Preface

In recent years, great attention has been focused on surface engineering that deals with methods for achieving the desired surface requirements for engineering components. Surface engineering incorporates, consequently, all the techniques by which a surface modification can be accomplished, including both coating and modification of the surface by different processes.

The surface of any components may be selected on the basis of texture and color, but in the case of engineering components it generally needs other functions because it often works under various conditions and also in aggressive environments. The engineering environments can be generally complex, often combining loading with chemical and physical degradation to the surface of the components. Therefore, aesthetics and functionality are both required for engineering applications and today the goal is to achieve more function at a time, defining the multi-functionality of the surfaces. Mechanical, optical, electrical, photoelectric, magnetic, and tribological properties are modified particularly in the area of thin films, adding some functionality to the surface. In this context, the interfaces can have a great importance.

For all these purposes, the surface engineering includes many facets of material science that help regulate the function, quality, and also safety of products such as automotive, aerospace, biomedical, textile, and electronic materials. Friction, wear, erosion, corrosion, adhesion, surface tension, interface science, surface finishing are just some aspects of interests, commonly investigated. New technologies and methods of characterization are developing to help enhance the surface performance.

Techniques for coating and surface modification strictly depend on the substrate material. In the case of traditional materials, surface engineering techniques include, for example, nitriding, boriding, and carburizing, while the newer ones can be ion implantation, laser beam melting, and coating of different materials mainly by chemical and vapour deposition.

Recently, the growing use of light alloys (aluminium, magnesium, and titanium alloy) in industry, such as aerospace, sport equipment, and biomedical devices, is driving research into surface engineering technologies to improve the corrosion, wear, and tribological properties of these materials. Surface engineering technologies, such as anodising, thermal spraying, physical vapour deposition, plasma-assisted surface treatment, and laser surface modification, are the most relevant for the applications.

New classes of materials, such as superlattices, nanotubes, nanocomposites, smart materials, molecularly doped polymers, and structured materials, can expand and increase the functionality of thin films and coatings used in different applications. New advanced deposition processes and hybrid processes are being used and developed to deposit advanced thin films and structures, obtaining performance not possible in the past.

In this context, the book provides recent developments in surface engineering techniques and applications, addressing mainly mechanisms of microstructure formation, properties, and characterization of surface layers. A wide range of applications is discussed. Greater emphasis is given to unconventional processes that today play a very central role in the manufacturing of many parts with high performance. Laser-additive manufacturing is an example of emerging technology, very useful to obtain very complex parts and surfaces by using different materials.

The book details scientific and technological results of different surface engineering techniques applied to different fields so that academics, practitioners, and professionals in these fields, as well as students studying these areas, can deepen their understanding of new surface processes. The audience can be therefore broad and multidisciplinary.

The book is organized into nine chapters. A short summary about the contents of the chapters is as follows.

Chapter one, written by A. Godi et al. from Denmark, deals with the functional surfaces in mechanical systems. A classification is proposed taking into account how the texture is designed. An overview of the fabrication methods and some practical examples are discussed. Finally, the surface metrology is proposed. This topic becomes fundamental in the design and generation of surfaces for functional purposes.

Chapter two, written by P. Sahoo et al. from India and Portugal, deals with design and selection of chemically deposited nickel coatings for optimum tribological behaviour. Different experimental tests are carried out to evaluate the performance of the coatings. Taguchi-based grey relational analysis is used for the optimization of the multiple response problem.

Chapter three, written by D. Persuad from USA, deals with surface treatment advancements and corrosion control techniques for degradable magnesium alloys. This chapter provides a detailed explanation of the most successful mechanisms used to control the corrosion of magnesium and its alloy and highlights the benefits and challenges for using them.

Chapter four, written by K. Surekha et al. from South Africa, is focused on the recent advances in the solid-state surfaces engineering techniques, including Friction Stir Processing (FSP) and Friction Surfacing (FS). The effectiveness of such techniques in improving the surface properties is discussed.

Chapter five, written by R. M. Mahamood et al. from South Africa, Nigeria, and India, deals with laser metal deposition used for improving the surface integrity of components. The chapter shows the capabilities of this process in production, repair, and improvement of surface properties.

Chapter six, written by M. Totleng et al. from South Africa and India, deals with Laser-Assisted Cold Spraying process (LACS). In the chapter, coatings of composite powders made of titanium and hydroxyapatite deposited on Ti-6Al-4V substrate by LACS technology are discussed.

Chapter seven, written by R. M. Mahamood et al. from South Africa, Nigeria, and India, deals with Laser-Additive Manufacturing (LAM) in surface modification of metals. Some of the LAM techniques are highlighted in this chapter, and a specific example is discussed for the surface modification of titanium alloy.

Chapter eight, written by Boschetto et al. from Italy, deals with surface characterization in fused deposition modelling. In this chapter, prediction models are presented and a new characterization approach is detailed.

Chapter nine, written by H. Kamiya from Japan, deals with surface modification and structure control for nano-and fine-particle aggregation and adhesion behaviour control in liquid phase. Two kinds of approaches for preparing surface-modified nanoparticles are discussed: post-synthesis surface modification and in situ surface modification. That ends the summary of the chapters.

The treated topics are across several fields of study and show different targets. This highlights the complexity of organizing a book on this matter.

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