to the level of complexity encountered. The also represent a design constraint. As detailed in chapter 7, a possible remedy for such a situation is to learn from natural surfaces since, by default, natural surfaces specially in biology are multi-functional.

Biology offers a wide spectrum of multi-scale and multi-functional materials. Variation in material scale (from nano to micro to macro) allows for adopting many topographical features and textural topologies. As a result, biological surfaces, despite facing the same physical constraints as man-made surfaces, manifest better performance and efficiency. The multi-scale nature of the building blocks contributes to the high level of endurance, structural integrity, and functional adaptation.

Scouring the multi-scale nature of biological materials ensued many decades ago. Synonymous with the intense work on surface phenomena, parent work on biological materials took place. The emerging picture showed that natural materials, and thereby natural surfaces, are in essence multi-functional and not mono-functional. This multi-functionality, it was found, has its roots in the multi-scale nature of the material building blocks of the surface. Examples of some materials are shown in table 1.

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