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PREFACE

Editorial

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Preface to the Special Issue "Advanced Polymers and Nanomaterials for Drug Delivery and Other Biomedical Applications"

Guest Editor of the Special Issue "Advanced Polymers and Nanomaterials for Drug Delivery and Other Biomedical Applications" is Professor Vitaliy V. Khutoryanskiy.

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Water-soluble polymers and their crosslinked hydrogel counterparts are increasingly used in biomedical technologies owing to their distinctive physicochemical properties. These materials not only improve drug delivery but also provide important functions for addressing medical challenges. They can also serve as platforms for the design of nanomaterials with tailored properties for a wide range of biomedical applications. In this context, the Special Issue "Advanced Polymers and Nanomaterials for Drug Delivery and Other Biomedical Applications" brings together 10 original research papers from experts in Iraq, Kazakhstan, Russia, and Uzbekistan.

In the opening article of this Special Issue, researchers from the Institute of Polymer Chemistry and Physics in Tashkent, Uzbekistan, focus on chitosan, a naturally derived polysaccharide well known for its biocompatibility, biodegradability, low toxicity, mucoadhesive properties, and ability to coordinate metal ions through its amino and hydroxyl groups. These distinctive features make chitosan an especially attractive material for biomedical applications, including drug delivery systems, wound dressings, tissue engineering scaffolds, and nanocomposite design. While chitosan is most commonly obtained by deacetylation of chitin from crustacean shells, this study highlights a more unusual and regionally distinctive source: *Bombyx mori* (silkworm). Using chitosan derived from *Bombyx mori*, the authors investigate the *in situ* synthesis of manganese-containing nanoparticles and demonstrate that the chemisorption method enables effective control over nanoparticle size and morphology. Their findings show how this silkworm-derived biopolymer can act as a stabilizing matrix for metal-containing nanostructures, opening new opportunities for the development of biocompatible nanocomposites and their future applications in biomedical engineering.

Another important study from the Institute of Polymer Chemistry and Physics (Tashkent, Uzbekistan) describes the development of chitosan–caffeine nanocapsules via a self-assembly approach. By using

Bombyx mori chitosan as the shell material, the researchers obtained stable nanostructures with high encapsulation yields, further underscoring the value of this distinctive silkworm-derived polysaccharide for the preparation of advanced nanocarriers and other functional biomedical systems.

The theme of chitosan-based materials is further developed in a study from Buketov Karaganda National Research University (Kazakhstan), which focuses on mucoadhesive chitosan nanoparticles for the delivery of the anti-tuberculosis drug rifampicin. Using a central composite design to optimise the formulation, the authors show that ionotropic gelation can be successfully employed to produce spherical nanoparticles with high drug loading and favourable drug release profiles, highlighting the promise of these systems for mucosal drug delivery applications.

Despite the unique properties of chitosan itself, there is sometimes a need to chemically modify this biopolymer, imparting new properties to the resulting products. In this regard, the next article in this special issue, from the Institute of Polymer Chemistry and Physics (Tashkent, Uzbekistan), reports the synthesis of chitosan sulfate from *Bombyx mori* chitosan. They demonstrate how the degree of sulfation, controlled by reaction temperature, directly influences the polymer's structural amorphization and hydrophilicity. With this polymer, they investigate the anticoagulant activity of the chitosan derivative.

Beyond chitosan, a number of cellulose-derived polysaccharides are also water-soluble. One such example is hydroxypropyl cellulose, which is widely used in pharmaceutical formulations. In their article, researchers from Kazan State Medical University (Russia) exploited the ability of hydroxypropyl cellulose to interact with lightly crosslinked poly(acrylic acid) in mixed systems and designed floating tablets for gastroretentive drug delivery. Sodium bicarbonate was incorporated into these formulations, and the tablets were loaded with acyclovir. The authors reported the *in situ* formation of hydrogen-bonded interpolymer complexes during tablet swelling in the acidic environment of the stomach.

Polymeric hydrogels continue to play an important role in a wide range of biomedical applications, including contact lens materials, wound dressings, drug delivery systems, and tissue engineering scaffolds. Researchers from the Department of Organic Chemistry and Polymers at Buketov Karaganda National Research University (Kazakhstan) present a study on pH- and temperature-sensitive hydrogels based on poly(ethylene glycol)maleate. Their investigation shows how external physicochemical factors influence the behaviour of these terpolymers, which exhibit a remarkably high swelling capacity and a porous network structure.

The second part of this special issue was devoted to nanomaterials for drug delivery and biomedical applications, and several papers explored different classes of such materials. Among them, researchers from the University of Sulaimani (Iraq) reported the development of solid lipid nanoparticles (SLNs) for oral drug delivery. Their study compared itraconazole-loaded SLNs prepared with different solid lipids, including myristic and stearic acids. The findings demonstrated that both lipid chain length and surfactant type, such as Pluronic F127 and Tween 80, play an important role in enhancing the solubility of poorly water-soluble antifungal agents and achieving controlled drug release under varying pH conditions.

A collaborative study by researchers from several Russian institutions, including Surgut State University and the Moscow Aviation Institute, investigates the design of biocompatible goethite (α-FeOOH) nanoparticles. The authors present the first comprehensive analysis of how different iron precursors and alkaline media affect the transformation of ferrihydrite into phase-pure goethite. Through the use of advanced characterisation techniques, including ^{57}Fe Mössbauer spectroscopy and electron microscopy, this work demonstrates the promise of iron-based nanomaterials as stable and safe platforms for biomedical and technological applications.

Further highlighting the importance of precise control over magnetic nanomaterials, researchers from the Moscow Aviation Institute and the Federal Research Center of Problems of Chemical Physics and Medicinal Chemistry (Russia) investigate how the size and magnetization of magnetite (Fe_3O_4) nanoparticles can be tuned. Their study systematically explores the effects of temperature and solvent ratios on nanoparticle stoichiometry and the rheological behaviour of ferrofluids. By revealing a clear relationship between the magnetic induction gradient and nanoparticle capture efficiency in flow-through systems, this work offers valuable guidance for the optimisation of magnetic fluids for magnetotargeting and other advanced biomedical applications.

Metal–organic frameworks (MOFs) are a versatile class of porous nanomaterials constructed from metal centres and organic linkers, and their scientific significance was recently underscored by the 2025 Nobel Prize in Chemistry, awarded for the development of metal–organic frameworks. Bringing the Special Issue to a close, a study by researchers from the Moscow Aviation Institute and the Sklifosovsky Research Institute for Emergency Medicine (Russia) emphasises the crucial influence of processing methods on the func-

tional properties of nanomaterials. Their work on magnetic MOF nanoparticles demonstrates that even routine procedures, such as mechanical grinding and ultrasonication, may trigger substantial structural changes, including variations in magnetite stoichiometry and MOF stability.

In summary, this Special Issue presents an excellent variety of examples demonstrating the applications of polymeric and nanomaterials in drug delivery and biomedicine. The papers collectively showcase the versatility of these systems and underline the importance of rational material design in achieving improved therapeutic performance and broader biomedical functionality. Taken together, they emphasise the continuing impact of advanced materials research on the development of next-generation pharmaceutical and biomedical technologies.