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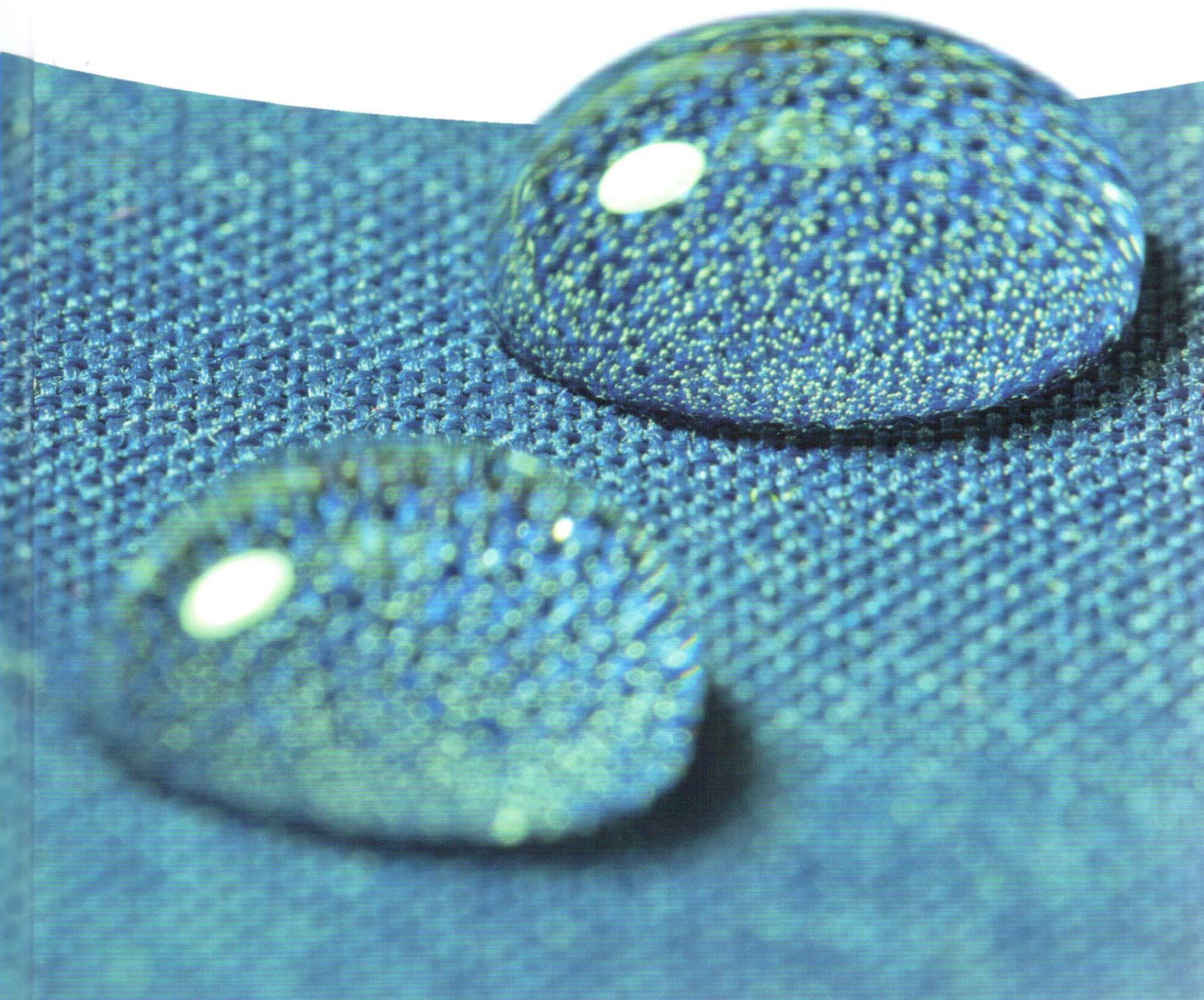

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Preface

The field of surface wettability has had an extraordinary period of development in the last decade due to its potential applications. When a new field appears, its growth is judged by the number of publications, presentations, and patents. In the past decade year, more than 10 000 papers have been published on surface wettability. It is well known that the surface wettability of a solid surface depends mainly on its surface structure and surface composition. Discovering the relationship between surface structure and surface properties is very important for scientists working in the field of surface chemistry.

The idea for this book titled *Surfaces and Interfaces of Biomimetic Superhydrophobic Materials* (*SIBSM*) came about in 2011 when I came back from Belgium to China and constituted my own research group in the Chinese Academy Sciences (CAS). More scientists paid attention to this field when more papers, preprints, talks, and words of mouth became available.

I am pleased to edit this book with Dr Fuchao Yang, who is now a lecturer in Hubei University, China, and who also was my PhD student in CAS during 2013–2016. *SIBSM* contains the recent progress, thoughts, and work of my group and many of the world's foremost scientists who work in the field of biomimetic superhydrophobic materials. We discuss the theory, fundamentals, fabrication, properties, applications, and uses of these very special materials inspired by Nature.

SIBSM contains 10 aspects of the superhydrophobic story, covered in the following chapters: (1) Nature is a huge gallery of art involving nearly perfect structures and forms evolved over the millions of years development. Inspired by Nature, scientists have recently fabricated many biomimetic surfaces through various smart and easy routes. Many plants and animals in nature, showing water-repellent properties with fine microstructures, such as the lotus leaf, the water skipper, and wings of the butterfly, are discussed. Some creatures with typical structures are also referred to, for instance, the rice leaf, desert beetle, rose petals, mosquito eyes, springtail, fish scale, shark skin, snail shell, lower surface of the lotus leaf, and clam's shell. (2) We start the theory from the classical wetting models to the most recent theoretical advances of superhydrophobic surfaces (SHPSs) with regard to the wetting process, and some promising breakthroughs in the advancement of the theory are proposed. (3) Further study on the relationship between structures and properties will be conducive to better transferring the micro- and nanostructures to engineering materials so as to obtain the desired superhydrophobic performances and a wide range of applications. The methods

to fabricate SHPSs with micro- and nanostructures are varied and generally divided into two. One comprise top-down methods including etching, lithography, anodization, and laser processing. And the other is bottom-up methods containing electrodeposition, hydrothermal method, sol-gel process and electrospinning.. (4) Oil spills and industrial organic pollutants have induced severe water pollution, and special wettability materials have been developed over the past decade to separate oil/water mixtures. On this topic, we mainly focus on the development of materials with either superhydrophobic or superhydrophilic properties in oil/water separation applications. (5) The purification of oily water, especially oil/water emulsions, is one of the important topics of environmental protection. Traditional filter membranes, to some extent, are useful for the separation of oil/water mixtures, but they have many limitations and there is no effective way to achieve emulsified oil/water separation. Superwetting materials, based on bionics, have opened a brand-new door to membrane separation techniques. (6) The adhesion behavior of SHPSs has become an emerging topic to researchers in various fields as a vital step in understanding the interaction between materials and organisms. Controlling the chemical compositions and topological structures via various methods or technologies is essential to fabricate and modulate different adhesion properties, such as low adhesion, high adhesion, and anisotropic adhesion on SHPSs. We summarize the recent developments in both natural and artificial SHPSs with various adhesive properties and pay attention to SHPSs switching between low and high adhesion. (7) Superhydrophobic nanocoatings, a combination of nanotechnology and SHPSs, have received extraordinary attention recently, focusing both on novel preparation strategies and investigations of their unique properties. In this part we summarize the contributions to this field reported in recent literature, mainly including materials, fabrication, and applications. (8 and 9) Recently, particular attention has been paid to smart surfaces that can show switchable and reversible water wettability under external stimuli such as pH, temperature, light, solvents, and electric field. In this section, several kinds of smart SHPSs (pH-responsive wettable surfaces, photo-induced self-cleaning surfaces, solvent-responsive wettable surfaces, and magnetically controllable behavior of superhydrophobic microspheres) based on our and other groups' published works are systematically summarized. (10) We primarily investigate the ice and frost formation mechanism for the rational design of anti-icing/anti-frosting surfaces. Significantly, the complex dynamics and thermodynamics of water droplets on the SHPSs under various freezing conditions that might be encountered in natural atmosphere (e.g., raindrops, condensation frosting) are comprehensively discussed. Critically, we explain why SHPSs play a fairly limited role in reducing ice adhesion strength. Furthermore, a family of novel superwetting materials termed icephobic surfaces (IPSs) for effortless ice detachment is introduced. Finally, future challenges and possible breakthroughs in this field are pointed out. It is believed that under the unremitting efforts of scientists, the second generation of anti-icing/de-icing techniques based on superwetting interfaces will be put to practical applications in the near future.

The book is aimed at the following readers:

- Advanced students and instructors in the fields of science and engineering.

- Professional scientists and engineers, who may be trained in more traditional disciplines but who need to learn about this emerging area.
- Policymakers and management experts looking for an understanding of the scientific challenges, prospective uses, and emerging markets for surface wettability.

The overall goal is to capture the multidisciplinary and multifunctional flavor of surfaces and interfaces of biomimetic SHPSs while providing in-depth discussions on select areas.

Importantly, I should show my appreciation to the contributors for their effort and dedication in preparing the chapters, to Hubei University, and to my PhD students, Mr Liwei Chen, Mr Yifan Si, Mr Gang Wen, Mr Lieshuang Zhong, Mr Pan Tian, Mr Zelinlan Wang, and Miss Xiaoyu Gao, for their continuous assistance and hard work in drawing the figures and putting the chapters together. I also thank Mr Hai Zhu and Miss Ting Jiang for correcting the proof. I also thank Dr Lifen Yang of Wiley, who gave me the idea of starting a book in the beginning this year, and her publication team for their continuous help and support. Finally, I am indebted to my wife, Yan Xin, and my two daughters, Zhehan and Zheyuan, for their kind and endless enthusiasm and support.

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Prof. Zhiguang Guo

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A comprehensive and systematic treatment that focuses on surfaces and interfaces phenomena inhabited in biomimetic superhydrophobic materials, offering new fundamentals and novel insights.

As such, this new book covers the natural surfaces, fundamentals, fabrication methods and exciting applications of superhydrophobic materials, with particular attention paid to the smart surfaces that can show switchable and reversible water wettability under external stimuli, such as pH, temperature, light, solvents, and electric fields. It also includes recent theoretical advances of superhydrophobic surfaces with regard to the wetting process, and some promising breakthroughs to promote this theory.

As a result, materials scientists, physicists, physical chemists, chemical engineers, and biochemists will benefit greatly from a deeper understanding of this topic.

*Professor **Zhiguang Guo** received his PhD degree from Lanzhou Institute of Chemical Physics (LICP), Chinese Academy of Sciences (CAS) in 2007. After that, he joined Hubei University. From October 2007 to August 2008, he worked in University of Namur (FUNDP), Belgium, as a post-doctoral research fellow. From September 2008 to March 2011, he worked in the Funds of National Research Science (FNRS), Belgium, as a 'Charge de Researcher'. During February 2009 to February 2010, he worked in the Department of Physics, University of Oxford, UK, as a visiting scholar. Currently, he is a full Professor in LICP financed by the 'One Hundred Talented People' program of CAS and the 'Excellent Youth Foundation' of National Natural Science Foundation of China (NSFC). In 2014, he obtained the award of SHIZHU WEN in Tribology, and in 2015 he obtained the National Natural Science Prize of China (Second Class) and in 2016, he obtained the 'Outstanding Youth Award' of International Society of Bionic Engineering. Now, he is an associate editor of RSC Adv, and the editorial broad member of Journal of Bionic Engineering and Chemistry Letters. To date, he has published more than 140 papers focusing on the surfaces and interfaces of superhydrophobic materials with more than 3000 times citations and H index 31.*

*Dr **Fuchao Yang** received his Master degree from College of Physics and Electronic Engineering at Northwest Normal University in 2013. Since then he joined Prof. Zhiguang Guo's group at LICP to pursue his PhD degree. From July 2016, he is a lecture in Hubei University after graduated from LICP in phD, China. His research interest is focused on the wetting behavior of superhydrophobic surfaces and fabricating surfaces with micro- and nano-structures applied for functional nanomaterials.*

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