***How to Cite:*** Kudaibergenov, S.E., & Nuraje, N. (2022) Foreword by the Editors of the Special Issue. *Bulletin of the University of Karaganda – Chemistry, 107(3), 5-8.* https://doi.org/10.31489/2022Ch3/3-22-00

# PREFACE

Received: 17 July 2022 | Published online: 01 August 2022

https://doi.org/10.31489/2022Ch3/3-22-00

S.E. Kudaibergenov[1], N. Nuraje[2]

[1]*Institute of Polymer Materials and Technology, Almaty, Kazakhstan;*
[2]*National Laboratory Astana, Nazarbayev University, Nur-Sultan, Kazakhstan*

## Foreword by the Editors of the Special Issue

The editors, guest editors, and advisory board members of *Bulletin of Karaganda University, Chemistry Series* decided to dedicate this Special Issue to the 90th anniversary of Doctor of chemical sciences, Professor, Academician of the National Academy of Sciences Esen Abikenovich Bekturov who has made an outstanding contribution to physical chemistry of polymers. In the frame of the Special Issue entitled: ***"Specialty Polymers in Oil Industry, Bio-, Nanotechnology and Medicine"*** colleagues from China, Czech Republic, Finland, Japan, Kazakhstan, Russia, Syria, UK, USA, and Uzbekistan share their research with readers of the journal.

The contribution of Professor Esen Bekturov to the Physical Chemistry of Polymers is outlined in the essay by Prof. **Sarkyt Kudaibergenov** (*Institute of Polymer Materials and Technology, Kazakhstan*). The essay briefly describes the life path, scientific and pedagogical activities of Professor Esen Bekturov together with his prominent contribution to R&D, role in the transfer of knowledge, and training of highly qualified specialists.

A review by Prof. **Vitaliy Khutoryanskiy** from the *University of Reading (UK)* and coauthors considers the state of the art in synthetic, natural, and semi-natural polyampholytes, as well as their interpolymer complexes with polyelectrolytes, proteins, DNA, non-ionic polymers including applications of these systems. Historical background on polyampholytes and interpolymer complexes provides comprehensive information on the current state of this subject.

A review by **Marat Sagyndikov** (*Satbayev University, KazMunaiGas Engineering LLP, Kazakhstan*) and Prof. **Randall Seright** (*New Mexico Institute of Mining and Technology, USA*) describes important aspects and performances of polymer flooding based on a survey of recent projects combined with the Kalamkas field experience. A comprehensive literature review allows optimizing the applicability of polymer flooding technology in temperature, brine salinity, water source selection, oil properties, formation type, and permeability.

The mini-review by **Perizat Kanabekova** and coauthors (*Nazarbayev University, Kazakhstan*) is focused on the use of electrospun nanofiber membranes for the development of lung-on-a-chip platforms. The authors briefly introduce microfluidic and lung-on-chip devices, microphysiological systems and demonstrate the perspectives of nanofiber membranes as a material for mimicking the basement membrane in the lung tissue.

Prof. **Hiroyuki Nishide** and coauthors (*Waseda University, Japan*) highlight the polymer complexes for electrocatalytic oxygen evolution. The paper discusses the prerequisites, characteristics, advantages and emerging challenges of π-conjugated polymers as electrochemical catalysts to modify anodic current collectors for water oxidation. It is demonstrated that the polymer complex of poly(ethylenedioxythiophene) and phytic acid supported by a hydrophilic poly(2-hydroxyethyl methacrylate) efficiently generates oxygen through anodic water oxidation.

 

Continuation of a series of articles presented by Prof. **Vladimir Lozinsky** and coauthors (*A.N. Nesmeyanov Institute of Organoelement Compounds, Russian Academy of Sciences*) is poly(vinyl alcohol) (PVA) cryogels derived from the urea-containing DMSO-solutions that can be applied as potential drug delivery system. Using a chaotropic additive like urea the authors were able to fabricate the PVA cryogels with high mechanical strength and thermal resistance. The release kinetics of model drug — ε-amino caproic acid from the drug-loaded PVA cryogels was evaluated. The suggested the concept of authors may open a possibility for biomedical applications of PVA-based cryogels.

Polymolecular complexes of natural polysaccharide — chitosan with *Bombyx mori* protein in aqueous solutions was studied by Prof. **Sayera Rashidova** and coauthors (*Institute of Chemistry and Physics of Polymers of the Academy of Sciences of the Republic of Uzbekistan*) with the help of FTIR spectroscopy. The density functional theory (DFT) method was also used for analysis and evaluation of complexes formed between chitosan and amino acids (asparagine, threonine, serine, glutamine, alanine, tyrosine, histidine, and lysine) isolated from the pupae of the silkworm *Bombyx mori*.

Researchers from the *Shakarim University of Semey* and *Astana International University, Kazakhstan* (Prof. **Binur Mussabayeva** and Dr. **Alexey Klivenko**) presented the application of interpolyelectrolyte complexes (IPEC) derived from chitosan and alginic acid for soil structuring. Treatment of soil by IPEC improves wind resistance, humidity and decreases the water permeability. The results of vegetation and field experiments in tillage treatment by IPEC showed a positive effect on the growth of radish of the Rubin variety.

The article by Prof. **Shimei Xu** and coauthors (*Sichuan University, Xinjiang University, P.R. China*) is focused on the reentrant phase transition of dual nanocomposite hydrogel composed of poly-*N*-isopropylacrylamide/Laponite/$SiO_2$ (PNIPAM/Laponite/$SiO_2$) upon shrinkage/reswelling process. The reentrant "coil-globule-coil" conformational and phase transitions of PNIPAM/Laponite/$SiO_2$ were attributed to competitive hydrogen bonds between water and polar solvents. The obtained results are promising in many applications for "on-off" switches, artificial organs and actuators in liquid environments.

Young Kazakh researchers in collaboration with Prof. **Vladimir Aseyev** (*Department of Chemistry, University of Helsinki, Finland*) investigated the immobilization of ionic dyes — methyl orange and methylene blue — within the matrix of charge-imbalanced amphoteric nanogels consisting of non-ionogenic (N-isopropylacrylamide), negatively charged (sodium salt of 2-acrylamido-2-methylpropanesulfonate) and positively charged (3-acrylamidopropyltrimethylammonium chloride) monomers and studied the dye release kinetics as a function of temperature and ionic strength of solution. A delivery system developed in this study may be a promising therapeutic platform for applications in pharmaceutics.

Oil displacement by amphoteric terpolymer consisting of acrylamide (AAm), 2-acrylamido-2-methylpropanesulfonic acid sodium salt (AMPS) and (3-acrylamidopropyl) trimethylammonium chloride (APTAC) was demonstrated in the article of **Nurbatyr Mukhametgazy** (*Satbayev University, Kazakhstan*) and Prof. **Heikki Tenhu** (*Department of Chemistry, University of Helsinki, Finland*). The advantage of amphoteric terpolymer AAm-AMPS-APTAC over hydrolyzed poly(acrylamide), that is traditionally used in enhanced oil recovery, was shown at high salinity of oil reservoir.

Amidation of polyethylene-*co*-acrylic acid copolymer (PE-*co*-AA) by alkylamines and further application as pour point depressants for waxy crude oils is reported by Dr. **Serik Kozhabekov** and coauthors (*Kazakh-British Technical University, Kazakhstan*). The efficiency of the modified PE-*co*-AA copolymers as a pour point depressant was tested with respect to highly wax crude oil from the Akshabulak field. The obtained results expand our fundamental knowledge of polymer additives with respect to the highly paraffinic oils of Kazakhstan.

Prof. **Nurxat Nuraje** and coauthors (*National Laboratory Astana, Nazarbayev University, Kazakhstan*) prepared superhydrophobic self-cleaning coatings by a simple, facile and cheap method using easily available materials such as poly(dimethylsiloxane) and $TiO_2$ nanoparticles. The wettability, particle size, and electrokinetic potential of superhydrophobic materials were studied. These materials can potentially be used in concrete fabrication as anti-ice paving slabs, building facades, roofs and waterproofing of buildings.

The molecular mechanism of binding of coumaric acid (CA) with polyphenol oxidase (PPO) was explored by Dr. **Ming Guo** and coauthors (*Zhejiang Agriculture and Forestry University, China*) by combination of spectroscopic and molecular modeling methods. According to the thermodynamic parameters, the CA-PPO complex is predominantly stabilized by hydrophobic interactions and hydrogen bonds between the interacting components.

Dr. **Alsu Akhmetshina** and coauthors (*Kazan National Research Technological University, Kazan, Russian Federation*) synthesized and characterized a series of aromatic oligoesters and oligoesteramides possessing liquid crystalline properties *via* high-temperature polycondensation of aromatic dicarboxylic acids with 4-hydroxybenzoic acid (or 4-aminobenzoic acid) and 1,5-naphthalene diol. As a result, high thermally stable polymeric materials in the range of 372–378 °C were obtained. The application area of liquid crystalline polymer covers the aerospace needs of today; they are an excellent candidate for printed circuit boards, fiber optic strength members, and conductor reinforcements.

The team of authors led by Dr. **Akerke Kazhmuratova** (*Karaganda Buketov University, Kazakhstan*) and Dr. **Jiri Plocek** (*Institute of Inorganic Chemistry of the Czech Academy of Sciences, Czech Republic*) reported the facile synthesis of novel hydrogels based on unsaturated polyester and acrylic acid by reversible addition-fragmentation chain transfer (RAFT) polymerization in dioxane. The structure, composition and morphology of obtained polymers were evaluated by FTIR, NMR spectroscopy and SEM.

Prof. **Meyram Burkeyev** and coauthors from *Karaganda Buketov University, Kazakhstan* and the *Institute of Inorganic Chemistry of the Czech Academy of Sciences, Czech Republic* stabilized the gold and silver nanoparticles by the copolymers of polypropylene glycol maleate phthalate with acrylic acid. The obtained nanocomposites in the range of 35–50 nm exhibited antimicrobial activity with respect to gram-positive and gram-negative bacteria.

Research team headed by Prof. **Erkeblan Tazhbayev** from *Karaganda Buketov University, Kazakhstan* prepared polymeric nanoparticles based on polylactide-*co*-glycolide and anti-tuberculosis drug – isoniazid by nanoprecipitation. The average size of nanoparticles varied from 93 to 869 nm. Incorporation of isoniazid into the polymer matrix was confirmed by TGA and DSC. The degradation of polymer matrix followed by drug release was evaluated at different pHs.

Theoretical approach, in particular the DFT method, was used by Dr. **Ilnar Nurgaliev** (*Institute of Polymer Chemistry and Physics, Tashkent, Uzbekistan*) to study the interaction between chitosan dimer with ascorbic acid (AA) and sodium tripolyphosphate for fabrication of chitosan-ascorbate nanostructures. The obtained results show that the complexation of chitosan dimer with AA proceeds through donor-acceptor interaction, which is energetically favorable among all kinds of considered interactions. The applied model can be used to control the size of the resulting nanoparticles of chitosan derivatives with organic acids, including AA, and further develop the drug delivery system.

Dr. **Anastassiya Mashentseva** and coauthors (*Institute of Nuclear Physics, L.N. Gumilyov Eurasian National University, Kazakhstan*) fabricated the composite track-etched PET-based membranes on copper microtubes using various compositions of precipitation solution and various types of reducing agents such as formaldehyde, dimethylamine borane, and glyoxylic acid. They were used as efficient catalysts for reduction of Cr(VI) present in wastewater to Cr(III) with a high yield of 95–97 %.

Metalloorganic framework (MOF) structures based on nickel and cobalt trimesinates were used for adsorption of organic dyes, in particular, Congo red (CR) and methylene blue (MB) by Prof. **Igor Uflyand** and Prof. **Gulzhan Dzhardimalieva** from *Southern Federal University, Rostov*-Don and *Institute for Problems of Chemical Physics RAS* (*Russia*). Temperature-dependent adsorption degree of CR and MB was equal to 97 and 83 %, respectively. The adsorption mechanism of dyes was analyzed by empirical models of Temkin and Freundlich, of which the Freundlich model was optimal. The calculated thermodynamic parameters reveal that the process is spontaneous and has an insignificant endothermic character.

Researchers from the *Institute of Complex Processing of Mineral Raw Materials, Kazakhstan* (Prof. **Abdurassul Zharmenov** and **Anas Houbi**) in collaboration with the Higher Institute for Applied Science and Technology, Damascus, Syria (Dr. **Yomen Atassi**) considered the ternary composite materials obtained from poly(aniline), NiZn ferrite ($Ni_{0.5}Zn_{0.5}Fe_2O_4$) and carbonyl iron using the sol-gel method and in situ polymerization technique. The composite materials were characterized by FTIR spectroscopy, XRD and SEM. In addition, the electromagnetic interference shielding and microwave absorption properties were measured in the frequency region of 8.8–12 GHz.

Prof. **Galymzhan Mamytbekov** and coauthors (*Institute of Nuclear Physics, Kazakhstan*) developed hybrid composite materials based on poly-N-vinylpyrrolidone and agar-agar in the presence of plasticizers (PEG-400, glycerin) and mineral filler bentonite by electron irradiation method. The structure of resulted hybrid composites is defined as an interpenetrating network within which the mineral component is distributed as intercalated particles. The swelling and mechanical properties of composite hydrogels were studied. It is expected that the hybrid composite hydrogels can be applied for tissue engineering and anti-burn hydrogel dressings with a wound healing effect and high bactericidal activity.

A group of researchers led by Prof. **Nigmat Ashurov** from the *Institute of Polymer Chemistry and Physics (Uzbekistan)* presented the properties of nanomaterials derived from the modified by maleic anhydride isotactic polypropylene and two kinds of clay minerals – montmorillonite that differs in the interlayer space. As a result, the formation of both intercalated and exfoliated nanocomposite structures was detected. The physicochemical and mechanical properties of nanocomposites were evaluated by XRD, TGA, DSC, and mechanical testing. The nanocomposites possess increased thermal stability and elastic modulus that are interesting from the practical point of view.

The Guest Editors of this Special Issue would be extremely happy if the compiled articles reached their goal and delivered a positive reader experience.

## Information about Guest Editors*

**Kudaibergenov, Sarkyt Elekenovich** — Full Professor, Doctor of Chemical Sciences, Director of the Institute of Polymer Materials and Technology, Atyrau-1, 3/1, 050019, Almaty, Kazakhstan; e-mail: skudai@mail.ru; https://orcid.org/0000-0002-1166-7826;

**Nuraje, Nurxat** — Associate Professor, Doctor of Chemical Sciences, Head of the Laboratory of Advanced Solar Energy Materials and Systems, National Laboratory Astana, Nazarbayev University, Kabanbay batyr avenue, 53, 010000, Nur-Sultan, Kazakhstan; e-mail: nurxat.nuraje@nu.edu.kz; https://orcid.org/0000-0003-4751-2719

*The editor's name is presented in the order: *Last Name, First and Middle Names*