Preface

Water pollution and water scarcity are among the most severe grand environmental challenges facing mankind nowadays. With rapid population growth, steadily improving living standards, fast industrialization and modernization of the developing countries, these challenges will persist, if not worsen, in the years to come. Conventional water treatment technologies, including adsorption, chemical treatment, membrane-based filtration, biological treatment, *etc.*, with no doubt have made critical contributions in sustaining human society in the past century. However, the ever-increasing demand for safe and clean water by the ever-growing human population has gradually pushed these conventional technologies to their limits over the past 100 years or so. Therefore, it is now a popular perception that the solutions to existing and future environmental problems highly hinge on further developments in materials science.

The concept of smart materials, since its inception in 1990s, has extended its presence in a variety of applications and has led to development of many new technologies. Smart materials are conventionally defined as materials that are designed to have one or more properties which can be significantly changed in a controlled fashion in response to external stimuli, such as stress, temperature, moisture, pH, electric fields or magnetic fields. Piezoelectric materials and shape-memory materials were the early types of smart materials. However, in essence, the response mechanism of all smart materials lies in the change in molecular movement in response to external stimuli, which then brings about the macroscopic property change of the materials. Following this line of thought, the origin of all smart materials is biomimicry as nature is the ultimate builder of machines. Thus, smart materials can also be generically defined as materials which are astute or "operating as if by intelligence", and the term "smart materials" can thus be used broadly

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to refer to materials that are designed and fabricated from bioinspirations, mimicking nature's procedures, structures or strategies.

The concept of smartness in materials design involves thinking outside the box and integrates multiple synergistic and advanced functions into one single material or device, which helps create new applications, broaden existing applications, enhance performances, and elongate the lifetime of the materials. Therefore, the development of smart materials represents the future of materials design and fabrication. It is not a surprise that smart materials have also set foot in the environmental field, and have shown great promise in coming up with novel and next-generation solutions to the large environmental challenges. In return, the interaction between environmental science and materials science has also promoted the development of new smart materials, and a series of novel smart materials and their application in environmental areas have been put forward and explored.

However, this book is not intended to be exhaustive about all areas of smart material applications to advanced environmental problem solving. Rather, it focuses on some selected topics, especially bioinspired smart interfacial materials, which I believe are novel and inspirational to conventional thinking. As you will see, the topics of the book chapters are truly multidisciplinary. They span from an introduction to smart materials and their applications (Chapter 1, Zhang and Professor Wang), smart draw solutions in forward osmosis (Chapter 2, Chen and Professor Lu), superwetting materials for oil–water separation (Chapter 3, Gao and Professor Jin), responsive particle-stabilized emulsions (Chapter 4, Kwok and Professor Ngai), self-healing materials (Chapter 5, Professor Zeng *et al.*), bioinspired fog collection (Chapter 6, Zhang and Professor Wang), nature-inspired "slippery" liquid-infused surfaces (Chapter 7, Professor Zacharia) to challenges and opportunities of superhydrophobic/superamphiphobic coatings in real applications (Chapter 8, Paven, Mammen and Professor Vollmer). The contributors are all established researchers who are in their early or mid career. In my opinion, they are the ones to watch in the years to come in this emerging field of smart materials and their applications to environmental problem solving.

I hope this book will provide an inspiration for readers who are interested in smart materials and who are passionate at further exploring smart materials to make contributions to the solutions to our grand environmental challenges.

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