Preface

Many good books have been written recently on this new field called biomimetics or bionics, but only few explore simultaneously the characterization and technological processes to produce man-made surfaces with similar properties as the biological ones. Bio-inspired surface structures offer significant commercial potential for the creation of antireflective, self-cleaning, and drag reducing surfaces, as well as new types of adhesive systems. This review book explores how the current knowledge of the biological structures occurring on the surface of moth eyes, leaves, shark skin, and the feet of reptiles can be transferred to functional technological materials. It analyses how such surfaces can be described and characterized using microscopic techniques and thus reproduced, encompassing the important areas of current surface replication techniques and the associated acquisition of good master structures.

It is well known that biological systems have the ability to sense, react, regulate, grow, regenerate, and heal. Recent advances in materials chemistry, micro and nanoscale fabrication techniques have enabled biologically inspired material systems that mimic many of these remarkable functions. Nature is the best technologist to overcome any adaptation for survival difficulty. The field of bio-inspiration is emerging as one of the most innovative areas of science today. Researchers and engineers are studying nature and its novel design solutions, using its principles to engineer technical breakthroughs. Self-cleaning surfaces, powerful LEDs, adhesive tape, and even novel computer algorithms are just some of the benefits of this research partnership with the natural world. The advent of bio-inspiration has not only brought nature closer to high technology engineering, but has also brought together scientists of complementary specialties. Bio-inspiration means that not only scientists and engineers must look to nature, but also be experts in other fields. In many aspects of science and technology, collaboration between nature and science is really the key to achieve breakthroughs in technological materials.

The book is divided into three sections, (1) an introduction of the skin functions and four functional properties of biological surfaces; (2) physical, chemical, and

microscopy techniques for describing and characterizing the surfaces, and (3) replication techniques for modifying non-natural surfaces.

The book begins with a chapter that describes certain functions of the skin which contributes to the new area of bio-inspired design. The next four chapter have more specific subjects with its technological applications. Chapter 2 analyzes the shark skin effect or the commonly known antifriction surfaces. Chapter 3 discusses the Lotus effect or the usually known self-cleaning surfaces. Chapter 4 analyzes the Moth-eye effect or the commonly known antireflection surfaces and Chap. 5 describes the Gecko effect or the usually known dry adhesive surfaces.

The second part of the book consists of four chapters. Chapter 6 discusses the principles and techniques used for observing biological surface structures, including optical microscopy (light microscopy, laser scanning confocal microscopy), electron microscopy (scanning electron microscopy, transmission electron microscopy), and scanning probe microscopy. Chapter 7 describes two image analyses techniques (RIMAPS and Variograms) used for topographical characterization in technological surfaces and recently in biological surfaces. Chapter 8 discusses interfacial and capillary phenomena present in multiple biological processes. Chapter 9 describes the chemical characterization of biological and technological surfaces, such as optical, electronic, and particle beams spectroscopies.

The third section has three chapters. Chapter 10 analyzes the Laser Interference Metallurgy which allows the creation of periodic patterns with a well-defined long-range order at the scale of typical microstructures (from the sub micrometer level up to micrometers). Chapter 11 discusses general phenomena involved in electrodeposition process, commonly used techniques and application of electrodeposition in different areas of research and industry. Lastly, Chap. 12 describes the plasma state and its application to modify surfaces in order to obtain a desired functional property in the biomedical field.

We hope that this book will be useful for undergraduate and graduate students from materials science and biology as well as for researchers working in the field of biomimetics, materials science, and engineering.

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