Nanomaterials for the Life Sciences

Edited by Challa Kumar

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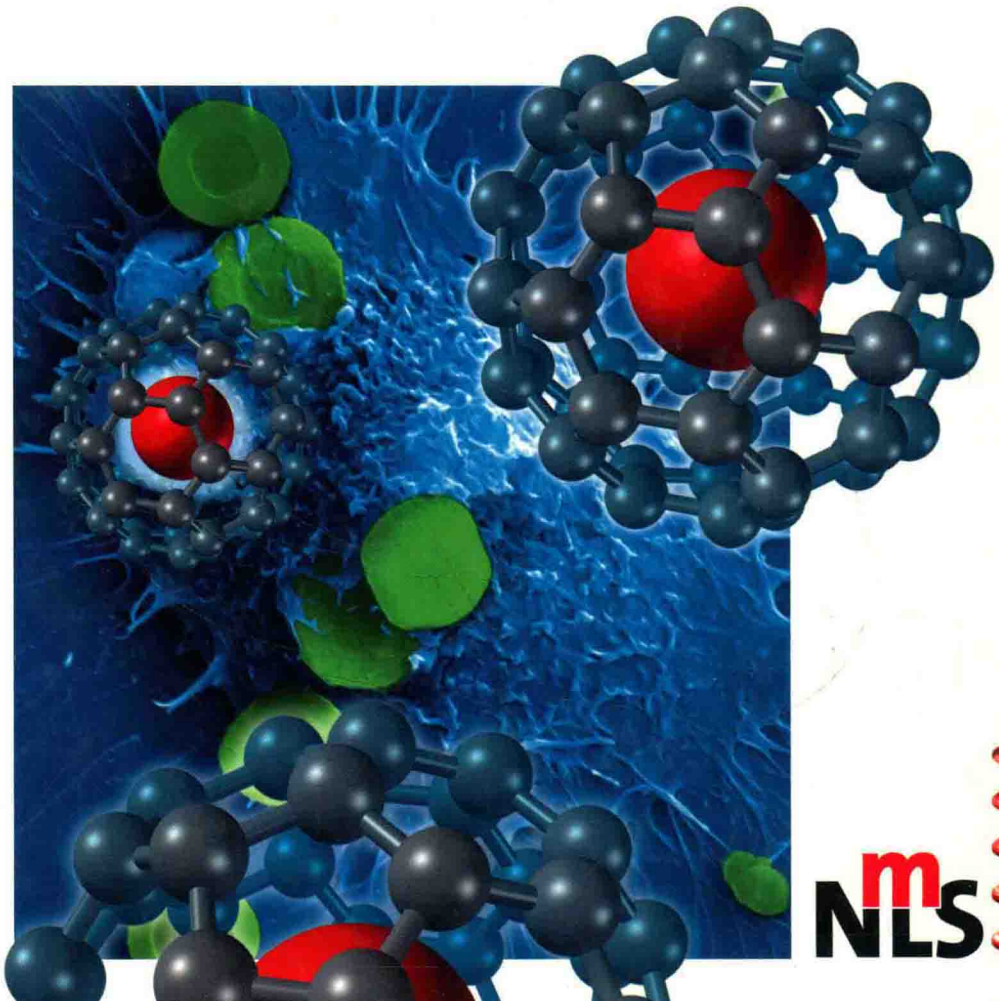
Polymeric Nanomaterials



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Volume 10

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Preface

What an extraordinary ending to a twenty volume combined series on nanotechnologies and nanomaterials for the life sciences? When the first ten volumes of the NtLS series (Nanotechnologies for the life sciences) were completed in 2007, we assumed that we have covered every aspect of nanotechnologies with respect to their applications in life sciences. When we began work on the second series, Nanomaterials for the life sciences (NmLS), little did we realize that synergic research investigations between nanomaterials and nanotechnologies and life sciences will outpace our ability to capture all the highlights in NmLS series. As I present the final volume in this series, I am overwhelmed with the amount of information that we have been able to capture and I have no doubt that we have created truly a sub discipline within the field of nanotechnologies and nanomaterials-Applications for Life Sciences. This is a long and successful journey made possible only through extraordinary efforts from close to 700 authors from around the globe. I am humbled by their high quality and timely contributions in addition to keeping in tune with the vision for all the twenty volumes. I have had great pleasure in working with the team from Wiley-VCH and in my view one the top rated publishers. Thank you Wiley-VCH!

In this volume, I introduce you to the applications of organic nanomaterials in life sciences. For the sake of clarity, the book is divided into three different sections. The first section provides an in-depth analysis of nanostructured gels, interfaces, carriers and polymerosomes created using organic molecules. While the second section focuses on more traditional organic nanoparticles including polymeric nanoparticles, the final section introduces readers to more sophisticated nanoscaffolds, nanotubes and nanowires.

The very first chapter provides a platform for addressing one of the grand challenges in materials science- to design "smart" synthetic systems with the ability for self-repair. In this chapter, authors demonstrate an important role the computational modeling plays in designing self-healing materials and coatings taking nanoscopic gel particles as an example. Continuing the focus on nanogels, but from an experimental point of view, the next chapter summarizes synthetic approaches to nanogels followed by the tools utilized in their charactreization. Highlighting the importance of nano interfaces in desiging „smart" materials, the

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third chapter reviews key types of organic nano interfaces that have the ability to repsond to external stimuli. In addition, the chapter provides excellent examples for their application in drug delivery, microfluidics, molecular separation and tissue culture. There is a renewed interest in peptide-based nanostructures and the ability to manipulate their assembly for a number of applications ranging from materials science and bio-nanotechnology to biomedicine and biotechnology. In tune with this, the fourth chapter contains the most recent review on "soft" methods targeted for positioning of self-assembled peptide nanowires and nanotubes. The fifth chapter in this section introduces to the reader the most recent developments in the field of polymeric, multifunctional pharmaceutical nanocarriers. The chapter provides a window to a broad selection of multifunctional systems with combined features ranging from longevity, targetability, stimuli-sensitivity, cell-penetrating ability and contrast properties. In the final chapter, readers learn about polymerosomes, a realtively new class of organic nanostructures that form amphiphilic membranes, bio mimetic analogues of natural phospholipid vesicles, obtained based on block copolymers. In this chapter, one can find not only the chemistry but also the physics and structure-dependent biomedical applications of polymerosomes.

In the second section of the book, a variety of organic nanoparticles made from organic polymers, solid-lipid polymers, core-shell type polymers are covered. It also includes a number of synthetic approaches, characterization methods and applications in biomedicine ranging from medical imaging to drug delivery. The first four chapters in this section bring out the most important tools for their synthesis including the micro fluidic technologies. The fourth chapter in the section (Chapter 11 in the book) is unique due to its focus on bringing out salient features in interactions between different polymeric materials with cells. Lessons from this chapter are the key to their application in biology and medicine. Two specific applications of organic nanoparticles have been included in the last two chapters. The first one is related to the development of radiopaque polymeric particles as contrast agents for x-ray imaging and the second one is on solid lipid nanoparticles (SLN) for brain drug delivery. Overall, this section is central to the theme o f the book.

The final section in the book deals with relatively newer concepts in organic nanomaterials with repsect to their applications in life sciences. For example, chapter 14 refelcts on the most recent strategies for synthesis and modification of polymeric nanofibers and opportunities to enhance their biological functionality especially as scaffolds in tissue engineering. Continuing to reiterate the importance of non-spherical organic nanomaterials, the next chapter surveys recent methods for controlled synthesis of organic nanorods, nanotubes, nanowires with the main focus being on the use of hard templates for the fabrication of organic nanostructures with well-defined shapes and dimensions.

Of the different types of organic nanomaterials conducting organic nanomaterials, which are polymers with spatially extended π-bonding systems due to alternating single and double carbon-carbon bonds, are important as sensing devices. Prominent among the conducting nanopoymeric materials are conducting poly-

meric nanowires. The chapters 16 and 17 reviews conducting polymer nanowires and nanotubes, which are expected to have increased sensitivities compared to the bulk materials due to their small size, high aspect ratios high surface-to-volume ratios and unusual target binding properties. From the combination of these two chapters, one would learn about all aspects related to various fabrication technologies including self-assembly, template synthesis, and their application in biomedical areas including biosensors, cancer-therapy via photo-thermal and/or radio-frequency ablation, and optical bio imaging. The final chapter brings out the latest information on peptide-based bio-friendly nanotubes including novel rosette nanotubes for drug delivery with special reference to receptor-mediated delivery.

With the publication of this book, the combined twenty volume book series on nanotechnologies/nanomaterials has come to an end. We have made attempts to put together 271 chapters contributed by close to 700 experts and encompassed most of the information related to nanotechnologies and nanomaterials with reference to life sciences. I am aware that knowldge base, new ideas and new perspectives we created will continue to grow at speeds difficult to keep up with. I would like to end this preface with exact words that I used when I concluded the NtLS series. *On behalf of all the authors who have made contributions to this exciting series, it is my privilege to play the role of a catalyst in inculcating new thinking by providing a multi pronged base of knowledge in nanotechnologies/nanomaterials for life sciences. It is my hope that this book series will help in stretching the limits of thinking in all those who come in contact with it.*

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