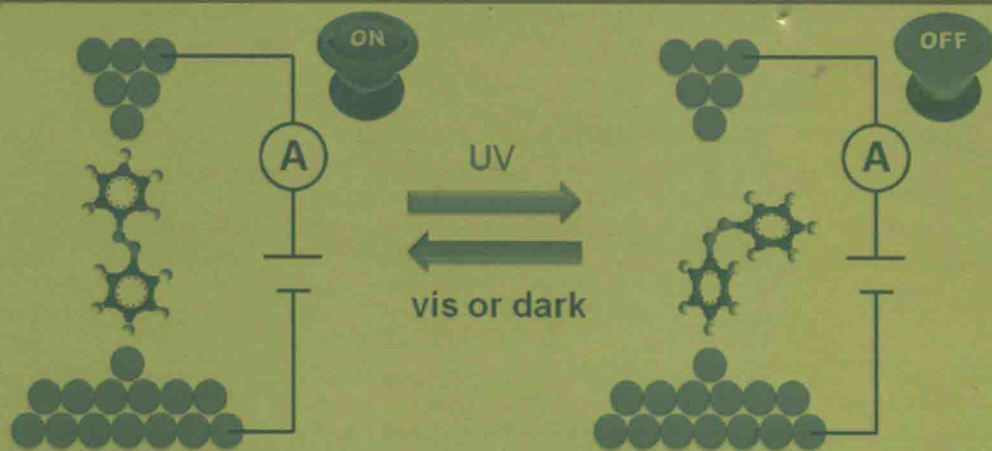


Advance Materials Series

# RESPONSIVE MATERIALS AND METHODS

State-of-the-Art Stimuli-Responsive  
Materials and their Applications



*Edited By*

**Ashutosh Tiwari and Hisatoshi Kobayashi**

# Responsive Materials and Methods

State-of-the-Art Stimuli-  
Responsive Materials and  
Their Applications

Edited by

Ashutosh Tiwari and Hisatoshi Kobayashi



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# Responsive Materials and Methods

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### **Advance Materials Series**

The Advance Materials Series is intended to provide recent advancements of the fascinating field of advanced materials science and technology, particularly in the area of structure, synthesis and processing, characterization, advanced-state properties, and applications. The volumes will cover theoretical and experimental approaches of molecular device materials, biomimetic materials, hybrid-type composite materials, functionalized polymers, super-molecular systems, information- and energy-transfer materials, biobased and biodegradable or environmental friendly materials. Each volume will be devoted to one broad subject and the multi-disciplinary aspects will be drawn out in full.

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## Preface

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The development of tuned materials by environmental requirements is the recent arena of materials research. It is a newly emerging, supra-disciplinary field with great commercial potential. Stimuli-responsive materials answer by a considerable change in their properties to small changes in their environment. They are becoming increasingly more prevalent as scientists learn about the chemistry and triggers that induce conformational changes in material structures and devise ways to take advantage of and control them. New responsive materials are being chemically formulated that sense specific environmental changes and adjust in a predictable manner, making them useful tools.

Stimuli-responsive materials are in widespread demand among researchers because they can be customized via chemistry to trigger induced conformational changes in structures or be taken advantage of in the form of structural or molecular regime via minute external environmental changes. Their effectors are both i) physical, i.e., temperature, electric or magnetic fields, mechanical stress; and ii) chemical, i.e., pH, ionic factors, chemical agents, biological agents. Thermoresponsive polymers represent an important class of "smart" materials as they are capable of responding dramatically to small temperature changes. The chapter on "Smart Thermoresponsive Biomaterials" describes a range of thermoresponsive polymers and the criteria that influence their thermoresponsive character for surface modifications and applications, in particular for cell culture and chromatography. In the chapter "Light-Triggered Azobenzenes: From Molecular Architecture to Functional Materials," the principle of light-triggered materials is covered, for example, azobenzene-based materials, their photochromic switching and oscillation ability, and potential biological and artificial muscle-like actuation applications. The chapter entitled "Functionalization with Interpenetrating Smart Polymer Networks by Gamma Irradiation for Loading and Delivery of Drugs," discusses the  $\gamma$ -irradiation

assisted graft copolymerization containing interpenetrating polymer networks and other architectures, mainly focusing on the performance of materials modified with stimuli-responsive components capable of high loading therapeutic substances and their control release properties. The recently investigated applications of smart or intelligent polymeric materials for tissue engineering, regenerative medicine, implants, stents, and medical devices are overviewed in "Biomedical Devices Based on Smart Polymers." The chapter "Stimuli Responsive Polymers as Adjuvants and Carriers for Antigen Delivery," illustrates the promising advantages of responsive materials in immunology as carriers for an antigen and adjuvant for enhancing immunogenicity of an antigen. "Cyclodextrins and Advanced Materials for Pharmaceutical Applications" highlights the combination of cyclodextrins and pharmaceutical excipients or carriers such as nanoparticles, liposomes, etc., and fosters the progress of the advanced dosage forms with the improved physicochemical and biopharmaceutical properties.

"Recent Advances in Smart Wearable Systems," presents an overview of the smart nanoengineering that yields state-of-the-art wearable systems and sensor technologies, and underlying challenges are overviewed. The high surface functionalities available in such materials provide an opportunity to modify their outer surfaces and achieve multivalent effects. The chapter on "Functionalization of Smart Nanomaterials" describes the surface nanoengineering aimed at coupling advanced features for a range of optoelectronic applications. A thrust towards the development of novel nanoparticles has paved the way for successful cancer diagnosis and treatment. The chapter "Role of Smart Nanostructured Materials in Cancers," summarizes different types of nanoparticles currently available for cancer therapy. Smart nanomaterials including visible quantum cutting and near-infrared quantum cutting phosphors such as fluoride phosphors, oxide phosphors, phosphate phosphors and silicate phosphors, and their potential application for PDPs and Hg-free fluorescent lamps, are the focus of "Quantum Cutter and Sensitizer-Based Advanced Materials for Their Application in Displays, Fluorescent Lamps and Solar Cells." The chapter on "Nanofibers of Conducting Polymer Nanocomposites" focuses on the preparative strategies of nanofibers of conducting polymers and nanocomposites and their electrical conductive properties and applications.

The biocompatible smart polymeric architect has significantly increased attention in biodevice and system managements.

"Stimuli-Responsive Redox Biopolymers" investigates arabic-co-polyaniline as pH-responsive redox copolymers and their properties for biosensor applications. The development of the metallocene catalysts, from their discovery to their present state-of-the-art, is portrayed in "Commodity Thermoplastics with Bespoke Properties Using Metallocene Catalyst Systems," with an emphasis on weighing up discrete catalysts for stereo-specific polymerization and technologically important processes.

The study of elastic properties provides information about the magnitude of the forces and nature of bonding between the atoms. The impact of solids on the world of science and technology has been enormous, covering such diverse applications as solar energy, image processing, energy storage, computer and telecommunication technology, thermoelectric energy conversion, and new materials for numerous applications. The chapter "Elastic Constants, Structural Parameters and Elastic Perspectives of Thorium Monochalcogenides in Temperature Sensitive Region" predicts the anharmonic elastic properties of thorium chalcogenides having NaCl-type structure under high temperature using Born-Mayer repulsive potentials and the long- and short-range interaction approach.

This book is written for a large readership including university students and researchers from diverse backgrounds such as chemistry, materials science, physics, pharmacy, medical science, and biomedical engineering. It can be used not only as a textbook for both undergraduate and graduate students, but also as a review and reference book for researchers in the materials science, bioengineering, medical, pharmaceutical, biotechnology, and nanotechnology fields. We hope the chapters of this book will provide valuable insight in the important area of responsive materials and cutting-edge technologies.

Editors

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August 15, 2013





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