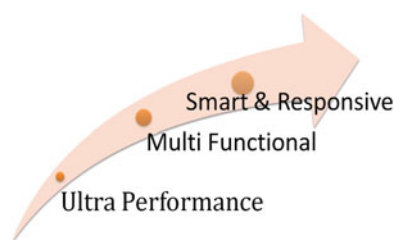


Preface

Bioinspiration, the study of the structure and function of biological systems as models for the design and engineering of materials, becomes increasingly important due to the following facts. The breakthrough of modern sciences and technologies depends to a large extent on the step advances in materials science. The research and engineering of materials have become one of the most exciting areas, across physics, chemistry, biology, and engineering. In addressing the current issues concerning health, environment, and the sustainability of development, new materials become particularly important. In this regard, the three major trends of research in materials science are summarized as follows.

Fig. 1 Three major trends in materials science and engineering



1. *Ultra-performance materials.* The materials refer to those having some extraordinary properties. For instance, the materials entirely or partially appear to be super hard, superhydrophobic, superhydrophilic, superconducting, etc.
2. *Multifunctional materials.* As suggested by the term, the materials correspond to those having more than one major in-use properties/functions.
3. *Smart and responsive materials.* These are the materials which respond to some external stimuli, in the way that some particular properties of the materials change drastically and/or in opposite to conventional materials. Sensing materials are one of the examples. *Under some external simulating*, the color, optical properties, conductivity, etc. of the materials change correspondingly. Artificial

gecko's foot (Chap. 7) is another example where the adhesive force of the surface of the materials will be tuned with the polarity and bias voltage applied.

In this context, we notice that many biomaterials, the materials which occur in organisms, or are formed in a biological environment, fall into one of the three categories. Spider silk is considered as one of the toughest materials in terms of energy and the density. It was estimated that one pencil thick spider silk string can stop a Boeing 747 in flight. Lotus leaves turn out to be one of the common examples of superhydrophobicity, with the capability of self-cleaning. The examples are not exhausted. Therefore, taking lessons from nature becomes one of the major strategies for materials scientists and engineering.

Due to the increasing demands in the modern society and the increase of the global populations, we are now facing some serious sustainable or even survival challenges ahead. These include the impacts of the human activities on the environment and the global climate, the exhaustion of crude oil and other fossil fuels, which turn out to be the raw materials for the most synthetic materials nowadays. To address the increasing concerns about the environmental and climate changes, "sustainable materials" become more and more important. The materials, which will not cause serious environmental impacts in either production or applications and are recyclable, are one of the key focuses in materials science and engineering. Nevertheless, the materials falling into this category, i.e., biomaterials, etc., are of inferior properties compared with the relevant synthetic materials in some aspects. The answer to address the questions is biomimicking or bioinspiration engineering, by which we can burst up some particular functions of these materials.

We notice that methods in bioinspiration and biomimicking have been around for a long time. However, due to current advances in modern physical, biological sciences, and technologies, our understanding of the methods have evolved to a new level. This is due not only to the identification of mysterious and fascinating phenomena but also to the understandings of the correlation between the structural factors and the performance based on the latest theoretical, modeling, and experimental technologies.

This book provides readers with a broad view of the frontiers of research in the area of bioinspiration from the nano- to macroscopic scales, particularly in the areas of biomineralization, antifreeze protein/antifreeze effect. It also covers such methods as the lotus effect and superhydrophobicity, structural colors in animal kingdom and beyond, as well as behavior in ion channels. A number of international experts in related fields have contributed to this book, which offers a comprehensive and synergistic look into challenging issues such as theoretical modeling, advanced surface probing, and fabrication. In order to serve as a tutorial for the new comers to the fields, the chapters are designed to cover the basic knowledge in the related fields. Therefore, the book provides not only a link to the engineering of novel advanced materials playing an important role in advancing technologies in various fields, but also the fundamentals behind the sciences and technologies. It suits for

a broad spectrum of readers, ranging from scientists and engineers to graduate students who are prepared themselves for the new challenges in the fields of materials science.

Xiang Yang Liu