

Nanocolloids

**A Meeting Point for
Scientists and Technologists**

Edited by Margarita Sánchez-Domínguez and Carlos Rodríguez-Abreu

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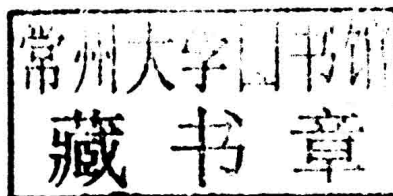
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To Prof. Conxita Solans on the occasion of her 68th birthday

In the memory of Nuria Azemar Sazatornil

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Preface

Over the last 30 years, there has been an increasing growth in valuable research dedicated to nanoscience and nanotechnology on one hand. The study of colloids, on the other hand, has a strong tradition dating back to centuries ago, and it continues to be of interest for both scientific and technological development. It has been recognized that colloid science provides a strong foundation for the advancement of nanotechnology and nanoscience. The area at which nanotechnology and colloid science overlap is the field of nanocolloids, which includes all kinds of hard colloids, such as inorganic nanoparticles, as well as soft colloids, such as nanoemulsions.

The aim of this book is to offer a multidisciplinary overview on several aspects of nanocolloids in a way that is attractive for both scientists and technologists. The book has been organized into 13 chapters.

Chapter 1 introduces basic concepts on nanocolloids. The dynamic behavior of nanocolloids is discussed, and the different types of interactions involved are described; equations to estimate the interaction potentials are presented. The most used parameters and methods to characterize colloidal stability are summarized.

Chapter 2 presents an overview on nanocolloidal noble metals. The main optical properties of these nanomaterials are described, and modeling of those properties is explained. Synthesis and preparation methods to obtain controlled morphology, shape, and surface functionalization are summarized. Finally, the main applications of nanocolloidal noble metals are discussed.

Chapter 3 is dedicated to magnetic nanocolloids. The principles of size-dependent nanoscale magnetism (nanomagnetism) are first explained. Synthesis and preparation protocols of magnetic nanocolloids with controlled morphology and shape by chemical methods are reviewed. Diverse applications of magnetic nanocolloids are presented.

Chapter 4 introduces the main properties of colloidal quantum dots. Wet chemistry-based synthesis methods are discussed. Applications of these systems in biomedicine and other technological fields are reviewed.

Chapter 5 deals with silica and titania nanocolloids. Preparation methods are reviewed with special attention to sol-gel chemistry and processing. The properties of silica and titania nanocolloids and their relationship with several applications are addressed.

Chapter 6 provides an overview about the synthesis of nanocatalysts from surfactant-assisted preparation methods and their potential applications in the energy and chemical production industries. Preparation methods include the synthesis of nanoparticles in microemulsions, as well as the use of templates for the preparation of metal oxides with structured pores. Furthermore, strategies for the optimum deposition of catalysts onto supports are also discussed.

Chapter 7 examines the chemical and physical methods to achieve dispersion of carbon nanomaterials. Different approaches such as mechanical dispersion as well as surface modification are presented. In addition, the role of X-Ray Photoelectron Spectroscopy (XPS) technique for understanding the relationship between structure-property-functionality of the modified carbon nanostructures is discussed.

Chapter 8 is focused on carbon polymer nanocomposites. Methods of preparation including different types of polymers and carbon nanostructures, surface and interface analysis on carbon nanocomposites, and examples of the most promising industrial applications are discussed.

Chapter 9 gives an introduction to scattering methods based on light, X-rays and neutrons, and their application for noninvasive characterization of nanocolloids. The chapter is focused on Dynamic and Static Light scattering, Small-Angle X-ray Scattering and Small-Angle Neutron Scattering.

Chapter 10 gives an overview about polymerization using nanocolloids as reaction media. The most important advances concerning polymerization in O/W, W/O and bicontinuous microemulsions are discussed. Different approaches resulting in well-stabilized polymeric nanoparticles, high polymer content, as well as the use of water as continuous phase are presented, demonstrating an important advancement towards cost-effective industrial processes.

Chapter 11 is dedicated to nano-emulsions as a class of soft nanocolloids. Nano-emulsion preparation is discussed, with emphasis in low-energy methods. Nano-emulsion properties and the methods to characterize them are described. Finally, relevant applications of nano-emulsions in the pharmaceutical field are reviewed.

Chapter 12 reviews recent progress in smart and stimuli-responsive colloids. Colloidal control and manipulation over interfacial and bulk properties may be achieved predictably and selectively using these systems. Common triggers such as pH, temperature and electrolyte concentration, as well as more sophisticated stimuli, such as magnetic and electric fields,

light, CO₂, sonication and enzymes are discussed. A particular emphasis on future directions and applications is also given.

Last but not least, chapter 13 deals with one of the biggest challenges to the commercialization of nanoproducts, which is related to the development of safety testing guidelines for evaluating their toxicity, aiming at standardizing the process. Thus, the last chapter brings a discussion on the potential toxic effects of nanocolloids, as well as on the actual state and perspectives regarding regulatory procedures.

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