



Editor: **Walid A. Daoud**

Self-Cleaning
**MATERIALS
AND SURFACES**

A Nanotechnology Approach

WILEY

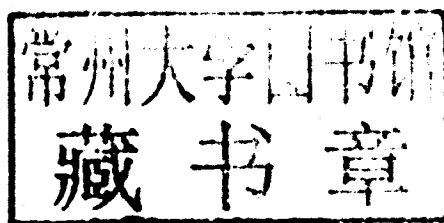
Self-Cleaning Materials and Surfaces

A Nanotechnology Approach

Edited by

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Hong Kong*



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Self-Cleaning Materials and Surfaces

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Preface

With increasing demand for hygienic, self-disinfecting, and contamination-free surfaces, interest in developing efficient self-cleaning, protective surfaces and materials has grown. Due to rising population density, the spreading of antibiotic-resistant pathogens remains a growing global concern. The ability of microorganisms to survive on environmental surfaces makes infection transmission a critical issue, and studies have shown that some infectious bacteria can survive on the surface of various polymeric and textile materials for more than 90 days. Self-cleaning surfaces not only provide protection against infectious diseases but also against odor, staining, deterioration and allergies. Advances in nanotechnologies could make dirt-free (or no-wash) surfaces a reality. This would improve the environment through reduced use of water, energy and petroleum-derived detergents.

Having been an active researcher in self-cleaning nanotechnology since 2002, witnessing a rapidly growing interest in the field of self-cleaning coatings, surfaces and materials from the media, industry, and academia, I felt a compelling need for a book that describes the recent developments and provides a timely account of this topic.

Following an invitation from Wiley, I have approached fellow researchers from across the globe, renowned experts in the field, to contribute to this book with their fascinating achievements covering all areas from the basic and fundamental knowledge of the concepts, potential applications, and recent and future development of self-cleaning nanotechnologies, to their potential hazards and environmental impact.

The book is divided into four parts, starting with the general concepts of self-cleaning mechanisms covering both hydrophobic and hydrophilic surfaces. This is followed by specific applications of self-cleaning surfaces and coatings, such as cementitious materials, glasses, clay roof tiles, textiles and plastics. The third part describes recent achievements in self-cleaning surfaces, using advanced materials and technologies, such as liquid flame spray, pulsed laser deposition, and layer-by-layer assembly. In the last part, the potential hazards, environmental impact, and limitations of self-cleaning surfaces are discussed toward further development.

Many aspects of this book can be used for general public education, further research and development, as well as in the curriculum development of courses in the areas of materials science and engineering, nanotechnology, and textile finishing.

I would like to take this opportunity to express my sincere gratitude to all the authors, my PhD student, Dr Wing Sze Tung, and my research assistant, Ms Stephanie Kung. Special thanks are also due to Wiley editorial staff, Ms Emma Strickland, Ms Sarah Tilley, and the editing team.

Walid A. Daoud

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Part I

Concepts of Self-Cleaning Surfaces

1

Superhydrophobicity and Self-Cleaning

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One of the ways that surfaces can be self-cleaning is by repelling water so effectively that water-borne contaminants cannot attach – by being superhydrophobic. This is demonstrated particularly well by the Indian Lotus, *Nelumbo nucifera*, which has leaves that remain clean in muddy water. The leaves can be cleaned of most things by drops of water, an effect that has been patented and used in technical systems [1].

1.1 Superhydrophobicity

1.1.1 Introducing Superhydrophobicity

Superhydrophobicity is where a surface repels water more effectively than any flat surface, including one of PTFE (Teflon®). This is possible if the surface of a hydrophobic solid is roughened; the liquid/solid interfacial area is increased and the surface energy cost increases. If the roughness is made very large, water drops bounce off the surface and it can become self-cleaning when it is periodically wetted. To understand more about this type of self-cleaning it is necessary to consider how normal surfaces become wetted and become dirty. The effect has been a focus of much recent research and has been reviewed recently [2–7]. A good mathematical explanation can be found in a recent book chapter by Extrand [8].