

Chapter 4

Surface Engineering Techniques

ABSTRACT

This chapter reviews both the economic and technological landscapes of surface engineering. It is shown that surface engineering aims to modify the properties of surface and subsurface layers of an object to meet a specific performance goal. The focus is on the enormous growth in the field in light of emerging technologies that enable manipulation of matter at virtually any scale. The presentation emphasizes the diversity of the subject and its relation to desired performance of objects in tribological situations. The chapter also defines the traits of an ideal tribological surface and briefly discusses obstacles that hinder materialization of the envisioned ideal surface construct.

INTRODUCTION

Properties of materials may be classified as those pertaining to the bulk and those that result from the characteristics of the surface. As seen in previous chapters the function of modern objects depends, to a great extent, on surface characteristics. Moreover, if those characteristics do not meet functional demands of the object, the structural integrity of the bulk material may be compromised. It is often the case that the ideal surface properties for a particular application are not satisfied by using certain material. To meet functional constraints, deliberate, often calculated, alteration of the properties of the surface has to take place. Alteration is realized through several routes

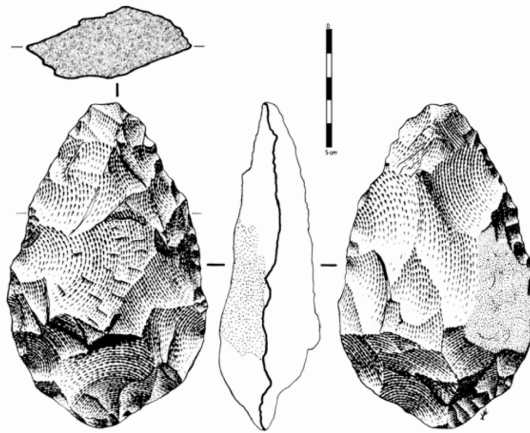
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and may include changing surface topography, heat treating of surface and subsurface layers, alteration of the chemical composition of the surface, altering the microstructure of subsurface layers, etc.

The process of deliberate change, or customization, of surface and subsurface properties is known as “surface engineering”. Such a process stands core of preventing catastrophic failure of engineering components. Although the scientific analysis of such a practice intensified around the early 1980s, the practice of customizing of surface properties has been around since antiquity.

Surface engineering has been practiced since the dawn of age when man learned to make and use tools, figure 1 (Frere, 1800)

Figure 1. A typical Acheulean handaxe; this example is from the Douro valley, Zamora, Spain. The small chips on the edge are from reworking



The fundamental techniques of surface modification comprise adsorption of small or large molecules onto surfaces through incorporation of a layer forming additive in a fluid layer above the surface, deliberate roughening (i.e. engineering of texture), or morphological modification of the surface. It is interesting that these techniques, in principle, have been practiced since antiquity. In ancient Egypt black patinated copper alloy objects has been produced as early as the middle Kingdom Period (2040 to 1782 BC). Production continued until disappearing after the fall of the Roman Empire (Giumlia-Mair. 1996, 2005). Studies on objects from the Egyptian Museum

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