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# Advances in Polymer Science



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The series Advances in Polymer Science presents critical reviews of the present and future trends in polymer and biopolymer science. It covers all areas of research in polymer and biopolymer science including chemistry, physical chemistry, physics, material science.

The thematic volumes are addressed to scientists, whether at universities or in industry, who wish to keep abreast of the important advances in the covered topics.

Advances in Polymer Science enjoys a longstanding tradition and good reputation in its community. Each volume is dedicated to a current topic, and each review critically surveys one aspect of that topic, to place it within the context of the volume. The volumes typically summarize the significant developments of the last 5 to 10 years and discuss them critically, presenting selected examples, explaining and illustrating the important principles, and bringing together many important references of primary literature. On that basis, future research directions in the area can be discussed. Advances in Polymer Science volumes thus are important references for every polymer scientist, as well as for other scientists interested in polymer science - as an introduction to a neighboring field, or as a compilation of detailed information for the specialist.

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Readership: Polymer scientists, or scientists in related fields interested in polymer and biopolymer science, at universities or in industry, graduate students.

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Oguz Okay
Editor

# Polymeric Cryogels

## Macroporous Gels with Remarkable Properties

With contributions by

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# Preface

Cryogelation is a simple strategy that allows the preparation of macroporous gels, so-called cryogels, of high toughness and superfast responsivity. The term "cryogel" was mentioned in the literature for the first time in 1984 by Vladimir I. Lozinsky to designate polymeric gels formed in frozen media. Cryogels have attracted intense attention in the last 10 years due to their extraordinary properties, which have resulted in numerous biotechnological and biomedical applications. The present volume entitled *Polymeric Cryogels: Macroporous Gels with Remarkable Properties* is intended to review the principles of cryotropic gelation processes as well as the advances made during the past two decades in the preparation and application of cryogels based on both synthetic and natural polymers. It is my great pleasure to have Vladimir I. Lozinsky as one of the authors of this volume. I very much enjoyed discussing many aspects of cryogels and some secrets of cryogelation processes with him, both in Istanbul and at cryogenic temperatures in Moscow (Fig. 1).

The history of polymeric cryogels and mechanisms of their formation are reviewed in the first chapter. Chapters "Basic Principles of Cryotropic Gelation" and "Synthesis and Structure-Property Relationships of Cryogels" cover the basic principles of cryotropic gelation, the synthesis–structure–property relationships of cryogels, and some of their novel applications. Aqueous poly(vinyl alcohol) (PVA) solutions form physical gels by cryogenic treatments, which are of great interest due to their outstanding properties. Formation of PVA cryogels under various conditions is discussed in detail in chapters "A Brief History of Polymeric Cryogels," "Basic Principles of Cryotropic Gelation," "Kinetic Analysis of Cryotropic Gelation of Poly(vinyl alcohol)/water solutions by Small-Angle Neutron Scattering," and "Poly (vinyl alcohol) Cryogels for Biomedical Applications." The structure of PVA cryogels and the principal processes taking place during their formation are discussed in chapter "Kinetic Analysis of Cryotropic Gelation of Poly(vinyl alcohol)/water solutions by Small-Angle Neutron Scattering". An effective method for the synthesis of polymer cryogels is the initiation of cryogelation reactions using UV irradiation, which is reviewed in chapter "Cryogels via UV Irradiation". Chapter "Inorganic Cryogels" covers recent advances in inorganic cryogels. I have to mention that, although the term "inorganic cryogel" has been used as the generic

**Fig. 1** Low temperature is a prerequisite for obtaining cryogels. O. Okay (*left*) and V. I. Lozinsky (*right*) discussing the content of this volume at −23 °C in Moscow (1 February 2014)

name for freeze-dried products of inorganic gels, precipitates, and colloidal solutions, it is more correct to call such freeze-dried products "cryostructurates" or "cryotexturates" rather than cryogels. However, as the term "cryogel" is most commonly used for inorganic materials obtained by free-drying, it will also be used in chapter "Inorganic Cryogels" to be consistent with previous studies in this field.

The last two contributions in this volume provide an overview of the biotechnological and biomedical applications of cryogels. Cryogels with their large pores open up a range of applications, e.g., isolation of microbial cells, capturing of cancer cells, use as matrices for immobilized cell reactors, and environmental separation. These applications of cryogels are reviewed in chapter "Cryogels for Biotechnological Applications." The unique mechanical properties of PVA cryogels make them an attractive candidate for biomedical, and especially medical device applications. In chapter "Poly(Vinyl Alcohol) Cryogels for Biomedical Applications," the formation process and processing parameters of PVA cryogels and their application in orthopedic and cardiovascular devices are reviewed and discussed.

The editor believes that the present volume covering a broad range of topics in the field of cryogels will contribute to a better understanding of the developments achieved during the past two decades in the synthesis and applications of cryogels. I also hope that this work will promote research in this rapidly developing area. I would like to thank all the authors who have contributed to this exciting volume on polymeric cryogels.

Istanbul, Turkey Oguz Okay

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