IVANE JAVAKHISHVILI TBILISI STATE UNIVERSITY

Seventh International Caucasian Symposium on Polymers and Advanced Materials

ICSP&AM7

27-30 IULY

TBILISI

2021

Welcome

Dear Colleagues,

On behalf of the Organizing Committee I wish to extend cordial welcome to all participants of the 7th International Caucasian Symposium on Polymers and Advanced Materials. 14 years ago, 2007, this symposium took place in Tbilisi, Georgia. In this year we will meet again a difficult Covid-19 situation in the world. In this year the conference will be held in hybrid mode and hopfully, the next meeting will take place in normal situation and we will see more participants on symposium.
We are delighted to host you in this year in our beautiful Georgia, in Tbilisi. These meetings led to the fact that we cooperate with Polish Universities in the Erasmus+ program, as well as with Lithunian Polythecnic niversity. We hope that this symposium will in the future lead to the strengthening of close scientific relations with other countries..
The purpose of the conference is to encourage scientists working in polymer chemistry and advanced materials to present their investigations dedicated to problems and discoveries in above mentioned fields. Also "ICSP&AM 7" will help to introduce effectively innovative scientific researches of Georgia in, Caucasian and neighboring scientific teams, which are less known for world scientific society. We hope that this year meeting, gathering almost 100 participants, shall provide a good platform for academic and industrial scientists to discuss recent advances in the area of polymers and advanced materials.

Professor Omar Mukbaniani

Organizing committee: Chair – Prof. Omar Mukbaniani
Co. Chair – Prof. Marc J.M. Abadie

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Lali Kemkhadze – PhD, TSU
Marina Gakhutishvili – PhD, TSU

ISBN 978-9941-491-09-2

SYMPOSIUM SCHEDULE

	27 July	
9.00-16.00	Registration	
18.00	**Welcome part**	
	28 July	
	Invited Presentations	
9.00-9.25	Opening ceremony Rector of Ivane Javakhishvili tbilisi State University	
	***Co-chairmen**: Prof. Arnos Hovhannesyan, Prof. Omar Mukbaniani*	
9.25-9.50	*N. Zavradashvili* – „Synthesis of biomimetic polymers based on nonproteinogenic α-amino acids” *Institute of Chemistry and Molecular Engineering, Agricultural University of Georgia, Kakha Bendukidze University Tbilisi, Georgia*	1
9.50-10.15	*Efkan Çatiker* – Synthesis and characterization of poly(acrylic acid-g-β-alanine) and poly(acrylic acid-g-a-methyl-β-alanine) *Department of Chemistry, Ordu University, Cumhuriyet mah. Ordu, Turkey*	2
10.15-10.40	*Jimsher Aneli* – „Polymer composites on the basis of the residual polyethylene and modified minerals”. *R. Dvali Institute of Machine Mechanics, Tbilisi, Georgia*	3
10.40-11.05	*Justyna Kozlowska* – „Sodium alginate/gelatin-based materials fused with polylactide microparticles as tools to improve the activity of active substance to be administered through the skin” *Faculty of Chemistry, Department of Chemistry of Biomaterials and Cosmetics, Nicolaus Copernicus University in Torun, Torun, Poland*	4
11.05-11.35	**Coffee Break**	
	Co-chairmen: *Prof. George Petriashvili, Prof. Jimsher Aneli*	
11.35-12.00	*Jozef Haponiuk* – „Flame retardant polyolefin blends” . *Polymers Technology Department, Faculty of Chemistry, Gdansk University of Technology, Gdansk, Poland*	5
12.00- 12.20	*K. Chubinidze* – „Visualization of subcutaneous hemangioma formation modified with gold nanoparticle infrared fluorescent dye nanocomposite” *Institute of Cybernetics of Georgian Technical University, Z. Anjaparidze 5, 0186, Tbilisi, Georgia*	6
12.20-12.40	*Temur Kantaria* – „Biodegradable pseudo-protein-based nanoparticles as ophthalmic drug delivery vehicles”. *Institute of Chemistry and Molecular Engineering, Agricultural University of Georgia, Kakha Bendukidze University, Tbilisi, Georgia*	7 (Online)
12.40-13.00	*Tengiz Kantaria* – Synthesis of new 1,2,3-triazole containing poly(ester amide)s and poly(ester ether amide)s” *Institute of Chemistry and Molecular Engineering, Agricultural University of Georgia, Kakha Bendukidze University, Tbilisi, Georgia*	8 (Online)
13.00-14.00	**Lunch Break**	
	Co-chairmen: *Prof. Akaki Peikrishvili, Dr. N. Zavradashvili*	
14.00-14.20	*Khatuna Barbakadze* – „Corrosion resistance of nanoparticle-based antimicrobial coatings”. *Tbilisi State Medical University, Faculty of Pharmacy, Department of Medical Chemistry, Tbilisi, Georgia*	9

14.20-14.40	*George Petriashvili* – „Spiropyran doped liquid crystal polymer film based personal reusable uv dosimeter”. *Institute of Cybernetics of Georgian Technical University, Z. Anjaparidze Tbilisi, Georgia*	10
14.40-15.00	*Marina Rukhadze* – “Study of process of drug release from microemulsions prepared on the basis of nonionic surfactants” *Department of Chemistry, Faculty of Exact and Natural Sciences, Ivane Javakhishvili Tbilisi State University*	11
15.00-15.20	Marina Gakhutishvili – „Antibacterial arsenic doped polymer composites in healthcare and hospitals”. *Department of Chemistry, Faculty of Exact and Natural Sciences, Ivane Javakhishvili Tbilisi State University*	12
15.20-15.40	Arnos. Hovhannisyan – „Synthesis of monodisperse latexes to create immunodiagnostic drugs *Scientific-Technological Center of Organic and Pharmaceutic Chemistry NAS Republic of Armenia*	13
15.40-16.10	**Coffee Break**	
16.30-17.30	**Poster Presentation**	1-55 pp.
	29 July	
	Co-chairmen:, *Prof. E. Çatıker, Dr. T. Tatrishvili*	
9.00-9.20	*Witold Brostow* – „Fire resistance of materials” *LAPOM, Department of Materials Science and Engineering, University of North Texas, 3940 North Elm Street, Denton, TX 76207, USA*	14 (Online)
9.20-9.40	*Douglas B. Grotjahn* - Ruthenium-based water oxidation catalysts with a sulfonate-bearing phenanthroline ligand – activities as a function of the second n,n,n ligand. *Department of Chemistry and Biochemistry, San Diego State University, 5500 Campanile Drive, San Diego, California, 92182-1030, United States*	15 (Online)
9.40-10.00	*O.A. Yeshchenko* - “Temperature driven plasmon-exciton coupling in thermoresponsive dextran-graft-pnipam / au nanoparticles / cdte quantum dots hybrid nanosystem”. *Physics Department and[2] Chemistry Department, Taras Shevchenko National University of Kyiv, 01601 Kyiv, Ukraine*	16
10.20-10.40	*L. Mirtskhulava* – “Developing and Classifying new polymer materials using artificial intelligence (AI) techniques”. *Department of Computer Science, Tbilisi State University, 13. University, 0186 Tbilisi, Georgia*	17
Meskhi	*E. Elizbarashvili* – “New functional azo dyes on the base of ecofriendly mo-eities” *Agricultural University of Georgia, 240 David Aghmashenebeli alley, 0159 Tbilisi, Georgia*	18
11.00-11.30	**Coffee Break**	
	Co-chairmen: *Prof. Jozef Haponiuk, Dr. Tengia Kantaria*	
11.30-11.50	*O. Mukbaniani* – „Triethoxysilylated styrene as a new coupling agent in wood composites” *Ivane Javakhishvili' Tbilisi State University, Faculty of Exact and Natural Sciences, Department of Macromolecular Chemistry,, Tbilisi 0179, Georgia*	19
11.50-12.10	*Akaki Peikrishvili* – „Liquid phase shock assisted consolidation of ta-al based composites” *F. Tavadze Institute of Metallurgy and Materials Science, Tbilisi, Georgia*	20
12.10-12.30	*M. Bratychak* – “Synthesis and properties of peroxy nitrogen-containing oligomers based on epoxy resins”. *Lviv Polytechnic National University, 12, S.Bandery St., 79013 Lviv, Ukraine*	21 (Online)

12.30-12.50	*Natia Jalagonia* – " Electromagnetic radiation absorber polymer nanocomposites" *Ilia Vekua Sukhumi Institute of Physics and Technology, 0186 Tbilisi, Georgia*	22
13.00-14.00	**Lunch Break**	
	Co-chairmen: Prof. *Justyna Kozlowska, Dr. Tem. Kantatia*	
14.00-14.20	*Rita Shahnazarli* – „Cyclopropane-containing polymer hydrogels on the basis of copolymers of substituted vinylcyclopropyl ethers with maleic anhydride". *Institute of Polymer Materials of Azerbaijan National Academy of Sciences, Sumgait, Azerbaijan*	23 (Online)
14.20-14.40	*T. A. Marsagishvili* – "Electrochemical composite coatings of copper containing carbon material". *Ivane Javakhishvili Tbilisi State University, R.Agladze Institute of Inorganic Chemistry and Electrochemistry, 0186, Tbilisi, Georgia*	24
14.40-15.00	*N. A. Durgaryan* – "Heterocyclic unit containing conjugated electroactive polymers, on the base of p-,m-phenylenediamines". *Yerevan State University Armenia, 375025, Yerevan, A. Manoogian 1,*	25 (Online)
15.00-15.30	**Coffee Break**	
	Co-chairmen: *Prof. Elizbar Elizbarashvili, Prof. O. Mukbaniani*	
15.30-15.50	*I. Savchenko* – „Synthesis, characterization, and luminescence properties of copolymers based lanthanide complexes and styrene". *Depatment of Chemistry, National Taras Shevchenko University of Kyiv***".**	26 (Online)
15.50-16.30	**Poster presentation**	27 56-111 pp
16.30-17.00	Meeting of the Scientific Council. Award to the young scientists:	
	30 July	
19.00	**Excursion, Galla dinner**	

Abstract

SYNTHESIS AND USE OF OLIGONAPHTHYLAMINES IN MAKING OF HEAT-RESISTANT ELECTRO-CONDUCTIVE RUBBERS

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The preparation of electro-conductive or antistatic rubbers is possible with the use of electro-conductive fillers [1]. At the same time, the use of electro-conductive fillers of organic nature due to the good compatibility of the components gives to rubbers, besides electrical conductivity, and also valuable physical-mechanical properties [2].

By oxidative polycondensation of 1-naphthylamine in the presence of hydrogen peroxide or sodium hypochlorite, the soluble and meltable polyfunctional polyconjugated oligomers ($\overline{M}_w$=1100÷1610 and $\overline{M}_n$ = 670÷940), consisting of aminonaphthylene links and showing the thermostable, semiconductive and paramagnetic properties. The composition and structure of the synthesized samples of oligonaphthylamine (ONA) have been established by the methods of elemental, chemical and IR spectral analyses. ONA can act as an antioxidant in the composition of composites, increasing thereby the heat- and thermal stability, as well as the period of their effective exploitation.

The synthesized oligonaphthylamines have been used as an active additive for preparation of rubber mixtures on the basis of butyl (BR) rubber. In this case, the rubber mixtures on the basis of BR have been prepared according to the standard receipt of ingredients with the only difference that instead of carbon black (partially or completely) the oligonaphthylamines (from 5.0 to 45 m.p. per 100 m.p. of rubber) have been used. It has been established that the introduction of ONA instead of carbon black into composition of the rubber mixtures leads to an increase of the relative elongation, the tensile strength and to a decrease of the modulus of elasticity of the obtained rubbers. Along with this, the thermal stability and lifetime of the obtained rubbers are increased, which has been connected with the structural peculiarity of ONA; the naphthalene rings in the aromatic polyconjugation chain stipulate the high thermal stability, and an availability of amine groups in the naphthalene rings and chains – antioxidant activity. ONA samples show the high electrical conductivity, and their joint use with electro-conductive carbon black allows to obtain the resins with $\sigma_V \sim 10^{-8} \div 10^{-6}$ $Om^{-1} \cdot cm^{-1}$. The growth of content of ONA from 22.5 to 45.0 m.p. (from mass of BR) instead of carbon black leads to an increase of specific electrical conductivity of the obtained rubbers. The dependence of the specific volume resistance on the mixing time at various contents of ONA has been established.

The reinforcing properties of ONA in the composition of the rubber composite have been probably stipulated by the optimal combination of such indices as small particle's size, low density, good compatibility of components and participation of amine groups in the formation of the spatial grid. Thus, the accumulation of the static electric charges on the surface of rubber-technical products based on the developed rubbers during their exploitation is minimized.

References

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Abstract

COMPOSITE MATERIALS ON THE BASIS OF LEAVES AND ECOLOGICALY FRIENDLY COUPLING AGENT

T. Abuashvili[1], L. Londaridze[1,2], I. Esartia[1,2], D. Otiashvili[1,2], E. Markarashvili[1,2], T. Tatrishvili[1,2], O. Mukbaniani[1,2]

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Now day, the composite materials containing disperse wood or other vegetable products attract the intense attention of both researches and practices due to availability and low cost of these materials. In the presented work investigation of the properties of composite materials based on fine dried leaves and triethoxysilylated styrene binders obtained with use of method of the hot pressing is considered.

On the basis of the renewable raw materials fine dispersive dry leaves and triethoxysilylated styrene and styrene as a coupling materials and reinforcement agent the new ecologically friendly composite materials were obtained. The strength at bending, impact viscosity, softening dependence on temperature, water absorption of composites formed by method of hot pressing was investigated. It is shown, that the measured physical parameters of these materials essentially depend on their composition - type, concentration and ratio of binder ingredient.

It is characteristic that the amount and the ratio of each binder in the composites is very low (mainly 3-5 wt%, in the separate cases 10 wt %). The numerical data of the measured parameters show that both the strength at bending and impact viscosity values depends on the composition of the materials differently.

The experimental results are based mainly on the magnitude of interaction between the phases, which on its turn facilitates the distribution of filler particles in the composite. Spectroscopic investigations by method FTIR have shown a presence of some chemical bonds between components of the composites in result of reactions between active groups of the ingredients. These bonds may be the main reason of improving of physical mechanical and thermal properties of obtained composites and their water resistance, although it cannot be excluded that the increasing of these properties may be described by diffusion of binder molecules to the matrix of the leaves through the structural defects of this material. It is established that these properties in general depend on both the concentration of the binders and their ratio.

Acknowledgments. The financial support of the Georgian National Science Foundation (Grant # FR-19-795) is gratefully acknowledged.

Abstract

POLYMER COMPOSITES ON THE BASIS OF THE RESIDUAL POLYETHYLENE AND MODIFIED MINERALS

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New polymer composites on the basis of residual polyethylene and different fine dispersed mineral powders (andesite, bentonite, diatomite) were obtained and their mechanical, (ultimate strength), thermal (temperature dependence of the softening) and water absorption properties were investigated. It was established that all properties of these materials were essentially improved, when the fillers modified by tetraethoxysilane (TEOS) were used. It was experimentally shown that composites containing binary fillers – diatomite and andesite at definite ratio are characterized with so called synergistic effect – acquirement of the maximal physical or chemical properties of composites at definite proportion of the ingredients.

The dependence of the mechanical strengthening of the composite is coincided to well known dependence with maximum of the polymer composite with inorganic (*e.g.* mineral) filler. When we introduce the high dispersed mineral modified with TEOS the changes are appeared at relatively low concentration of modifier, the analogues composite containing modified by 3 and 5wt % TEOS bentonite the maximum on the curve of dependence of ultimate strength on the filler concentration is shared to relatively high concentration of bentonite. This phenomenon is due to increasing of the compatibility of ingredients in the composite. TEOS decreases fragility of composites and increases in the same time the compatibility of ingredients, decreases the formation of the defects, as empties (Fig. 1). At high concentrations of bentonite appears so called effect of high filling, which is decreased under influence of the modifier. The molecules of modifier envelop the fillers particles and form the buffer zone between polymer matrix and filler (Fig. 2). Comparison of the mechanical properties, softening temperature and water absorption for polymer composites based on residual polyethylene and unmodified and modified by tetraethoxysilane of used minerals nanofillers leads to conclusion that modify agent stipulates the formation of heterogeneous structures with higher compatibility of ingredients and consequently promote to enhancing of technical characteristics.

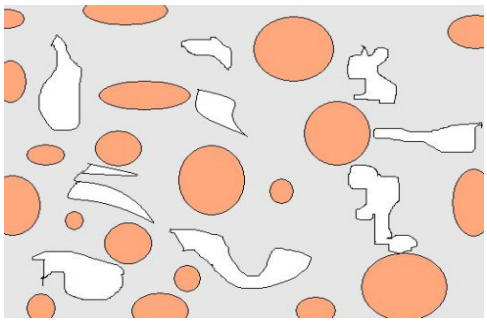

Figure 1. Model of imagination of microstructure of composite with unmodified mineral. The circles–mineral particles, white areas– empties, grey area – polymer matrix,

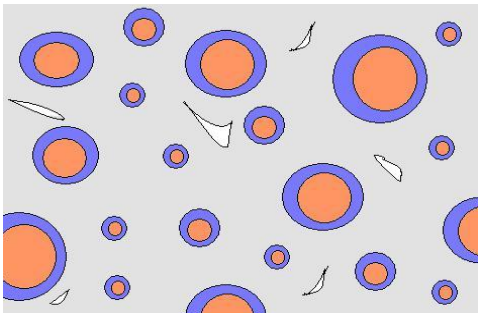

Figure 2. Model of imagination of microstructure of composite with modified by TEOS mineral. The circles –mineral particles, white areas–empties, grey area – polymer matrix, rings -TEOS

Acknowledgment. This work was supported by Sh. Rustaveli National Sci.Fund, grant CARIS-19-2692.

Abstract

DRYING OF MEDICINAL PLANT MATERIALS IN A POLYCARBONATE SOLAR DRYING UNIT

K. T. Archvadze [1], I. R. Chachava [2], E. Sh. Gavashelidze [1], N. S. Gelashvili [1], R. G. Liparteliani [1], Z. N. Chubinishvili [1]

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Drying plants - a specific method of preserving them through optimal dehydration - is a complex biological process.
Each type or group of raw materials has its own optima, experimentally established.
An essential detail during air drying is the question to what extent the sun's rays affect the safety of pharmacologically active substances and the appearance of raw materials. When dried in the sun, chlorophyll is destroyed and the leaves take on a brown color. The color of the corollas of many flowers changes from direct sunlight.
Very often, air-sun drying is useful for pre-drying berries and other juicy fruits. Different drying regimes are followed for different plant organs
New drying methods are of interest. High-quality drying is carried out using heliodryers, freeze drying, drying by the action of a high frequency electric field, etc.
Depending on the morphological characteristics of the raw material, its initial moisture content, the total surface of the material to be dried, as well as the moisture content, temperature and speed of movement of the coolant, different drying methods are selected. One of them is drying without artificial heating - drying in a solar dryer. A type of solar dryer is a polycarbonate solar dryer (S / D).
To dry medicinal plant materials, polycarbonate S / D with a tin cover was used. Using the indicated S / D, the drying process is accelerated, the dried product is stored longer than usual and, as shown by laboratory analysis, biologically active substances are better preserved.

References

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3. K.T. Archvadze, I.R. Chachava. "Experience in drying agricultural products and determination of efficiency. polycarbonate drying plant ". Journal "Transport and Mechanical Engineering", **1(41),** 193-199, 2018.

Abstract

SYNTHESIS AND HYDROSILYLATION OF 2-METHYL(ETHYL)-1-ALLYL PYRROLE

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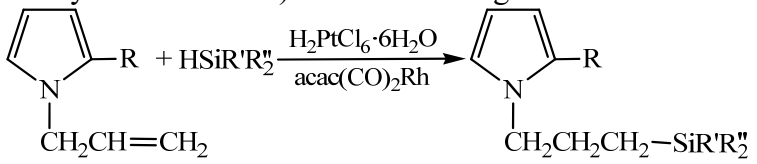
It was known from literature that the pyrrole and its derivatives occur in nature in the free state, and also as fragments in the composition of complex natural compounds. In the organism, they are present during fulfillment of the most important physiological functions [1].

In this connection and in continuation of the investigations in the field of synthesis of organosilicon 1-methyl (ethyl)-1-allyl pyrroles [1], the study of the addition reaction of trialkyl(aryl)hydride silanes with 1-methyl(ethyl)-1-allyl pyrrole in the presence of 0.1 n of platinohydrochloric acid or rhodium acetylacetate dicarbonyl and, thereby, an elucidation of influence of the nature of substituents at the multiple bond of allyl radical on the yield and structure of the reaction products is of scientific interest.

We have developed the method of synthesis of pyrrole-containing organosilicon compounds by reaction of trialkyl(aryl)hydride silanes with 2-methyl(ethyl)-1-allyl pyrrole in the presence of the catalyst (0.1 n of platinohydrochloric acid) on the following scheme:



I, II (III-XII)

R = CH_3 (I); R' = CH_3, R'' = C_2H_5 (III); C_4H_9 (IV); C_5H_{11} (V); C_6H_5 (VI); $(CH_2)_4$ (VII)

R = C_2H_5 (I); R' = CH_3, R'' = C_2H_5 (VIII); C_4H_9 (IX); C_5H_{11} (X); C_6H_5 (XI); $(CH_2)_4$ (XII)

The study of spectra (III-XII) showed that the absorption bands in the field of 3440-3400 cm^{-1} are referred to the pyrrole ring, the absorption bands in the field of 1251-1231 cm^{-1} are referred to the valence vibrations of C – N bond, and a frequency at 1620 cm^{-1} – to the valence vibrations of Si – $C_{alk.}$bond. The deformation (1358, 1421, 1458 cm^{-1}) and valence (2873, 2911, 2951 cm^{-1}) vibrations are referred to C – H-bond in CH_2-group. The deformation vibrations (1458, 1421 and 1350 cm^{-1}) are referred to vibration of C – N-bond, and the valence vibration at 2873 cm^{-1}– to C – H-bond].

Thus, under the conditions accepted by us, the addition reaction of silicon hydrides with 2-methyl (ethyl)-1-allyl pyrrole, catalyzed by 0.1 n of platinohydrochloric acid or rhodium acetylacetate dicarbonyl proceeds on C = C bond of allyl radical with formation of organosilicon compounds of pyrrole, and the triorganosilyl group is fixed at the peripheral carbon atom

The synthesized compounds have been investigated for antimicrobial properties and it has been established that they can be used as antimicrobial drugs.

References

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ONE-STAGE METHOD OF THE SYNTHESIS OF TRIGLYCERIDE OF SACCHARIN-6-CARBOXYLIC ACID

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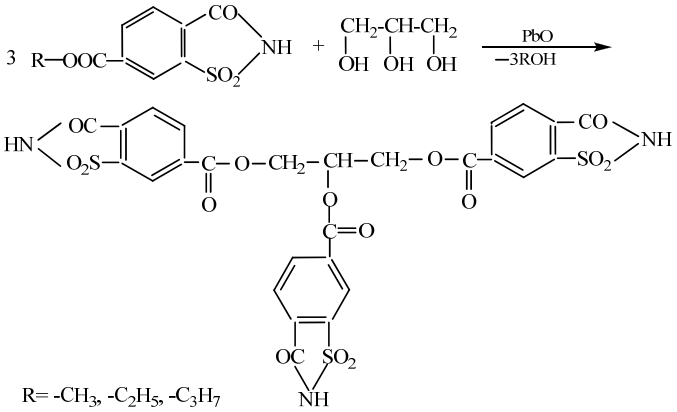
It was known that polysulfoimides have high thermal stability (500-650°C), solubility, resistance to radiation, light, acidic and alkaline hydrolysis. The combination of these properties makes polysulfoimides especially valuable for a number of industries – space and nuclear technology. Based on the above-stated one, we have synthesized triglyceride of saccharin-6-carboxylic acid as a monomer for the preparation of polysulfoimides [1].

The synthesis of triglyceride was carried out by reesterification of the alkyl esters of saccharin-6-carboxylic acid with 1,2,3-propantriol (glycerin) according to the following scheme:



The obtained product is a beige powder, soluble only in aprotic solvents, such as DMFA, DMAA, DMSO, etc.

It has been found that the obtained product corresponded to T_m.=167°C, the yield – 73%.

The composition and structure of the obtained compound has been determined by elemental analysis and IR spectroscopy.

In the IR spectra of the obtained compound the following absorption bands were observed: deformation (720, 395, 1454 cm^{-1}) and valence vibrations of C-H-bond of CH_2 groups; valence (1644 cm^{-1}) vibrations of C=O bond of amide; valence (1719 cm^{-1}) vibrations of C=O bond of ester; valence (1153 cm^{-1}) vibrations of C-O-bond of ester; valence (1239, 1283 cm^{-1}) vibrations of SO_2-group; valence (1019 cm^{-1}) vibrations of S=O-bond; deformation (1573 cm^{-1}) and valence (3276 cm^{-1}) vibrations of N-H-bond; deformation (617, 678, 750, 859, 1607 cm^{-1}) vibrations of C-H-bond of substituted benzene ring [2].

The synthesized triglyceride of saccharin-6-carboxylic acid is of interest for its use as a monomer in preparation of highly branched and netlike sulfoimide-containing polymers, epoxide resins, as well as a hardener-plasticizer of industrial epoxide resins.

References

1. T. A. Aslanov, M. S. Salakhov, A. A. Efendiev. Polymer Science. Series B, **47**, 65-67, 2005.
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Abstract

THE POINT OF VIEW: DOUBLE CONDENSED PHOSPHATES – AS ANALOGS OF INORGANIC POLYMERIC COMPOUNDS. GEOPOLYMERS – THE BILATERAL MATERIALS, RECIPROCALS OF ORGANIC AND/OR INORGANIC POLYMERS

M.A. Avaliani[1], E.V. Shapakidze[2], G.V. Todradze[2], N.V. Barnovi,[1] M.B. Vibliani[1], G.T. Magradze[1], N.A. Esakia[3]

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The worsening environmental situation in the world has pushed scientists to find optimal ways for the development of new technologies that will ensure appropriate sustainable development. The chemistry of inorganic compounds of phosphorous namely condensed phosphates, so called inorganic polymers has progressed intensively in the last decades for the reason that condensed compounds of phosphorus are utmost relevant, convenient and suitable to promote development of the chemistry of inorganic polymers, and even more important - they are reasonably recognised as the best fertilizers, detergents and materials used in engineering, construction and other areas, such as raw materials for creation of phosphates glasses, thermo-resistant constituents, cement substances etc. Our team of scholars has been working for inorganic synthesis to develop an environment-friendly chemistry – the technology for used chemicals less harmful in the form of decreased wastes. During years we were conducting fundamental researches on M^{I}_2O-$M^{III}_2O_3$-P_2O_5-H_2O poly-component systems for purpose to obtaining double polymeric phosphates, we have synthesized and investigated at least 85 new inorganic polymers (where M^{I} –alkali metals and M^{III}–AL, Ga, In and Sc).

In the construction sector, new materials have emerged as an appropriate and suitable alternative, the production of which is characterized by a lower degree of negative impact on the environment. One of these construction materials are geopolymers, which are considered as additional replacement for Portland cement because they are characterized by properties similar to those of the abovementioned material. As it is well-known, geopolymers are inorganic polymers consisting of repeating chains, formed through the polymerrization process. In other words, georpolimers are the bilateral advanced materials, reciprocals of organic and/or inorganic polymers; primarily the influence of inherent characteristics of volcanic rocks on the creation of geopolymeric binders' structure was studied. We concluded that some condensed phosphates can improve the binding properties of certain materials**;** considering this fact our idea for further research in the aim of searching diverse forms of additive binders is focused on the study of the possibility to obtain new geopolymer binders based on slag, metallurgical discharge, and phosphoric acid, and by adding synthesized double condensed phosphates.

The opportunity of activation of crystallized slag with phosphoric acid and double condensed phosphates during thermo-processing is in the stage of examination, as well as influence of different modes of mechanical-activation and curing on the reaction-ability of components of geopolymeric binders. Of course, first of all it was compulsory to synthesize the necessary inorganic polymeric phosphate that has already been done.

Abstract

METRONIDAZOLE-LOADED PSEUDO-PROTEIN MICROSPHERES FOR INTRAVAGINAL DRUG DELIVERY

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Intra vaginal drug delivery for treating various diseases related to the female reproductive system still is a challenge in gynecology [1]. One promising way of overcoming this problem is to use the special micronized biodegradable drug carriers, which can safely deliver drugs directly to the locus of disease, degrade by erosive mechanism in sustainned/controlled fashion, and can maintain a proper therapeutic concentration of drug for a prolonged time. The purpose of the present study is to elaborate a novel formulation – gelling suspension of drug loaded pseudo-protein microspheres (MSs), and to study the MET encapsulation and the kinetics of its release from the MSs. Metronidazole (MET) - an antibiotic and antiprotozoal agent used to treat cervicitis and pelvic inflamematory diseases was selected as a drug. Pseudo-protein of poly(ester amide) class - **8L6** composed of L-leucine (**L**), 1,6-hexanediol (**6**), and sebacic acid (**8**) [2] was selected for preparing MSs. This and related **L**-based pseudo-proteins were found to biodegrade by erosive mechanism, an optimal for drug release in sustained/controlled fashion, and showed a high tissue regeneration potential [3].
The suspension of MET-loaded pseudo-protein MSs (MET-MSs) was successfully obtained using the W/O/W double emulsion-solvent evaporation method. MET incorporation into the MSs was studied using the UV-spectrophotometric method. The drug release kinetics was studied using the dialysis method under sink conditions in PBS at 37°C [4]. Poloxamer 407 (PEG-PPG-PEG triblock copolymer widely used in pharmacy [5]) was added to the suspension at a 20% w/v concentration with the purpose of gelling it at 36-37 ^{o}C, in order to facilitate its delivery and fixing in and preventing the leak of the formulation from the locus of disease (vagina).
The suspension of MET-MSs was characterized by size using a laser particle analyzer (LS-C(III), Omec Instruments Co., China), which varied from 0.44 µm to 2.27 µm with the average diameter of 1.17 µm (a wide distribution) [4]. The encapsulation efficiency (EE%) of MET into the pseudo-protein MSs was 18.2%. The release kinetics of MET from the MET-MSs showed a biphasic release pattern - an initial burst release and a much more continuous slow release. The size characteristics of the MET-MSs were suitable for intravaginal (topical) drug administration. The drug MET was successfully encapsulated into the pseudo-protein MSs with an average efficiency of 18.2% [4]. The kinetics of MET release from the MET-MSs was typical of biodegradable micronized particles with a biphasic release pattern. The obtained gelling suspension of MET-MSs is promising as an intravaginal drug delivery formulation**.**

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Abstract

CORROSION RESISTANCE OF NANOPARTICLE-BASED ANTIMICROBIAL COATINGS

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Nanotechnology is currently growing as a multidisciplinary field of science and has proved its potential by fetching benefits in modern functional coatings development. The addition of nanoparticles to coatings can upgrade many properties of the coating system and can produce multipurpose materials. The unique composition, better strength, flexibility, anti-reflective in nature and good adherence on the different type of materials along with excellent gloss and transparency makes nano-coatings even more effective and add another advantage to coating industry. Such coatings are applicable in many ways: from scratch-resistant to corrosion-resistant coatings.
Antimicrobial composites and coatings with specific properties based on polyurethane and nano sized arsenic trioxide obtained by transformation of secondary resources of Georgian region have been created and studied. For modification of some characteristics (elasticity, formation of homogeneous films on various substrates, hydrolytic and thermal stability) of basic polyurethane matrix polyoligoorganosiloxanes with functional groups at silicon atom have been used.
Thermo-physical characteristics (the glass and phase transition temperatures, decomposition behavior and thermal stability parameters), basic tribological (scratch resistance, wear, dynamic friction) and surface properties (morphology, outward appearance, optical stabillity) of the obtained composites and materials have been studied.
It has been shown that by the proper combination of the structure, bioactivity, ratio of basic components of antimicrobial composites and materials could improve their mechanical, thermal and operational properties to the desired direction. Strong intermolecular interactions and compatibility between materials components are verified by performed tests and reflected in morphology of the hybrids as well. The elaborated inorganic-organic antimicrobial hybrid coatings are characterized with good fixation on various samples and wares, good strength, elasticity and good tribological properties. They do not change the color during photo- and isothermal aging. Thus, developed novel multifunctional nanoparticle-based hybrid coatings have the real prospect to control biocorrosion processes and to solve the problem connected to antimicrobial safety in the various spheres (medicine, materials science, ecology etc.) as well.

Abstract

SUGAR-BASED BIOPOLYMERS: POLY(SUGAR ACID ETHERS) – BIOLOGICALLY ACTIVE POLY[3-(3,4-DIHYDROXYPHENYL)GLYCERIC ACID] FROM MEDICINAL PLANTS OF BORAGINACEAE FAMILY

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Sugar-based biopolymers have long been studied and widely used in medicine and pharmaceutics. Novel representative of poly(sugar acids) is the main chemical constituent of high-molecular (>1000kDa) water-soluble preparations from medicinal plants Symphytum asperum, S. caucasicum, S. officinale, S. grandiflorum, Anchusa italica, Cynoglossum officinale and Borago officinalis (Boraginaceae). According to data of liquid-state 1H, 13C NMR, APT, 1NOE, 2D 1H/13C HSQC, 2D DOSY and solid-state 13C NMR spectra this biopolymer was found to be poly[oxy-1-carboxy-2-(3,4-dihydroxyphenyl)ethylene] that is poly[3-(3,4-dihydroxyphenyl)glyceric acid] (PDPGA). The polyoxyethylene chain is the backbone of this polymer molecule with a residue of 3-(3,4-dihydroxyphenyl)glyceric acid as the repeating unit and 3,4-dihydroxyphenyl and carboxyl groups are regular substituents at two carbon atoms in the chain. PDPGA as a derivative of poly(2,3-glyceric acid ether) belongs to a rare class of poly(sugar acid ethers) as well. Its basic monomeric moiety glyceric acid is an oxidative form of aldotriose glyceraldehyde. In this case poly(2,3-glyceric acid ether) chain is the backbone of this polymer molecule and 3,4-dihydroxyphenyl groups are regular substituents at 3C carbon atoms in the chain. Every repeating structural unit of a unique PDPGA contains two phenolic hydroxyl groups in ortho-position and one carboxyl group. Multifunctionality of PDPGA should be a reason of its wide spectrum of biological activities. The monomer of PDPGA was synthesized via Sharpless asymmetric dihydroxylation of trans-caffeic acid derivatives using a potassium osmate catalyst. Methylated PDPGA was synthesized via ring opening polymerization of 2-methoxycarbonyl-3-(3,4-dimethoxyphenyl)oxirane using a cationic initiator BF3·OEt2. PDPGA and its synthetic monomer exerted anticancer activity in vitro against human prostate cancer (PCA) cells via targeting androgen receptor, cell cycle arrest and apoptosis. Anticancer efficacy of PDPGA against PCA cells is more compared to its synthetic monomer. Methylated synthetic analogue of PDPGA did not show any activity against PCA. Study in vivo showed that PDPGA feeding of male athymic nude mice with 22Rv1 xenografts inhibited 22Rv1 tumors growth by 88% at 5 mg/kg body weight doses, without any toxicity, together with a strong decrease in prostate specific antigen level in plasma by 87%. Thus, PDPGA was identified as a potent agent against PCA without any toxicity.

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OBTAINING OF MULTICOMPONENT BORON CARBIDE MATRIX CERAMICS

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Boron carbide matrix ceramics containing tungsten boride are mainly obtained by sintering commercial powders at 1500-2200°C. We have previously obtained nanoized B_4C, B_4C – TiB_2, B_4C – TiB_2-Co and WC – Co from available compounds by wet method [1-2]. Simple method for obtaining of ultradispersive powders of B_4C-MB_2-W_2B_5 and B_4C-MB_2-W_2B_5-Co (M = Ti, Zr, Hf) complex was developed using oxides and salts. Organic compounds were used as carbon sources. For example by the pyrolysis of paste, obtained from ZrO_2-WO_3-B-Co $(CH_3COO)_2{\cdot}4H_2O$-$C_{12}H_{22}O_{11}$ at 200-1500°C gradually were formed WC–Co, ZrB_2, W_2B_5 and B_4C phases (Fig. 1). Powder particle sizes are in the range of 200-400 nm.

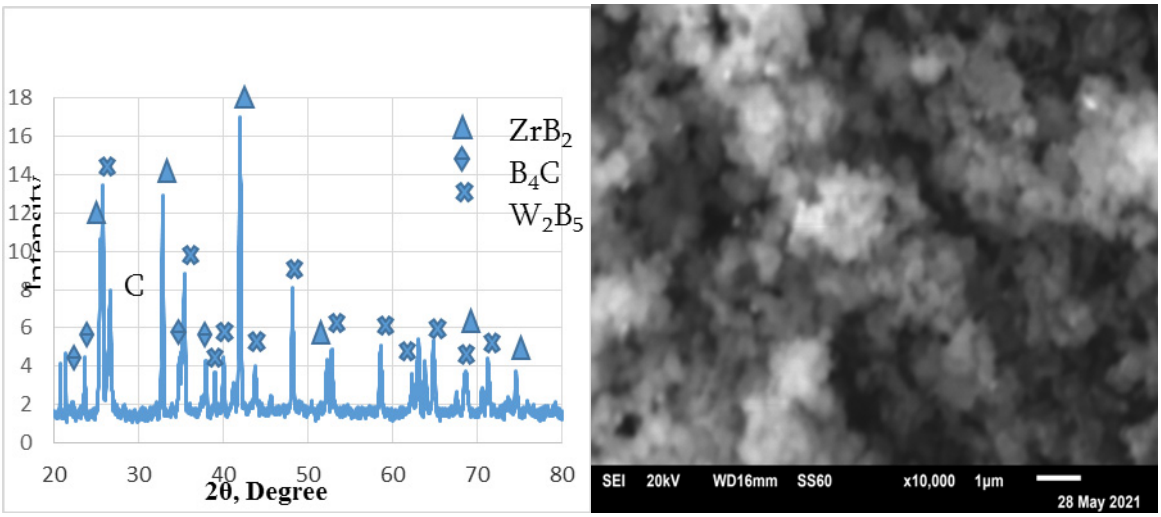

Figure 1. XRD pattern (I) and SEM micrograph (II) of B_4C–ZrB2-W_2B_5-Co (II) composite obtained at 1500°C.

It is established, that phases of WC and Co obtained via in situ are growth inhibitors of boron carbide and titanium boride grains.

Acknowledgments
This work was supported by the Shota Rustaveli National Science Foundation of Georgia (SRNSFG) – Grant # AR–18–1045: "Obtaining of boron carbide-based nanostructured heterophase ceramic materials and products with improved performance characteristics".

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Abstract

BENTONITE (ASKAN) CLAY AND ITS CONNECTION WITH PARASITIC BACTERIA

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Bentonite clays takes special important position among clay formations. They are different from other types for their many specific features. Exactly these features define their widespread use in various branches of light and heavy industry.
Total amount of the listed deposits supplies of Georgian bentonite clays is about 170 mln tons. Taking into consideration geological conditions and prospecting work results and depending on predicted supplies it can be stated that industrial supply will significantly increase.
Not any other mineral is as widely used in any branch of industry as natural bentonite. Therefore, it is desirable to prospect bentonite clays supplies their mining, working technology and other factors of usage.
Noteworthy is bentonite clay application for natural and sewerage water treatment. Many people in Central Asia and Australia used bentonite clays in different ways. People carried dried clay with them, which they dissolved in water and drank during the meal.
Despite this, there is not any information on the usage of the clay for water treatment processes in the municipal and industrial water supply. There is some statement on the usage of the clay for cleaning wastewater in Baku meat plant, where electrical charges were used for removing heavy metals, when suppling and discharging water. It is interesting to mention bentonite clay usage for cleaning wastewater from railway. Such water contains a lot of pollution ranging from oil to heavy metals.
Here is provided perspective deposits of Bentonite clays in Georgia. It is indicated that, Georgian Bentonite clays has potential and perspectives in different branches of industry.
The sorption ability of Askan clay, has been explored. The sorption ability of Askan clay for the total number of bacteria (KOE) and also for the group of Escherichia coli, which lactose's positive bacterium are defined and shown. The results show that, the Askan clay has antibacterial feature. here is presented technological scheme for water purification (additional purification) with Askan clay filter.

SYNTHESIS AND PROPERTIES OF PEROXY NITROGEN-CONTAINING OLIGOMERS BASED ON EPOXY RESINS

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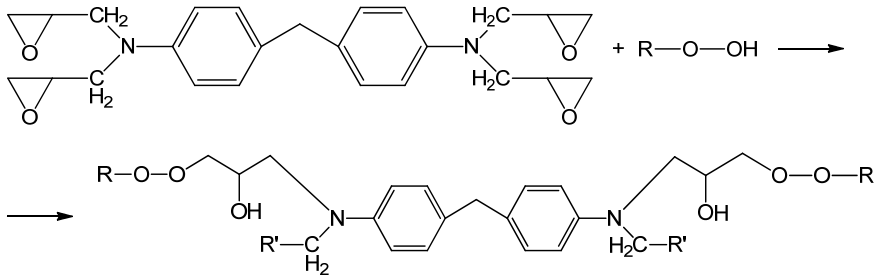
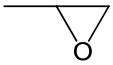
The structure of the majority of polymeric systems and compositions is formed in the presence of the compounds capable to be the source of free radicals under definite temperatures [1]. Among a large number of peroxy compounds being a potential source of free radicals, oligomeric peroxides are of special attention [2]. On the other hand, it is known [3] that nitrogen atoms in the structure of peroxides provide both the increase in the decomposition rate of epoxy group and the decrease in free radicals formation rate.

The work deals with the investigation results regarding the formation of peroxy nitrogen-containing oligomers based on *N*,*N*,*N*',*N*'-tetraglycidyl methylenedianiline (TGMD) according to the equation:



(1)

R = —$C(CH_3)_3$ or —$C(CH_3)_2C_2H_5$;

R' = —$CH(OH)CH_2OOR$ or 

Epoxy resin with molecular weight of 750 g/mol and epoxy number of 25 % was used as TGMD. *Tert*-butyl hydroperoxide (TBHP) and isopropylbenzene hydroperoxide (IPBHP) were used as hydroperoxides. The catalyst was a mixture of benzyltriethylammonium chloride (BTEACh, 60% aqueous solution) and potassium hydroxide (40% aqueous solution). The amount of quaternary salt in the mixture was 15.0 mol % per 1 g-eq of epoxy group. Toluene was a solvent. We examined the reaction (1) conditions and synthesized the nitrogen-containing compounds, the structure of which was confirmed by chemical methods and NMR-spectroscopy. By means of thermal analysis it was found that the synthesized oligomers are characterized by lower temperature of free radicals formation (by 40-60 K) in comparison with peroxy oligomers based on dianic epoxy resins [2]. The cross-linking properties of the synthesized oligomers were studied on the example of formation of cross-linked structure based on Krasol-LB liquid rubber.

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FIRE RESISTANCE OF MATERIALS

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To give an example, fires in Australia in 2019 destroyed about 1,000 homes and burnt more than 12 million acres. Historians talk about eruption of the volcano Vesuvius in year 79 of our era which destroyed soft tissues of the humans – while the hard tissues remained. Stone made buildings remained also - covered for a long time with ash. Now Pompei is a United Nations Educational, Scientific and Cultural Organization (UNESCO) Heritage site.
Organic raw materials are typically fuels [1]. We consider fire resistance of metals, ceramics, synthetic polymers and also of wood [2]. Fires do not have significant effects on metals orceramics, hence we shall discuss more in detailbehavior of polymers under fire – and focus even more on fire retardants for polymers and polymer-based materials (PBMs). Enthalpy of combustion $H^{comb}$is an important measure of the effectiveness of a fire retardant. Thus, aluminium hydroxide $Al(OH)_3$ has H^{comb} between 1050 and 1300 kJ/g. Fire retardants include those based on phosphorus, nitrogen, silicon, and those containing nanolayers, nanofibers and nanoparticles. There are also intumescent systems that form a protective carbon foam under fire conditions.
There are also special objects studied from the point of view of fire performance – such as the Plataforma Solar de Almeria in Tabernas, Almeria, Spain. The furnace can reach a peak of 300 W/cm^2. Fire doors have been created to resist the solar furnace heat. It is possible to maintain temperatures at the back door not exceeding 70°C while the front door is subjected to 950°C for 1-h time periods. The standard requires temperatures not exceeding 140°C at the back door [3].

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Abstract

SYNTHESIS AND CHARACTERIZATION OF POLY(B-ALANINE-CO-3-HYDROXYBUTYRATE) THROUGH HTP AND AROP

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Synthetic and natural polymeric materials [1–2] are used in biotechnology, medicine, and pharmacy as implants, biosensors, bioadhesives, orthopedic/dental materials, tissue/cell culture scaffold materials, diagnostic test kits, components in drug delivery systems, disposable medical materials, and wound healing materials. This wide range of use of polymeric materials is possible thanks to the variety of chemical structure and composition, the change of topological and mechanical properties, and the ability to convert them into different shapes (fiber, membrane, film, gel, particle, microsphere, and even spongy). Recently, there is a need for functional biocompatible polymers for use in tissue engineeering, medicine, gene therapy, and drug delivery systems. Thus, the modification of existing polymeric biomaterials and the design of novel synthetic polymeric materials have become of interest. The limitation in the diversity of natural polymeric biomaterials and the difficulty of their chemical modification are beginning to force researchers to design new synthetic polymeric materials. The novel aliphatic polyesters [3], polyphosphoesters [4], poly(ester amide)s [5], polyanhydrides[6], poly(ester urethane)s [7] are the most emphasized synthetic polymer groups. In the study, acrylamide as the highest polymerizable monomer through hydrogen-transfer polymerization (HTP), and β-butyrolactone as a comonomer (mole% of BBL; 10, 25, 50, and 75) were used to synthesize a novel poly(ester amide). Compositions, average molar masses, and thermal properties of the copolymers were elicited by using elemental and spectroscopic analyses (FTIR and NMR), mass spectrometry (MALDI), and thermal analyses (DSC and TGA), respecttively. The copolymers were found to have compositions different from the feed ratio applied but close when the data obtained from elemental analysis were evaluated in detail. The results obtained from different methods to determine the copolymer compositions were found to be consistent with each other. The highest average mass of 6000 g/mol was reached for the copolymers prepared. Glass transition temperature (T_g) shifts between 0 and 10 ^oC in the DSC thermograms of the copolymers proves the existence of ester blocks in the main chains. DTG thermograms exhibit two-step thermal decomposition shifts centred at about 240 ^oC and 340 ^oC that also supports the existence of two chemically distinct blocks in the copolymer samples.

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SYNTHESIS AND CHARACTERIZATION OF POLY(ACRYLIC ACID-g-β-ALANINE) AND POLY(ACRYLIC ACID-G-a-METHYL-β-ALANINE)

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It has been demonstrated that oligomers with olefinic end groups are obtained by hydrogen transfer polymerization (HTP) [1]. It is also known that these oligomeric structures are functionalized (activated) by chemical modification, the use of this structure as macromonomer and new block copolymers are obtained [2, 3]. In the study, oligomeric structures obtained from acrylamide, methacrylamide and crotonamide by HTP were used as macromonomers. With these oligomeric structures, free radical polymerization of acrylic acid was polymerized in solution medium. Since the olefin-terminated macromonomers and vinyl monomers were in the same chain in the free radical polymerization, grafting of macromonomers to the acrylic acid were achieved. Thus, branches with an amide skeleton were attached to the acrylic acid with a carbon skeleton. The copolymer structures obtained were summarized in Figure 1. Characterization of the copolymers was provided by FT-IR and ^{1}H-NMR techniques.

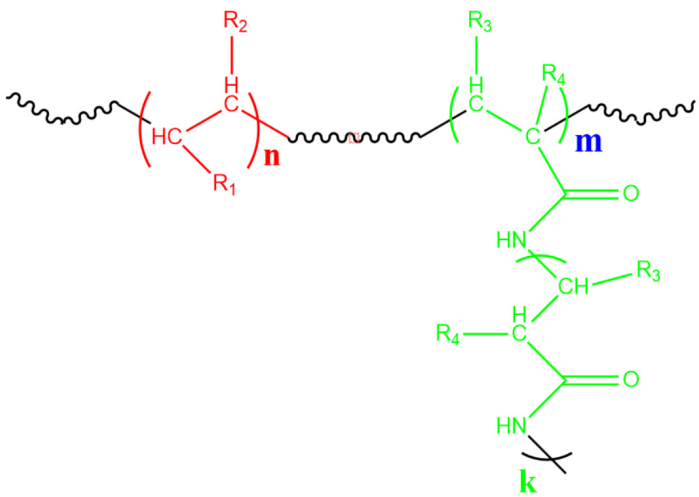

Figure 1 The structure of the copolymers (R_1: **H**, R_2: **COOH**, R_3: **H** or **CH_3** and R_4: **H** or **CH_3**

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Abstract

FREE RADICAL ADDITION OF POLYHALOIDOLEFINS TO α-PYRROLIDONE AND N-METHYLPYRROLIDONE

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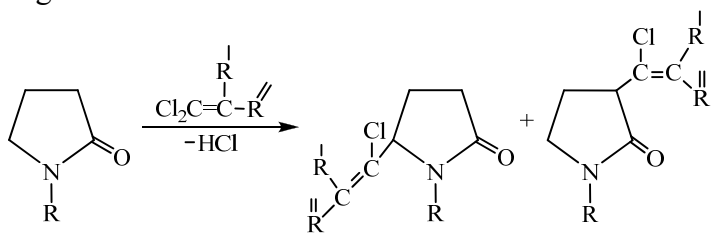
A large number of publications has been devoted to the study of the reactivity of α-pyrrolidone, and a significant part of the papers includes the development of methods of the synthesis of known natural substances and synthetic drugs on the basis α-pyrrolidone and its derivatives. The high attention to the chemistry of α-pyrrolidone heterocycle has been connected with the detection of the physiological active substances in a series of its substituted derivatives. At the same time, the structural peculiarities of molecules containing unique heterocyclic structure, combining C^3H- and NH acid centers, carbonyl group of lactame in molecule open up large prospects for their active participation in the chemical conversions [1, 2].

The main purpose of the carried out investigations was the study of the free radical addition of α-pyrrolidone and N-CH_3-pyrrolidone to trichloroethylene and tetrachloroethylene in the presence of the initiator of ditretbutyl peroxide (DTBP).

All experiments were carried out in glass apparatus at atmospheric pressure. The mixture solution of DTBP and unsaturated compound was uniformly added to the addend during the reaction. As a result, a large excess of the addend in relation to the unsaturated compound was achieved, which favored the formation of adducts 1:1 and hindered the telomerization reaction behavior. The analysis of forming adducts 1:1 showed that they are mixture of two isomers, i.e. the reaction proceeds on the following scheme:



The synthesized derivatives of α- and N-CH_3-pyrrolidones have been characterized by data of elemental analysis, GLC, IR and PMR spectroscopy.

It has been revealed that tetrachloroethylene with α-pyrrolidone in the presence of DTBP form only 5-(trichlorovinyl)-pyrrolidone. Trichloroethylene and tetrachloroethylene with N-CH_3-pyrrolidone form the mixture of 3- and 5-(α-dichlorovinyl)-N-CH_3-pyrrolidones at ratio 1:3. It has been detected by PMR spectroscopy that the absence or presence of a hydrogen bond between the reacting substrates is responsible for the regionselectivity of the addition.

It has been shown that the synthesized compounds can be used as semiproducts in the synthesis of biologically active substances.

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WOOD POLYMER COMPOSITES

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Wood polymer composites (WPC) are made by impregnating wood with a polymerizable monomer or prepolymer and then curing the monomer or prepolymer to a solid. Solid wood (lumber) or any wood composite (such as waferboard and medium density fiberboard) can be used to make WPC, although solid wood is usually used. WPC has polymer in cell lumens or in cell lumens and walls. WPCs have many changed and improved physical properties compared with the parent wood. Notable are an increase in surface hardness and dimensional stability, and the possibility of fine finishing without surface coating.

Over the years, researchers have impregnated wood with a variety of chemicals to produce WPC. A few of these have found commercial applications, some for a limited time.

Currently, there are several companies producing WPC products, mainly flooring. There are many potential applications for the material.

Therefore, one of the main tasks of research for new binders in order to obtain environmentally friendly binders and composite materials based on them that do not contain melamine-, urea- and phenol-formaldehyde rubber.

The new binders have been obtained via alkylation reaction of styrene with trimethoxyvinylsilane at 1:1 ratios of the initial components in the presence of anhydrous aluminum chloride.

The structure and composition of obtained trimethoxysilylated styrene were determined via FTIR, 1H, 13C, 29Si and hetero cozy NMR spectra data.

On the basis of new binder, a new polymer composite material has been prepared.

The morphology of composites has been studied via optical microscopy, scanning electron microscopic and energy dispersive X-ray micro-analysis. Physical-mechanical properties of composites has been studied

Acknowledgments. The financial support of the Georgian National Science Foundation (Grant # FR-19-795) is gratefully acknowledged.

Abstract

SOME NEW TYPES OF INSULATION MATERIALS

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The aim of our research is to prepare a new type of cheap waterproofing materials based on the resources available in Georgia. The key factor in achieving this goal is the utilization of cheap raw materials. We consider different types of waste in the country as such raw materials. Refers to petroleum and recycled polymers, including tires, rubber, packageing materials, cables, and other wastes. At the same time, it is possible to solve the problem of utilization. These wastes contain components with many useful properties, and their use, in addition to the above purpose, is possible in many other equally important areas.

Our main targets are: sedimented waste in oil pipeline so-called "Waxa", heavy oil waste (goudrons, etc.), used tires, packaging materials, cables, bottles, bags, etc., as well as some other construction organic and mineral waste.

By mixing liquid (> 450 ^{0}C) and solid (> 550 ^{0}C) goudrons (obtained from,, Waxa" vacuum rectification) in different ratios with secondary tire powder an adhesive mass is obtained, which has high waterproofing properties. By adding other organic and inorganic components in this mass, are formed compositions of different viscosity and density, in which by adding liquid glass or another type of glue and to homogenize it, we have obtained both lubricants and pressing elastic waterproofing materials.

The work was financially supported by Shota Rustaveli National Science Foundation of Georgia (SRNSF). Grant AR-18-741, Project title: Obtaining highly effective penetrant, waterproofing materials and other products via non-waste processing of some industrial and oil residues“

Abstract

SYNTESIS OF HEAT-RESISTANT AROMATIC POLYESTERS

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Dependence a some of properties of polymers on their structure was established on the example of various class polymers, which enables us to obtain polymers of preliminarily focused properties. Softening temperature of rigid structure polymers is higher than their destruction temperature. This makes impossible to process the polymers from their melt, while poor solubility complicates their treatment from polymer solutions. Such situation restricts the area of practical application of many very interesting polymers. We have synthesized polyarylates on the base of cyclic bisphenols, which at the central carbon atom possess norbornane type non-coplanar substituents. This enables to obtain polymers which simultaneously will be characterized by good solubility in organic solvents as well as by high heat- and thermo-resistance. 4,4[1] diphenyl oxide dicarbonic acid dichlorane hydride was used as an acid component. Synthesis was realized by high temperature polycondensation method in ditolyl methane. Schematically reaction of homogeneous polyarylate can be expressed as follows:

$nHOAOH + nClOCBCOCl = 2nHCl + [-OAOOCBCO-]_n$

Where A –is a trace of bisphenol molecule, B – is a trace of dicarbonic acid molecule.

The obtained polyarylates are characterized by high softening temperature. At the increase of volume of substituent in bisphemol, softening temperature of the polymer is increased. Presence of oxygen atom in phenyl nuclei of diphenyl oxide dicarbonic acid conditions decrease of polymer softening temperature and increase of flexibility. In case of norbornane substituent it falls from 345-350°C to 260-280°C, while in case of indan from 355-360°C to 310-315°C. Presence of methyl group in phenyl nucleus, and presence of chlorine atoms decrease softening temperature of the polymer. Results of thermo-gravimetric analyses show that thermal resistance of polymers somewhat decreases. Polymers obtained on the base of diphenyl oxide dicarbonic acid are characterized by amorphous structure.

From the solutions of organic solvents polymers form transparent, stable films, which possess good mechanical and dielectric properties. Thus, e.g. tangency of angle of dielectric losses for polymers containing norbornane and indane card groups, equals to 6.10^{-3} and 5.10^{-3}, correspondingly. Tensile strength equals to approximately 400 kg/cm^2. Polymers retain high mechanical and dielectric indices at high temperature too. Thus, at heating at 200°C, they retain more than 50 % of strength. Specific volumetric resistance of polymers is within 10^{17} ohm. cm, at heating at 200°C it falls only to 10^{13}, which refers to the fact that they are good dielectrics and can be successfully used as insulation materials.

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Abstract

VISUALIZATION OF SUBCUTANEOUS HEMANGIOMA FORMATION MODIFIED WITH GOLD NANOPARTICLE INFRARED FLUORESCENT DYE NANOCOMPOSITE

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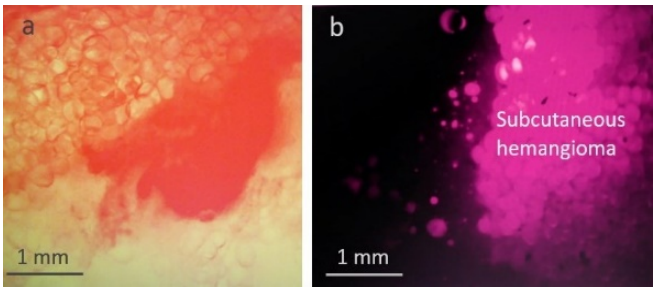

Hemangioma is one of the most common types of infantile vascular benign tumor, possessing the potential for local tissue destruction, infection, bleeding, and pain. Although the diagnosis can sometimes be made clinically, the alternative assessment is often helpful in the management of vascular anomalies, particularly for atypical or deep lesions, and is important for treatment planning. Ultrasound (US) and magnetic resonance imaging (MRI) is the mainstay of imaging vascular anomalies, with limited roles for radiography and computed tomography (CT), [1]. In this work, we propose a non-invasive, rapid, and inexpensive method of the visualization of subcutaneous hemangioma, based on the monodisperse spherical gold nanoparticles (GNPs) functionalized by the near-infrared fluorescent dye 3, 3′-Diethylthiatricarbo cyanineiodide. GNRs functionalized with the fluorescent dyes offer a number of properties that make them suitable for use in biological applications, [2]. In particular, in this type of imaging, GNRs/ NIR dye complex was introduced into the sample of hemangioma removed during the biopsy, and has been shown that this kind of modality serves as an effective contrast agent for the visualization of hemangioma located deeply under the epidermis. In experiments we used a small piece of skin tissue which was inserted in the Petri dish filled with 2×10^{-5} g NIR dye: 1.2 ml water: 7.15×10^{10} *N* GNPs /ml, dispersed in an aqueous buffer (0.02 mg/ml). The Petri dish was stored in a humidified atmosphere at 37°C, for 24 h to achieve the desired incubation rate of NIR dye. After the treatment by GNPs/NIR dye, tissue was washed two times with 1.5 ml Dulbecco Phosphate Buffered Saline. Then the solution was deposited by drop-coating to the glass slide treated with deionized water. The coated film on the substrate was stored for 24 h at room temperature to let the water evaporate completely. The obtained sample was examined and investigated using optical and confocal microscopes. The specimen was exposed to an external red laser light that can deeply penetrate the biological tissue. When a light beam reaches the GNR / NIR dye complex, the dye emits a NIR light which was then picked up by a CCD camera and was studied by a series of spectroscopic and microscopic techniques. Our results indicate that GNPs can promote the transport of GNPs/NIR dye nanocomposite across the skin and thus enable us to visualize the localization of the subcutaneous hemangioma formation, through fluorescence.

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SMART" POLYMER FILMS BASED ON NEW PHOTOCHROMIC COMPOSITIONS

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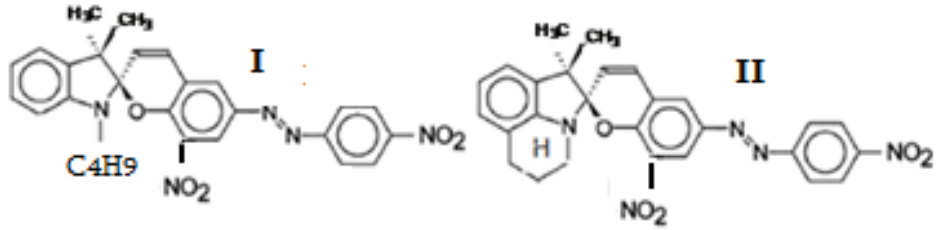
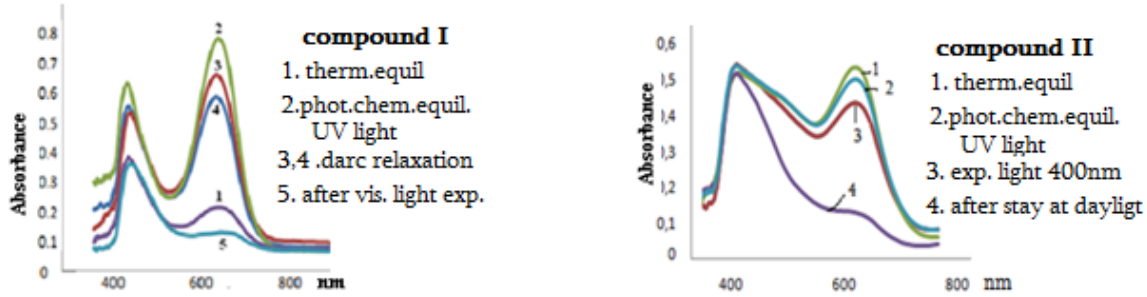
New hybrid compounds, which molecule contain two photochromic fragments of different nature have been synthesized and investigated. The marriage of photocromic spiropyran and azobenzene can lead to the birth of novel hybrid materials SPAZ. Two typesof photochromic hybrid compounds were synthesized:by coupling azobenzene with (**I**) indoline spiropyran or (**II**) tetrahydroquinoline spiropyran with increased sensitivity to visible light [1].



Photochromic transformations and thermodynamic parameters were investigated in the PMMA (polymethylmethacrylate) films doped with hybrid molecules **I** and **II** at room temperature.



Bathochromic shift of the absorption bands, caused by elongation of the π -conjugation system, was observed in both types of samples. In sample **II**, in contrast to **I** [2], the thermodynamic equilibrium constant is greater than photochemical one and it is manifested in negative photochromism. In sample **II**, unlike **I**, due to the steric hindrance UV light does not affect the absorption band of the azobenzene moiety.

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ELECTROSYNTHESIS OF NANOMAGNETITE AND APPLICATION FOR PURIFICATION BY PHENOL PREVIOUSLY CONTAMINATED WATER

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Nanoiron oxide – magnetite (Fe_3O_4) is a prospective material for water purification and application in the biomedicine field. It enables us to purify water from bacteria and toxic, heavy metals, such Hg, Pb, Cd, Tl and so on. It is the best sorbent. Dyes, pesticides and other organic pollutants can be removed by means of magnetic nano-particles.
The aim of the study is the electrosynthesis of $F_{e3}O_4$ nanomagnetite and purification of from phenol pre-contaminated water. The main component of the filter is magnetite nanoparticles stabilized with oleic acid, obtained by electrosynthesis in a two-layer bath. An aluminum arc was used as a rotating cathode and optimal electrolysis parameters were determined. A porous filter was obtained after impregnation of bohemite with magnetic nanoparticles and its subsequent burning at 450 ° C.
The optimal parameters of electrolysis are determined. The resulting nanomagnetite was characterized by X-ray analysis (XRD), Infrared Spectroscopy (FT-IR), Elementary Analysis and Scanning Microscopy (SEM-EDS). Particle size determined by Dynamic Light Scattering (DLS Malvern). A filter based on nanomagnetite shows a significant effect in the process of purifying drinking water from phenol.
A porous γAl_2O_3 filter containing nanomagnetite can be used to purify water contaminated with phenol at the place of consumption.

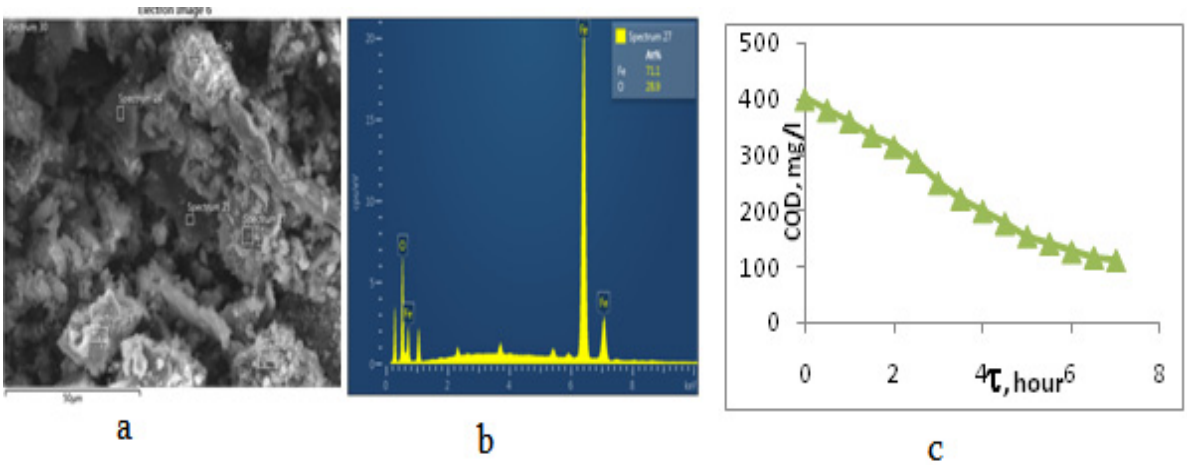

Figure. images of Fe3O4 Nps: a)SEM, b)EDS, c)Purification of phenol contaminated water

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PREPRATION AND INVESTIGATION OF MALEINIZED OLIGOPROPYLENE

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Polyolefins are one of the most widely produced and used polymers. The physical-chemical and mechanical properties allow their use in various fields. However, the low miscibility of this type of polymer does not allow us to obtain homogeneous composition materials. Due to the functionalization of polyolefins, one can overcome these defects and expand the area of their application [1].
One of the methods to make polyolefins functional is to combine more active functional groups, such as unsaturated carboxylic acids and their derivatives, in oligoolefins, which have unsaturated bonds in the end group. From this point of view, the maleinization of polyolefins is of great interest.
In the literature, there is extensive information about the grafting of polyunsaturated carboxylic acid derivatives with the participation of free radical initiators. The functionalization reactions proceed usually at high temperature extrusion of reagents mixture. However, the formation of additional mixtures as a result of such processes as destruction, grafting, negatively influence on the yield and properties of the purposeful product, leading to a decrease in its quality. One of the most widespread methods of preparation of functionalized polyolefins is the formation of peroxide groups in macromolecules by their preliminary ozonation and carrying out of polymer-analogous conversions. The multi-stage nature of the process leads to excess energy consumption. In our previous investigations, it was reported that the oligomers containing biologically active salicylic group on the basis of polypropylene macromonomer having double bond in the end groups have been obtained [2].
This work has been devoted to the study of the maleinization reaction of polypropylene macromonomer (PPMM). Alpha-maleinized oligoolefins have been obtained by addition of oligomers with average molecular weight 500-700, in other words, oligoolefin macromonomers under special conditions in the presence of initiators of benzoyl peroxide to maleic anhydride (MA). The maleinized oligopropylene containing 8-15% mass % of malein group has the following properties: characteristic viscosity – 0.22 g/100 ml, melting temperature – 169°C, and is dissolved in all proportions in dimethylformamide. Unlike the polyolefin maleinization reactions, in PPMM maleinization reaction, depending on the conditions, a binging of maleic anhydride only with the end group of alpha-oligopropylene is observed. This fact has been confirmed by the analysis of IR and NMR spectra of the samples. The influence of factors such as temperature, ratio of the components participating in the reaction and the reaction time on the yield of PPMM maleinization reaction has been studied and the optimal reaction conditions have been determined. The investigations showed that the optimal conditions for the maleinization of PPMM are as follows: T = 65-75°C; PPMM:MA = 1.2 : 1; t = 6 h.

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Abstract

IMPACT OF POLYMERIC MATERIALS ON SAFETY OF FOOD

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Under the Georgian Food Law, there is a regulation on food materials that sets norms for the migration of substances from various polymeric materials [1], like in other countries [2,3], but there is no supervisory authority or other regulatory body.
Different types of polymeric materials are used for food packaging, which can affect the composition of food and, as a result, human health [4, 5].
On the basis of existing research, the migration of harmful substances from polymeric materials into food products has been gathered and studied considering various conditions: such as, food packaging technologies, storage duration and temperature, physicochemical, microbiological characteristics of packaged food products [6].
It is established that the polymeric material used for food packaging in Georgia in case of violation of the conditions established by international regulations [7] may result in the migration of harmful substances such as phthalates, formaldehyde, styrene, vinyl chloride, bisphenol and heavy metals such as Hg, Cd, Cr^{6+}, Pb [8, 9].

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Abstract

OPTIMIZATION OF SYNTHESIS OF DISULFONATED 4,4'-DIFLUORODIPHENYLSULFONE AND SYNTHESIS AND CHARACTERIZATION OF POLY(PHENYLENE SULFONES) WITH DIFFERENT IONIC FORMS

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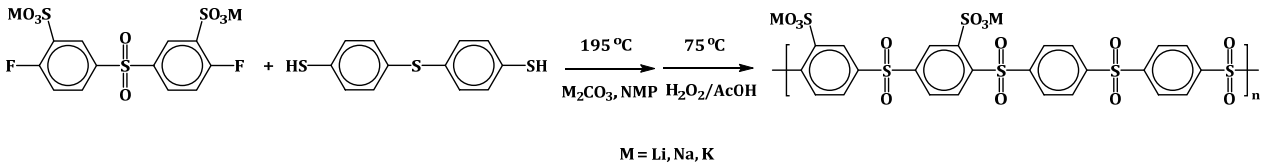
Due to the growing problem of the global energy crisis, there is an urgent need for the development of alternative energy sources, such as fuel cells (FC). Among the different type of fuel cells, proton-exchange membrane FCs (PEMFCs) have a great potential due to high energy density and zero local pollution. PEMFCs can replace modern internal combustion engines and become a practical candidate for use in the automotive industry. Benchmark PEM materials are perfluorosulfonic acids (PFSAs) such as Nafion®. However, PFSA materials have crucial disadvantages such as low operation temperature (this is due to the low glass transition temperature: $T_g \approx 90$ °C) which leads to the poisoning of the catalyst, environmental incompatibility, high gas permeability, high fuel crossover, high cost, high electroosmotic drag of water from the anode to the cathode and deterioration of mechanical properties at high temperature and low humidity. Therefore, there is substantial interest to develop novel proton conducting materials. One of the most promising materials for use in PEMFCs as proton-conductive membranes are poly(phenylene sulfones), where main backbone consists of phenyl rings connected merely with electron-withdrawing sulfone ($-SO_2$) units, which causes stabilization effect and provides high hydrolytic and thermosoxidative stability of the polymer. In this work, we have optimized the synthesis conditions of disulfonated 4,4'-difluorodiphenylsulfone (SDFDPS), which is the most essential comonomer in the synthesis of sulfonated polysulfones. Moreover, SDFDPS in different ionic forms (Li, Na and K) were obtained and the influence of metal ions on the polymerization in terms of molecular weights of half sulfonated poly(phenylene sulfone) — $sPSO_2$-360's was investigated.



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Abstract

INFLUENCE OF COMPOTIBILIZATOR ON THE FULLERENCE-CONTAINING COMPOSITES

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In recent years, the development of polymer nanocomposites has attracted great scientific and industrial interest. Prevention of aging of polymer composite materials (PCM) as a result of long-term use, which has a special place in materials science is one of the important issues . Additives that increase the stabilizing activity of polymers are necessary to slow down the aging process [1].

Carbon nanoparticles including fullerenes are among them and they are considered as promising fillers bearing antiradical functionality. However the bad compatibility one of the constraining factors for wider use of these advanced polymeric materials [2].

To obtain a polymer blend or nanocomposite with the desired properties, compatibilization is an important issue. In fact, differences in chemical nature between polymers or polymer matrices and nanoparticles can lead to the appearance of co-systems with inadequate properties. Compatibilization gains importance in order to improve the properties [3].

Compositions based on isotactic polypropylene (PP), fullerene soot (FS) and maleinized high density polyethylene (MA-g-PE) were prepared by the melt blending technique. To improve the compatibility between the components of the PP composition, a compatibilizer was inserted into its composition - maleinized high-pressure polyethylene (MPE), the presence of which in the composite structure affects the interfacial region, contributes to an even greater system structuring. It was shown that the insertion of FS into the composition of the PP together with MPE leads to a significant increase in the ultimate strength and relative elongation of the composite, which is apparently due to with the synergistic effect of the interfacial interaction of fullerene-containing nanoparticles in the PP matrix with the components of the polymer composition - maleic groups of the MPE, the mutual influence of which contributes to an increase in both the deformation value and the strength index [4].

The presence of maleic groups in the composition of the MPE creates the possibility of its interaction along the double bonds of the FS, which further strengthens the structure of the nanocomposite.

Derivatographic studies have shown that the introduction of MPE into the composition of the PP/FS composition improves the thermal-oxidative stability of the obtained nanocomposites.

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HETEROCYCLIC UNIT CONTAINING CONJUGATED ELECTROACTIVE POLYMERS, ON THE BASE OF P-,M-PHENYLENEDIAMINES

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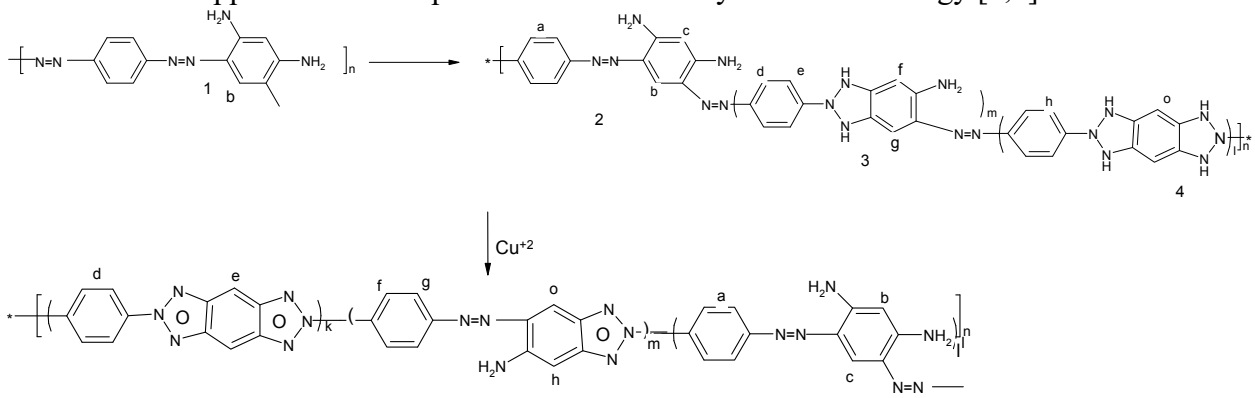
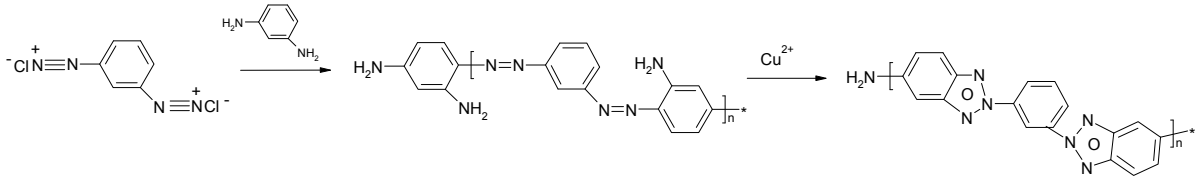
Benzotriazolegroup containing polymer hasbeen synthesized, chemical and biological properties of which can find application inbothpharmaceuticalindustryand biotechnology [1,2].



Scheme 1



Scheme 2

Poly(azo-m(p)-phenyleneazo-2,4-diamino-1,5-phenylenes) have been synthesized by the method of diazotization of corresponding p- and m-phenylenediaminesand azocoupling with m-phenylenediamine (Scheme 1) [3]. As it has been established by spectral data, simultaneous reaction between azo and ortho-amino groups proceeded with formation of dihydrotriazole cycles were processed.In the main polymer chain benztriazoleunits containingnew polymer prepared was prepared by the subsequent oxidation of the obtained polymers with coopersulphate pentahydrate.(Scheme 2). Based on step grow mechanism of polymerization, some oligomers: trimer and pentamer were also synthesized. Comparative study of the obtained azo and amino group containing polymers has been carried out to reveal possible applications.

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Abstract

STUDY OF POSSIBLE NEGATIVE IMPACT OF A NEW WOOD COMPOSITE CONTAINING SILYLATED STYRENE ON A LIVING SYSTEM IN EXPERIMENT

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Purpose of the study. Nowadays the study of the environmentally friendly, new binder compounds and their applicability in wood composites is of particular importance. Therefore, the aim of the study was to investigate the potential adverse effects on the adult white mice obtained by in situ polymerization during hot pressing method of triethoxysilylated polystyrene (obtained via Diels-Alder reaction of vinyltriethoxysilane and styrene) with pine sawdust.
Study objects, Methods and Material. The study was conducted on white adult mice (25- 30 g). Blood and liver were used as study material. Changes in hepatic histoarchitectonics were assessed by microscopic observation of paraffinembedded tissue section. Goriaev camera was used to count the total number of leukocytes in the blood. Duration of experiments was- 90 days.
Results: Studies have shown that a new composite of triethoxylated styrene wood causes no change in the total number of leukocytes in the blood of white mice. Also, no changes in hepatic histoarchitecture were observed.
Conclusion: The new wood composite, in which triethoxylated styrene is used to bind wood, have no negative impact on various tissues of white adult mice. Thus, the wood polymer composite can be considered as environmentally safe.

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Abstract

NEW FUNCTIONAL AZO DYES ON THE BASE OF ECOFRIENDLY MOEITIES

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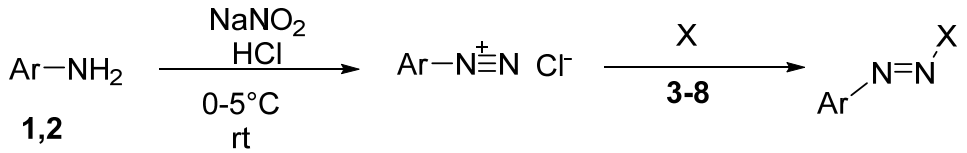
Diazotization and azo coupling reactions are versatile tools of fine organic synthesis. These consecutive reactions commonly are used for the generation of azo chromophore and colored materials, having ability to color other substances. Azo dyes have very interesting physical, spectral and chemical properties and are widely used in the different fields of the science and technology. Moreover, some of them have very significant biological activity and are used in the healthcare or medical diagnostics. Azo dyes usually are in close contact to human body and potentially may penetrate into organism in some quantity and undergo metabolism process forming mutagenic and toxic primary aromatic amines. Therefore, it is very important to choose the non-toxic, eco- or biofriendly diazo and azo partners during azo compound construction [1-3].

In the current research we have obtained several new dyes bearing azo group as well as two π-conjugated azo and chromene, thiobarbituric acid or quercetin chromophores. The target compounds were synthesized in accordance with two sequential stages of diazotization-azo coupling, as shown on scheme below. 6-aminocarine (**1**), 5-aminosalycilic acid (**2**) were chosen as the diazo partners, and 2-hydroxybenzoic acid (**3**), naphthalen-2-ol (**4**), 4-amino-5-hydroxynaphthalene-2,7-disulfonic acid (**5**) and (E)-3-(4-hydroxyphenyl)acrylic acid (**6**), thiobarbituric acid (**7**), quercetin (**8**) for azo partners.



Diazotization of **1**and **2** has been carried out in the deluted hydrochloric acid media by the action of sodium nitrite at 0-5 °C under stirring for a period of 60 min. Finaly, diazonium salt in the form of water solution was filtered off quikly on the filter paper in the ice bath for avoiding decomposion of diazoniums salts and been used immediately in the azo coupling reaction with preliminarily prepared and cooled to 0°C alkali solutions of azo partners **3-8.** The azo coupling reactions were caried out by adding diazopartner solution to the azo partner solution under vigorous stirring and carefull monitoring of pH value. The final compounds have been precipitated by adding 10% hydrochloric and isolated. Obtained azo dyes have been used for dyeing wool fiber and variuos technical (dye uptake ability, ligth fastness and resistance agains wet treatment.

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Abstract

STUDY THE MODIFIED MORDENITES IN LEAD ADSORPTION FROM WATER

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The environmental pollution is the most important challenge in the modern world. Human's industrial, agricultural and domestic activities affect the ecological system,caused global warming and the generation of wastewater, containing large amounts of hazardous pollutants. Zeolites are aluminosilicative crystal minerals that have been characterized by good sorption properties and are alternative means of environmental protection. Natural mordenite takes a special place due to its unique adsorption, catalytic, ion-exchange properties, and considerable chemical and thermal stability. The high content of zeolite in rock allows us to use it widely, as in our country there is no synthetic zeolite production and the purchase thereof is quite expensive.

In this study we used Georgian natural zeolite - mordenite, as initial one, and modified forms obtained by improved methods. The research aim is effective prevention from wastewater pollution. Accordingly, the main task of this research is to study lead ion adsorption using cheap and eco-friendly sorbents. We used a laboratory experiment to evaluate the effectiveness of selected adsorbents for the removal of heavy metals from industrial effluents. These include studies of sorption parameters, kinetic studies and regeneration.

Investigation of sorption processes and characterization of adsorbents requires sensitive methods of analysis that are still in the process of formation. To characterize the modified mordenite samples (HMOR, NaMOR, NH_4MOR) and to study adsorption processes we use: Atomic-adsorption spectroscope (AAS), Scanning electron microscope (SEM), Energy Dispersive Spectroscopy (EDS), X – Ray Fluorescence (XRF), (XRD) and etc. As the result of both EDS and XRF analysis shows, mordenite is mainly composed SiO_4 and AlO_4^- tetrahedra. The analysis also showed that cations Na^+, Mg^{2+}, K^+ and Ca^{2+} compensating charge of structure, are located in the zeolite cavities. Na^+ ions prevail.

Kinetic studies have shown that the sorption of lead ions increased with increasing adsorbent mass and crushing time. Zeolite samples in quantity of 0.1 - 5 g were contacted with a model solution of constant volume lead (Pb^{+2}). Experiments were performed in different time ranges (0.5-90 minutes) to select the optimal adsorption time. Lead concentration in initial and post-sorption solutions was determined by atomic adsorption spectroscopy method. The results show that the removal efficiency of Pb^{+2} 60% to 99% when increasing the adsorbent mass from 0.1 to 5 grams, respectively. The dynamic sorption capacity in regard to Pb^{+2} varied between 0.50-0.69 mg/g. The maximal results were reached for NaMOR. The equilibrium studies show that, the sorption capacity changes with the change pH in solution. A significant role is played the sorption activity of mordenite in relation to lead, which makes it possible to use mordenite for cleaning storm water and adjacent areas of large highways.

Abstract

ANTIBACTERIAL ARSENIC DOPED POLYMER COMPOSITES IN HEALTHCARE AND HOSPITALS

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Improving cleanliness in hygiene-critical healthcare environments by enhancing products, equipment with an added level of protection against bacterial growth becomes the most important issue since 2020 Covid-19 pandemic. New research indicates that the patient environment is just as important as the nurse's hands in its impact on the patient's overall wellbeing [1-2]. The importance of antibacterial coatings for various devices, components and materials are now in progress. Polymer-based composites (PBCs) are used fairly often and make possible wide ranges of property modification. New antibacterial arsenic doped PBCs were created and their antibacterial activity against E. coli, S. aureus, C. albicans and S. epidermidis were studied; high thermal stability was demonstrated by thermogravimetric analysis (TGA, PerkinElmer) - as a consequence various types of behavior and a promising performance in Healthcare and Hospitals services [3-5].

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Abstract

THE ROLE OF NANOCOMPOSITES IN VETERINARIAN SCIENCE

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The Arsenic compounds, such as As_2O_3, As_2S_2, As_2S_3,$(RO)_3As$, $ZnHAsO_4$, $SnHAsO_4$, $MnHAsO_4$ are widely used as nanomaterials. One of the study directions of our research is to create and manufacture the compounds of Nano helminthes.

The parasitic diseases of plants and animals are very perfidious and trespass the producer. Now-adays, the modern and efficient anti-helminthes Nano-compounds are scrutinized –Tin (II) hydro arsenic with the Copper sulfate as an adjunct; Zinc hydro arsenic with the Albendazole. The active substance, Tin(II) hydro arsenic as the Nano-compound, is obtained by the synthesis of pharmacopoeia 7-10 % arsenic acid and Tin (II) chloride. The second active compound- Zinc hydro arsenic as the Nanosubstance is produced by the combination of pharmacopoeial 11-12% arsenic acid and zinc oxide. Above mentioned Nano-compounds are highly effective anti-helminthes and they possess the ability of synergic operation. These Nano-compounds are conferred to Anti-Anoplocephalic product. After obtaining the defined dose, the compounds are not cumulated in theparachimatous organs. The world's veterinary organizations and services aspire to seek and produce the fastest and highly efficient Anti-helminth compounds, which is eminently crucial for different kinds of animals and birds.

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DESIGNING AND 3D PRINTING OF POLYMER STENTS FOR CHRONIC SINUSITIS

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Chronic sinusitis is one of the most common nasal diseases. It occurs, when nose and sinuses are swollen and inflamed due to infection or polyp growths. It is commonly treated by using drugs based on steroids, but in some cases, the surgery has to be done e.g. to remove polyps. In such cases, weakened sinus has to be reinforced to not allow its shrinkage. Such reinforcement can be done by using bioresorbable polymer stent. The first step toproduce polymer stent for chronic sinusitis is to design its geometry and select a manufacturing technology. The production technology that was chosen was Fused Deposition Modeling (FDM). FDM is an additive manufacturing process that belongs to the material extrusion family. Objects are built by selectively depositing melted thermoplastic material in a pre-determined path layer-by-layer [1]. The biggest advantage of using 3D printing technology is the ability to print any shape, structure geometry, and the ability to combine it with diagnostic imaging methods as computer tomography, magnetic resonance or x-ray radiation to allow patient-specific solutions.There are many drawings of stents that are applied to the sinuses in patent US 10,471,185 B2[2]. The design of geometry for the new stent was based on them. The stent geometry was designed in the 3D AutoCAD design program. The next step was exporting 3D model as an .stl file. The complex part behind STL files is that the surfaces of 3D model are converted into complex network formed from tiny triangles. Such .stl file has to be processed in program designated for specific 3D printer, called “slicer”. At this point, the material from which the designated stend will be printed, has to be chosen. Currently, the most common medical filaments for FDM printers are thermoplastic biopolymers based on polylactide (PLA) or polycaprolactone (PCL). They provide the required properties such as biocompatibility, biodegradability and adequate mechanical strength. Slicer slices the triangle network into layers of designated height. Then it prepares the travel path of the printer nozzle in order to print the model using G-code. G-code is a universal language used for programming manufacturing devices using series of commands which tell the machine what to do e.g. move orwhich temperatures have to be used[3]. In this study commercial PLA was used to establish the parameters of 3D FDM printing with different types of PLA and estimate the quality of obtained printouts of designed stent geometry.

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Abstract

PRODUCTION OF THE NEW KIND POTASSIUM-CONTAINING NATURAL FERTILIZER USING THE NATURAL SORBENTS

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The potassium-enriched fertilizer is produced on the basis of the natural zeolite. It is a nitrate-free, ecologically pure product.
Essence of the method includes using of the cheap natural sorbents for treatment of sea water, which are able to provide the selective extraction of alkaline and alkaline-earth ions.
Cheapness and availability of primary raw material (the natural zeolite of Dzegvi and Tedzami fields, namely clinoptilolite is used as a substrate and sea water – as a potassium ions source) makes this method very interesting and prospective for the countries having the recourses of clinoptilolite, locating in the seaside regions and maintaining developed agrarian production (Georgia, Rumania, Bulgaria).
In comparison with the other ocean waters content of potassium ions in the Black Sea is half as much. That is why a great amount of water is needed for production of the final product. For this purpose, concentration of potassium ions in sea water using the membrane technology for further passing through the sorbent was performed.
For concentration of sea water the method of membrane filtration was used, which allows to produce mineral salts solution of maximum concentration and water as filtrate. For separation of bivalent ions (Ca^{+2}, Mg^{+2}) and univalent ions (K^{+}, Na^{+}, Li^{+}) in sea water the technological process developed by us was used.
Specially matched membranes and filtration parameters will allow production of sea water concentrate with K^{+} ions concentration indexes exceeding those of the other ions.
In each cycle of concentration electrodes polarity and direction of hydraulic flow were changed aiming prevention of precipitation on the electrodes and membranes.
The model apparatus allows concentrating sea water with production of the concentrate where concentration of potassium ions is twice over sodium ions. Membrane and sorption filtration of sea water will allow us to produce sea water concentrate with potassium ions concentration four times over the initial index.

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Abstract

NANOPOROUS THERMOSTABLE CYANATE ESTER RESIN/POLYTETRAMETHYLENE GLYCOL HYBRID NETWORKS

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Nanoporous thermally stable polymer films from Cyanate Ester Resins (CER) and polytetramethylene glycol (PTMG) hybrid networks have been developed using nuclear technologies. Namely, the CER/PTMG=90/10 wt.% hybrid networks were synthesized and their thin films (thickness of 50 μm) were prepared and then irradiated with α-particles followed by chemical etching. The additional sensitization by γ-irradiation of some of the irradiated samples was applied for potential increasing the etching rate. The porosity of the resulted materials was examined by using SEM and DSC-based thermoporometry techniques. Average pore diameter was found to be around 13–15 nm and nanoporous CER/PTMG hybrid networks had quite narrow pore diameter distribution. It has been found that through pores were obtained and their sizes were almost the same on both sides of the film when using the nuclear approach (irradiation by α-particles). The chemical structure of the precursors and the resulting nanoporous CER/PTMG hybrid networks was confirmed by FTIR spectroscopy and no significant changes in chemical structure of the polymer systems obtained after irradiation were observed. The thermal properties of nanoporous CER/PTMG hybrid networks were investigated by DSC and TGA techniques. The series of nanoporous films synthesized possess appropriately high thermal characteristics: T_g ~ 166 °C to ~189 °C, $T_{d5\%}$ ~ 225-362 °C, and $T_{d\ max}$ ~ 446-459 °C. It was found that the CER/PTMG nanoporous thermostable materials demonstrate effective gas transport properties examined with gases He, CO_2, and O_2. Thus, one can conclude that the nanoporous materials developed are promising for using, for example, as selective membranes for advanced technologies, especially under extreme conditions.

Acknowledgement. The authors gratefully acknowledge the National Academy of Sciences of Ukraine (NASU) and the "Centre National de la Recherche Scientifique" (CNRS) for partial financial support through Ukraine-France cooperation Project PICS No. 5700 and French-Ukrainian International Associated Laboratory on Nanoporous Thermostable Polymer Materials "LIA POLYNANOPOR".

RUTHENIUM-BASED WATER OXIDATION CATALYSTS WITH A SULFONATE-BEARING PHENANTHROLINE LIGAND – ACTIVITIES AS A FUNCTION OF THE SECOND N,N,N LIGAND

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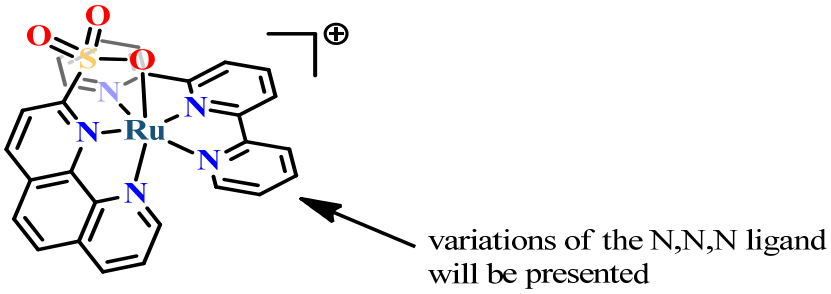
Using sunlight to extract electrons from water is called water oxidation, and in the future could be used on large scale to replace carbon (coal), photovoltaics, or other sources of electrons with which to do useful chemistry that could store solar energy. For example, the electrons generated from sunlight and water could be used to reduce water protons, making so-called green hydrogen.
Catalysis will be key to these efforts. We consider catalysis to be a race between the desired catalyzed process and undesired catalyst loss. To win the race we can either improve catalyst longevity (increase turnover number) and/or rate of reaction (increase turnover frequency). Water oxidation demands the movement of four protons and four electrons in order to form oxygen. Pendent bases are well known to accelerate reaction rates by facilitating proton transfer during the catalytic cycle (higher turnover frequency).
This presentation shows that ligand design can result in fast **and** durable catalysts, and shows the effects of electron-donating and –withdrawing groups on catalyst performance. The catalysts show good electrocatalytic activity in acid, which is highly unusual for molecular water oxidation electrocatalysts. We have recently published the parent compound **1** with phenanthrolinesulfonate ligand and terpyridine as N,N,N co-ligand [1]. Here, the discussion will be about comparison of the parent compound and analogs with different N,N,N co-ligands.



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Abstract

ZINC-CONTAINING NANOCOMPOSITES BASED ON ISOTACTIC POLYPROPYLENE AND BUTADIENE-NITRILE RUBBER

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The intensive development of the global petrochemical industry involves the constant search for new materials with high consumer properties, environmental safety and ease of processing. Such materials are not without reason thermoplastic elastomers (TPE). The creation of TPE is a priority area of work in the field of polymer materials science. A distinctive feature of TPE is the combination of the properties of vulcanized rubbers during operation and thermoplastics during processing.

A large number of studies on TPE and TPV were obtained using polypropylene (PP) as a thermoplastic, and EPDM, natural rubber, butadiene nitrile rubber (BNR), etc. as elastomers, using various fillers or compatibilizers to improve compatibility, physical-mechanical and technological properties of the compositions[1, 2].

The development of research on nanoscale and cluster metal-containing particles in polymer matrices was largely facilitated by the creation of metal-polymer composite materials with specific physical-mechanical and operational properties: enhanced thermal and electrical conductivity, high magnetic susceptibility, the ability to shield ionizing radiation, etc.

In the present work, we studied the effect of small NF additives containing NPs of metal oxides on the properties of mixed TPEs based on isotactic PP and BNR.

The nanoparticles (NPs) of zinc oxide I (ZnO) stabilized by a high-pressure polyethylene polymer matrix obtained by the mechanochemical method in a polymer melt were used as NF. The content of nanoparticles is 5 wt. %, size 26±1.0 nm, and crystallinity 35-45. The ratio of the components of the composition (wt.%): PP / BNR/ NF = 50/50 / (0.3; 0.5; 1.0).

It was shown that the introduction of metal-containing NF into PP/BNR leads to an increase in the strength index from 5.04 to 6.94 MPa and to an increase in the rupture strain of the composite by 2.0–2.5 times. A study of the Vicat softening point of the obtained compositions showed that the introduction of a nanofiller into the composition of PP / BNR leads to an increase in the heat resistance index from 87 to 125°C. The melt flow index (MFI) increases from 0.089 to 0.287g/10 min, which indicates an improvement in the yield strength of the composition and the possibility of processing it by injection molding and extrusion.

Derivatographic studies have shown that the introduction of NF containing NPs of zinc oxide into the composition contributes to an increase in the half-decay temperature of the samples: T_{50} from 300 to 380°C; the half-decay time $\tau_{1/2}$, increases from 62.8 to 80.3 min., the activation energy (E_a) of the decomposition of the thermooxidative destruction of the obtained nanocomposite increases from 124.48 to 204.77kJ/mol, while T_{melt} remains at the level of 150°C.

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FORMATION OF ARENO-FORMALDEHYDE RESINS DURING MODIFYING CRUDE OIL RESIDUES WITH FORMALDEHYDE

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In order to obtain high-quality commercial paving bitumen, crude oil residues (tars) undergo the oxidation or deep vacuum distillation; as a result oxidized or distillation bitumen, respectively, is produced. During these processes, it is almost impossible to obtain bitumen with good performance properties (especially heat resistance), which would meet modern requirements. Therefore, the bitumen is usually modified with expensive polymer modifiers (e.g, SBS). Previous studies have shown that modification of crude oil residues with formaldehyde allows to obtain paving bitumen with higher performance (higher softening point and adhesion to the surface of crushed stone) in comparison with oxidized and distilled bitumen. It means that tars modification with formaldehyde allows to obtain paving bitumen that meets and exceeds the standards for oxidized and distillation bitumen.

The first stage of investigation was to determine the effect of adding solvent-diluent in order to reduce the viscosity of the reaction mixture and increase the intensity of modification. Tar and oxidized bitumen of BND 60/90 grade (PJSC Ukrtatnafta, Kremenchuk, Ukraine) with softening temperatures of 39 and 46 ºC, respectively, were used as raw materials. The modification process was carried out in the presence of a catalyst (HCl) at a temperature of 120 °C for 3.0 hours. Toluene, p-xylene, naphtha solvent and n-octane were used as solvents. The possible chemistry of the copolycondensation process is given below.

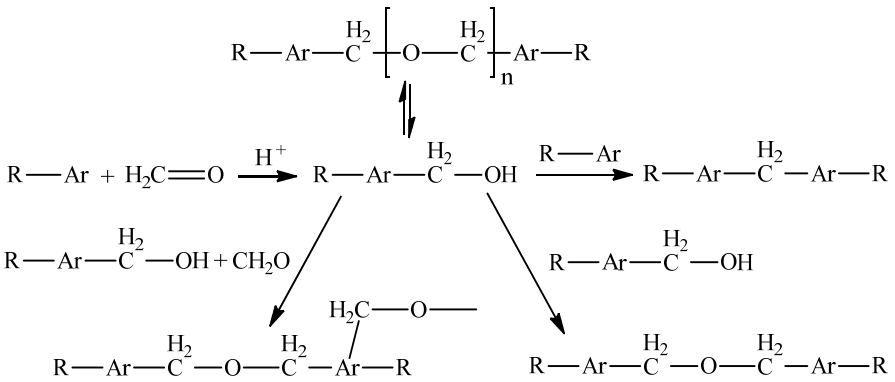

Figure. Chemistry of the aromatic compounds copolycondensation with formaldehyde

It was found that the solvent should be used for the modification of bitumen (distillation and oxidized), rather than tars, due to the higher viscosity of bitumen. When oxidized bitumen was modified without solvent, the softening temperature increased by 7 ºC; when 40 wt % of toluene, naphtha solvent and n-octane were used, the temperature increased by 12, 12 and 13 ºC, respectively. That is, the efficiency is twice as high. When solvent-free tar was modified, the softening temperature increased by 13 ºC; when 40 wt % of toluene, p-xylene, naphtha solvent and n-octane were used, the temperature increased by 11, 5, 9 and 13 ºC, respectively.

Abstract

REGULARITIES OF THE EPOXIDATION REACTION OF THE COTTON OIL WITH HYDROGEN PEROXIDE ON THE CHLORINE-CONTAINING CATIONITE KU-2X8

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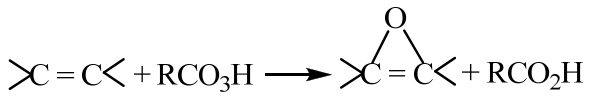
The search of effective catalysts for the epoxidation reaction of unsaturated compounds in a combined system by peracid at the time of its formation as a result of interaction of carboxylic acid and hydrogen peroxide is of great practical importance. We have previously showed that the cation-exchange resin of KU-2x8 type is more effective catalyst than mineral acids for the epoxidation of unsaturated compounds in a combined system. It should be noted that the destruction of polymer matrix of cationite under action of temperature and oxidizers influences negatively on its activity and service life [1].

In this paper, the results of epoxidation of the cotton oil by perpropionic acid at the time of its formation from propionic acid and hydrogen peroxide using chlorine-containing cationite KU-2x8 as the catalyst have been presented. It has been established that unlike KU-2x8, its chlorine-containing analog is more stable to action of oxidizers. The chlorinated cationite with chlorine content 9.5% does not lose its weight and initial activity even after 3500 hours of exploitation. However, a service life of KU-2x8 cationite in the medium of hydrogen peroxide and carboxylic acid does not exceed 1600 hours [2]. The epoxidation process of the cotton oil at the time of formation by perpropionic acid in a combined system is sequentially two-stage.

In the first stage, the propionic acid is oxidized with hydrogen peroxide on the chlorine-containing cationite KU-2x8 to perpropionic acid, which then interacts with the cotton oil. Although the stage of formation of perpropionic acid is reversible, but due to the consumption of peracid at formation for epoxidation, the all process becomes practically irreversible:

$$H_2O_2 + RCO_2H \longleftrightarrow RCO_3H + H_2O$$



It has been established that the epoxidation process of the cotton oil in a combined system is limited by the stage of formation of perpropionic acid. With an increase in temperature from 40 to 700°C, the epoxidation rate in the presence of 10 mass % chlorine-containing cationite increases from $0{,}95\cdot10^{-4}$ mol/l.s to $9{,}7\cdot10^{-4}$ mol/l.s.

The selectivity of the epoxidation process on the chlorine-containing cationite reaches 95%.

The mixing intensity of the reaction mixture higher 100 rev/min practically provides the reaction behavior in the kinetic field and the cotton oil epoxidation process rate does not depend on the grain size of the chlorine-containing KU-2x8. During carrying out of the epoxidation reaction without mixing of the reaction mass, the concentration of perpropionic acid in the aqueous phase increases, which has been connected with the diffusion inhibition of the epoxidation stage.

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Abstract

SYNTHESIS OF AROMATIC POLYESTERS BASED ON NORBORNANE-CONTAINING DIOLS

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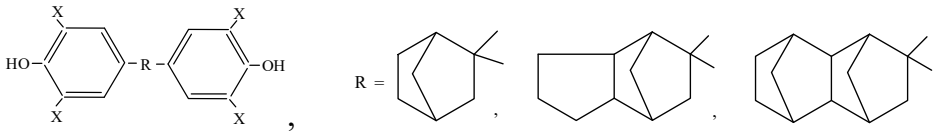
Progress of many branches of modern technology requires creation of new type materials, which at strict terms of exploitation - at high temperature and high mechanical charges will retain high strength, will be characterized by high heat- and thermal resistance and other properties.

With this in view, the so-called card polymers are most perspective polymers. These polymers contain cyclic side groups in repetition rings, one atom of which simultaneously is a component of a macromolecule. Presence of such groups grants specific properties to polymers when high thermal resistance of polymers is fused with their good solubility.

To obtain hetero chain polymers we used norbornane type card monomers, bisphenols, containing such groups.

The structure of norbornane type polycyclic bisphenols used by us for the synthesis of polymers is as follows:



X = H, CH_3 - , Cl

Acid that was used as a component was 4,4[1]-diphenyl-di carbonic acid dichlorane hydride. Polymer synthesis was realized by the method of high-temperature polycondensation in ditolyl methane. Polymers obtained on the base of polycyclic bisphenols and aromatic dicarbonic acid are characterized by high thermal resistance. Polymers are characterized by high thermal resistance. Reduction of their mass at heating on air starts above 300-400°C.

Polymers which contain polycyclic bisphenols are characterized by high resistance to water impact. Films fabricated on the base of these polymers are characterized also by high resistance to concentrated alkali solutions as well to impact of ultra violet emission. At long-term exposure to such terns' polymers remain practically unchanged. Chlorine containing polymers are characterized by refractoriness.

The obtained polymers are well soluble in chlorinated hydrocarbons. They form transparent films in solutions, which possess good mechanical and dielectric properties.

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Abstract

COMPOSITIONS BASED ON AMIDE OLIGOMERS AND THEIR APPLICATION IN AGRICULTURE

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Polymer that is obtained by polycondensation of carbamide with formaldehyde can be used as a nitrogenous fertilizer acting by prolonged mechanism. Polymerized carbamide undergoes biodegradation at the impact of urease bacteria and it passes into the form digestible by a plant and this process is kept for the whole period of vegetation.

For the purposes of getting complex fertilizers, we obtained polymer composites, which alongside with prolonged action nitrogenous fertilizer contain natural phosphorites, potassium salts and microelements. Mixing of the components is performed at room temperature in rotor pellet making unit and the microbial preparation designed for degradation of fertilizer is added in the very unit. Then the mix is granulated. The obtained composite is an ion-exchange system, where ammonium ions created as a result of degradation of nitrogenous fertilizer interact with natural phosphate and substitute calcium atoms in it; as a result of its phosphate, in the form of ammonium salts passes into soluble state and at the action of bacteria is gradually consumed by a plant.

Ion exchange fertilizers consist of hardly soluble ingredients, which as a result of buffer effect of chemical reactions going on in soil are released and are assimilated by plants according to their demands,

Thus, all main nutrients of the composite are released and plants can assimilate them. Alongside with it, other nutrients are released too at the dissolution of P-rock, which, as usual, is very rich in various microelements.

Chemical and field experiments proved that ion-exchange fertilizers are highly efficient and they, helping a plant to assimilate nutrients more effectively, reduce nutrients washing off and contamination of environment. Besides, crop productivity is increased compared with that obtained at the application of common soluble fertilizers

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8. THERMAL PROPERTIES OF TRACK-ETCHED NANOPOROUS POLYHYDROXYBUTYRATES

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Since more than 95% of membrane and porous materials are made of synthetic polymers, thus much attention of scientists and industrial companies focuses on the development of bioplastic and biodegradable materials as promising substituents. Among numerous requirements imposed on membranes is their thermal stability, the aim of this study was to reveal the effect of formation of porous structure on thermal properties of film materials from commercially available and the one most widespread biodegradable polyhydroxyalkanoate, namely microbial poly(3-hydroxybutyrate, PHB).

For the present study, initial thin PHB samples obtained by film casting of dilute PHB solution in chloroform, were irradiated by α-particles during 330-690 s. Subsequent track-etching procedure by using $CHCl_3$/MEK =70/30 (wt.%) mixture revealed well-developed nano-sized porous structure with an average pore diameter around 35-65 nm (depending on irradiation time). Initial PHB film was used as a reference.

The TGA data showed the presence of single degradation stage for all the samples investigated. However, the temperature of degradation onset slightly shifted from 276 °C for the reference PHB to 266-268 °C for the nanoporous films and the temperature range of destruction expanded by 10 °C caused by the formation of a less dense porous structure, char residue increased from 0.3 to 0.6-0.9 % after pore formation.

Analysis of the DSC data disclosed that the temperature values of glass transitions as well as of cold crystallization and melting for nanoporous PHB samples deviated by 1-2 °C from the same values for nonporous analogue. At that, an increase of crystallinity degree (by 5-10 %) after pore generation was also observed, testifying the reduction of amorphous microphase due to its partial removal by irradiation and subsequent etching.

Thus, formation of nano-sized porous structure maintained relatively high thermal stability of initial PHB and the development of porous PHB-based materials using nuclear technologies opens up prospects for production of promising effective biocompatible and biodegradable water-insoluble membranes.

The authors gratefully acknowledge the Ambassade de France en Ukraine for the partial financial support under scientific research work "Novel nanoporous films from fully renewable poly-hydroxybutyrate of microbial origin for membrane technologies" (2016).

Abstract

RECENT ADVANCES IN ELASTOMERIC COMPOSITES FOR NEUTRON SHIELDING APPLICATIONS

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Ionizing radiations which include particles such as alpha, beta, neutron particles also high energy electromagnetic radiation such as X rays and Gamma rays emits in a nuclear reaction due to radioactive decay. If not, efficiently shielded these radiations will cause huge damages to living cells causing cancer, tumors, etc. So, shielding these radiations is the utmost priority as far as safety is concerned. Concrete, lead, aluminum, etc. are usually used as shielding materials, but for complex geometries and uneven surfaces, it is very difficult to use these materials due to their rigid nature. So the development of flexible elastomeric composites for shielding application is been the main area of focus for research community for a long time. The main objective of this paper is to review the latest development made in elastomeric composites for neutron shielding applications.

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Abstract

INVESTIGATIONS ON THE EFFECT OF EPDM CONTENT ON MECHANICAL, MORPHOLOGICAL, RHEOLOGICAL AND THERMAL PROPERTIES OF PP/EPDM BLENDS

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The application of polypropylene as an engineering plastic is limited due to poor toughness at low temperatures or low strain rates. Compounding or blending with elastomeric particles was proven to be an effective and economical approach to create materials with enhanced toughness. In this study, polypropylene (PP) and high-molecular grade ethylene-propylene-diene rubber (EPDM) blends were prepared with different constitutive ratios using melt blending followed by compression moulding technique. The tensile, impact and flexural analysis of all blend formulations were carried out. At lower parts of EPDM (i.e., at 2.5, 5 & 7.5 parts per hundred EPDM rubber) impact strength values are found to be good for PP/EPDM blends. The morphological examinations of cryofractured and impact fractured surfaces were done using SEM and HRTEM to identify mechanisms of toughening in PP/EPDM blends. It is evident from the SEM morphology of impact fractured specimens that, the mechanically induced cavitation behaviour is responsible for the impact resistance of PP/EPDM blends.HRTEM images shows that the increase of EPDM content increased the average diameter of dispersed particles and causes a decrease in the number of dispersed EPDM particles. The low shear rate rheology and dynamic viscoelastic properties of blends were carried out to study rheological behaviour of PP/EPDM blends. Non-isothermal crystallisation kinetics, nucleation activity and glass transition temperature of blends were investigated using DSC analysis. The maximum degradation temperature of blends was obtained by thermo gravimetric (TGA) analysis.

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A REVIEW ON FABRIC SUPER CAPACITORS DERIVED FROM WASTE

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The Fabric Super capacitor is a flexible electrochemical device for energy storage application. It is designed to power up flexible electronic systems used for, for example, information sensing, data computation and communication. The development of a flexible Super capacitor is important for e-textiles since Super capacitor can achieve higher energy density than a standard parallel plate capacitor and a larger power density compared with a battery. Efficient energy storage devices have attracted interest from both the scientific communities and the commercial sector [1]. One such device, the Super capacitor, originated in 1957 [2] is one potential energy storage [3]. Electronic fabrics, also known as e-textiles or smart fabrics, can achieve both the function of normal garments, such as protection from the outside environment, and electronic functions such as sensing, data processing, energy harvesting and energy storage [4]. Potential applications of e-textiles include medical monitoring and personal electronics [1]. Potential utilization of waste materials as feedstock is attractive because they are readily available and inexpensive while nano materials (NM) synthesis is an innovative method of waste treatment and recycling. Considering the present situation, our society would be better off if we can efficaciously recycle and valorize selected waste materials for the synthesis of NMs. At present, many attempts have been made for NM production from a variety of biological and industrial wastes. Employing agricultural waste as an initial feedstock for NMs is also potentially cost-effective [5-8]. In the present review, fabric super capacitors derived from waste and their importance have been discussed.

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Abstract

STUDY THE IMPACT OF IONIC LIQUID MODIFIED GRAPHENE OXIDE ON THE MECHANICAL, THERMAL, AND TRIBOLOGICAL PROPERTIES OF SILICONE RUBBER NANOCOMPOSITES

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Polymer tribological applications in industry and other applications have developed recently because of significant increases in bulk strength, modulus, and toughness with lightweight. In high-demand applications, polymers are nearly always used as composites. The mechanical, thermal, and tribological properties of silicone rubber (QM) were studied after it was compounded with imidazolium ionic liquid modified graphene oxide (ILGO). The pin on disc triobometer was used to examine the tribological properties experimentally, with load, sliding velocity, and temperature as the varying parameters. With load, sliding velocity, and temperature as the variable parameters, the pin on disc triobometer was utilised to investigate the tribological properties experimentally. Ionic liquid performed as a self-lubricating layer for graphene, producing a strong GO-IL interface connection with the rubber matrix. QMILGO1.5 has a 42 percent lower coefficient of friction (COF) than pure QM. This study discusses a novel approach to improving the tribological properties of silicone rubber. Inclusion of ILGO significantly reduces the friction coefficient and specific wear rate. The wear mechanism involves formation of transfer film at the interphase between composite and steel counter surface.

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Abstract

CHALLENGES IN POLYMER NANOCOMPOSITE PROCESSING TECHNIQUES; AN OVERVIEW IN BRIEF

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Of late, nanoscience and technology seem to hastily thrust its applications in all phases of life through the engineering and medicine sectors. Materials science and engineering have incredible advancements in nanocomposite development with enhanced physical, chemical, and mechanical properties. A broad range of researches has already been carried out for the processing of nanocomposites. The consolidation of systems mentioned above, from baggy particles to bulk free form entities, has always been challenging. To name a few, achieving proper dispersion and Co-continuity of phases and controlled assembly of the nanoparticle–matrix interphase are strong limitations during polymer nanocomposites processing. This contribution reviews in brief, through various studies on different methods for manufacturing nanocomposites with enhanced properties and retained nanostructures.In addition, the challenges and recent advances in the area of polymer nanocomposite processing will be discussed.

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Abstract

RUBBER RECYCLING - CURRENT TRENDS, PROBLEMS AND FUTURE DEVELOPMENT

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Although demand for rubber goods continuously increases, the current level of rubber recycling is still atan unsatisfactory level. Estimated data show that up to 2030, the number of waste tires generated to the environment should increase by 20%, resulting in 1 200 million waste tires/per year [1].

In many countries, waste tires are used as an alternative fuel in cement kilns or electrician plants to recover energy. However, this approach is not a "green" and "environmentally-friendly" solution. Therefore, searching and developing new methods of waste tire recycling is fully justified [2].

According to European Tyre and Rubber Manufacturers' Association (ETRMA), rubber grinding is the most common approach. Around 87.5% of all forms of recycling [3] other possibilities are related to rubber pyrolysis and rubber reclaiming/devulcanization.

In this work, current trends, problems, and future development of rubber recycling technologies with particular attention focused on rubber reclaiming/devulcanization technologies and reclaimed rubbers properties are highlighted and discussed. Presented data can be helpful information for researchers, start-ups, or companies working on technologies based on the application of ground tire rubber.

Acknowledgments. Financial support of project LIDER/6/0035/L-8/16/NCBR/2017 provided by the National Centre for Research and Development (NCBR, Poland) is gratefully acknowledged.

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Abstract

CELLULOSE CONTAINING COMPOSITE SORBENTS TO REMOVE HEAVY METALS

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The most common and effective method for heavy metals removal is sorption method. The advantage of this method is that it is possible to purify wastewater that contains a large amount of impurities (for example, organic or inorganic). In recent years, for water purification, much attention has been paid to natural sorbents or sorbents based on materials of natural origin.
Natural sorbents are widely used due to their low price. The cost of natural sorbents is ten times less than the cost of artificial sorbents. In the past few years, chemically modified carriers have been proposed to improve the adsorption selectivity towards ions. The most promising carriers were ion exchange resins, cellulose, activated carbons, natural minerals. The application of these materials led to the development of several new sorbents.
Cellulose is the most common biopolymer in the world and the presence of several hydroxyl groups in the structure of its molecules allows modifying its surface properties with the introduction of several chemical groups. Cellulose and its derivatives are used as an adsorbent to remove several contaminants. After chemical modification, cellulosic materials exhibit new properties that are more effective than starting materials. These new modifying groups on the surface of cellulose increase the interaction with pollutants (metals, dyes, drugs, etc.) in the process of absorption from the aqueous medium, which strongly depends on the pH of the solution. Cellulose materials modified by various functional groups are promising for use in the removal of pollutants from the aquatic environment.
By ICP-MS method, the sorption properties of organic-mineral composite sorbents are investigated. The diatomite of the Jradzor deposit and bentonite of the Sarigyuh deposit (Armenia) were used as inorganic constituents. Diatomite serves as a structure-forming component and provides mass transfer due to its high porosity (V=2.0 cm^3/g) and large pore sizes, the size of which is 150-200 nm. Bentonite is responsible for the functionality of the sorbents. The organic component is also responsible for the functionality of the resulting sorbents. As the organic component used paper, pre-treated with acids (nitric and phosphoric). A synthetic solution containing cations of heavy metals was used as an object of study. The experiments were carried out in a static mode on the device Jar-Test.

Abstract

SYNTHESIS OF MONODISPERSE LATEXES TO CREATE IMMUNODIAGNOSTIC DRUGS

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Monodisperse latexes are the main raw material for the production of immunodiagnostic drugs.
Doing a search in scientific journals and on the Internet one can find plenty of publications in which provided recipes are synthesis of monodisperse latex. After reading these recipes, one can make a conclusion that the monodisperse latex is prepared likely intuitively than using programmed recipes.
The main method for producing monodisperse latexes is polymerization in a highly dispersed monomer-water system (emulsion polymerization).
The report presents the results of the study of the mechanism of formation of latex particles in the polymerization of different monomers in a heterogeneous static monomer-water system. Based on this study, we have developed recipes for the synthesis of monomodisperse latexes. The report demonstrates electron photographs of particles of the latexes synthesized based on chloroprene, styrene and vinyl acetate.

THE ROLE OF MALEIC ANHYDRIDE IN THE PROCESSES OF OIL RESIDUES MODIFICATION

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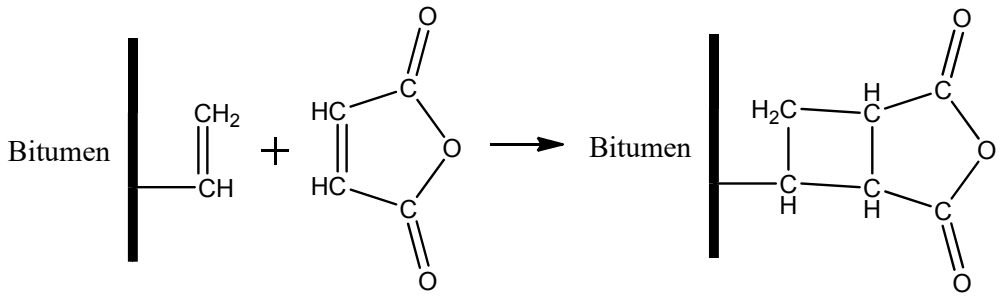
Paving bitumen is the main binder used in road construction. There are a number of problems with its production and application: (i) the impossibility to obtain high-quality paving bitumen at the existing oil refineries of Ukraine; (ii) insufficiently high heat-resistant and adhesive properties of commercial bitumen; (iii) the necessity of expensive polymer modifiers addition to improve the bitumen serviceability.

It is known from the literature that resin-asphaltene substances, which are the main part of petroleum residues, can interact with maleic anhydride by the Diels-Alder reaction:



Modification of BND 60/90 oxidized bitumen with maleic anhydride (MA) was performed at 150 °C for 1 h in a nitrogen atmosphere. To confirm the positive effect of MA addition on the properties of modified bitumen, the main characteristics of the original bitumen and MA modified bitumen were compared (Table).

Table

Charcateristics of the original bitumen and MA modified bitumen

Bitumen	Penetration at 25 °C (0.1 mm)	Softening point (°C)	Adhesion to the crushed stone (points)	Fraass breaking point (°C)
BND 60/90	71	46	2.5	-10
BND 60/90 + 1% MA	44	49	3.5	-3
BND 60/90 + 2% MA	34	52	4.5	-3
BND 60/90 + 4% MA	22	66	4.5	-11.5

It is obvious that MA addition to the oxidized petroleum bitumen BND 60/90 increases its heat resistance (softening point increases from 46 to 66 ºC) and adhesion to the crushed stone (from 2.5 to 4.5 points). The interesting tendency should be also noted when adding MA in the amount of 4 wt%: the heat resistance of the obtained bitumen increases (penetration decreases and the softening point increases), while the breaking point decreases.

Abstract

INSTALLATING THE ENLARGED LABORATORY SETUP FOR SYNTHESIS OF MULTTI-WALLED CARBON NANOTUBES

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Multi-wall carbon nanotubes (MWCNT) are one of the main innovative materials used for the development and application of carbon nanotechnology. However, to date, the cost of CNT remains relatively high, and in this regard, the development of improved technologies, methods and installations with advanced capabilities for the synthesis of CNT is an important and urgent task. In our work, for the first time in Azerbaijan, an enlarged laboratory installation for the synthesis of MWCNT from gas raw materials using the "Chemical Vapore Deposition" (CVD) method was designed and installed (Fig.1).

Figure1. Installation of the synthesis of MWCNTs materials by the CVD method.

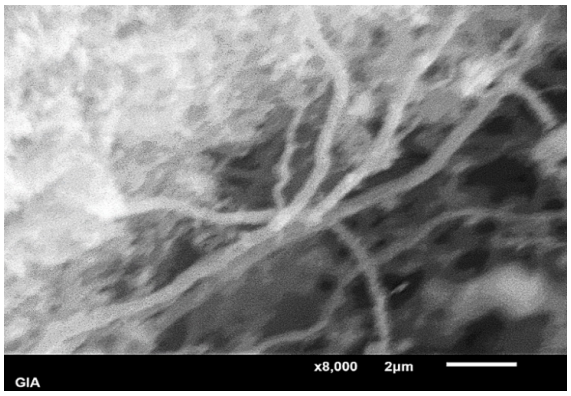

Figure 2. SEM image of MWCNTs synthesized from gas raw propane.

Installation dimensions 180 cm x 180 cm x 80 cm. The length of the tubular two-section furnace is 100 cm, and its internal diameter is 30 mm (Fig. 1, >2). The length of the quartz reactor is 150 cm. The design of the installation is universal and allows for the synthesis of MNT with both a horizontally and vertically located reactor. Various gases or their mixtures can be used as hydrocarbon raw materials - methane, ethane, propane butane, as well as their unsaturated derivatives – acetylene ethylene propylene, butylene and butadiene. Hydrogen is used as an activator gas, and argon is used as a diluent gas. The precursor of the catalyst in the synthesis process can be ferrocene, cobaltocene, nickelocene and other metallocenes. The synthesis process can also be carried out on pre-prepared catalysts on substrates. The quality and morphology of the resulting carbon nanotubes can also vary due to changes in the pressure of the reaction medium provided by the vacuum unit (Fig.1, >5). SEM images of CNTs synthesized at 950 ^{o}C and atmospheric pressure are shown in Fig. 2. Depending on the raw material used, the productivity of the MWCNTs installlation ranges from 1 gram to 10 grams per hour. The advantages of the synthesis method used and the design of the plant are the availability and cheapness of gas raw materials, as well as the possibility of scaling CVD technology for industrial production.

The work was supported by the Science Development Foundation under the President of the Republic of Azerbaijan - Grant № EİF-MQM-ETS-2020-1(35)-08/05/4-M-05

Abstract

ELECTROMAGNETIC RADIATION ABSORBER POLYMER NANOCOMPOSITES

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Recently electromagnetic radiation has been considered a danger to electronics, biological systems, high quality information and safety technologies, etc., for when the electromagnetic waves interfere with a signal coming from an electronic device, a noise known as the electromagnetic interference pollution (**EMI**) occurs [1-3].

After discovery of the unique properties of graphene, new possibilities for research and development of polymer nanocomposites have been opened up. The sphere of application of the innovative polymer nanocomposites produced by using other graphene and carbon nanostructures is enormous, since such nanocomposites can be characterized by extraordinary multifunctional properties [4-6]. Based on the composition and processing complexity, a serious question for mass production of such nanocomposites is how control over the structure, dispersion degree, and morphology will be exercised, so that a material with best properties is produced.

Graphene structures containing polymer (Acrylnitrilbutadien styrol and Polydimethylsiloxane) nanocomposites is developed for application as EMI shielding material. The reflection coefficients of the produced absorbing materials were measured in the frequency range from 10 KHz to 6 GHz. We can note that materials can absorption ability in the ≈ 4.5 – 5 MHz area. The reflection measurements were performed by ASTM D4935 (Standard test methods for measuring the electromagnetic shielding effectiveness of planar materials) method. The structure and composition of the obtained materials were studied by UV, XRD, Raman and SEM. Obtained polymer nanocomposites have potential to use as EMI shielding material.

Acknowledgments. This work was supported by Shota Rustaveli National Science Foundation of Georgia (Grant number CARYS-19-315).

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Abstract

SEPARATION OF ENANTIOMERS OF CHIRAL BASIC DRUGS WITH POLYSACCHARIDE -BASED CHIRAL COLUMNS IN HIGH -PERFOMANCE LIQUID CHROMATOGRAPHY

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In this study, amylose- and cellulose-phenylcarbamate-based chiral columns with different chiral-selector (CS) chemistries were compared to each other for the separation of enantiomers of basic chiral analytes in acetonitrile and aqueous-acetonitrile mobile phases in HPLC. For two chemistries the amylose-based columns with coated and immobilized CSs were also compared. The comparison of CSs containing only electron-donating or electron-withdrawing substituents with those containing both electron-donating and electron-withdrawing substituents showed opposite results for the studied set of chiral analytes in the case of amylose and cellulose derivatives. Along with the chemistry of CS the focus was on the behavior of polysaccharide phenylcarbamates in acetonitrile versus aqueous acetonitrile as eluents. In agreement with earlier results, it was found that in contrast to the commonly accepted view, polysaccharide phenyl- carbamates do not behave as typical reversed-phase materials for basic analytes either. In the range of water content in the mobile phase of up to 20–30% v/v the behavior of these CSs is similar to hydrophilic interaction liquid chromatography (HILIC)-type adsorbents. This means that with increasing water con- tent in the mobile phase up to 20–30% v/v, the retention of analytes mostly decreases. The important finding of this study is that the separation efficiency improves for most analytes when switching from pure acetonitrile to aqueous acetonitrile. Therefore, in spite of reduced retention, the separation of enantiomers improves and thus, the HILIC-range of mobile phase composition, offering shorter analysis time and better peak resolution, is advantageous over pure polar-organic solvent mode. Interesting examples of enantiomer elution order (EEO) reversal were observed for some analytes based on the content of water in the mobile phase on Lux Cellulose-1 and Lux Amylose-2 columns.

SODIUM ALGINATE/GELATIN-BASED MATERIALS FUSED WITH POLYLACTIDE MICROPARTICLES AS TOOLS TO IMPROVE THE ACTIVITY OF ACTIVE SUBSTANCE TO BE ADMINISTERED THROUGH THE SKIN

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The addition of oils to water in the presence of an emulsifier leads to creating an emulsion system, which consists of two immiscible phases: aqueous and oily. Emulsions are widely used in the cosmetic, pharmaceutical, medical, and food industries [1,2].
Our study aims to prepare materials in the form of polymeric matrices with the addition of microspheres containing plant extract. We want to obtain new advanced composite materials for topical applications. These materials improve the barrier function of the stratum corneum by combining microspheres, which are the carriers of the active ingredients, and the polymeric matrix made from hydrophilic polymers with the addition of glycerol and lipids. The polymers used in this work were: polylactide-to obtain microspheres; sodium alginate and gelatin-to get the polymer matrices in the form of film and sponge structure.
Firstly, biopolymer solutions were prepared and mixed with a plasticizer (glycerol) and lipids (cottonseed oil and beeswax). Next, microparticles with encapsulated pot marigold flower extract were added to the obtained emulsion. Finally, thin emulsion films were prepared by the solution casting method. In addition, the obtained emulsion was frozen and lyophilized to obtain sponge materials.
Test results indicate satisfactory dermatologic efficiency of the formulation containing 1% glycerol, 3.4% lipids, and 6% PLA microparticles of the encapsulated Calendula officinalis flower extract [3, 4].
Acknowledgment. Financial support from the National Science Centre (NCN, Poland) Grant No UMO-2016/21/D/ST8/01705 is gratefully acknowledged.

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POLYMERIC MATRICES BASED ON GELATIN AND ISOLATED WHEY PROTEIN WITH POT MARIGOLD EXTRACT FOR TOPICAL APPLICATION

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The skin is the largest organ of the body. Skin is an important site of drug application for both local and systemic effects. However, in the skin, the *stratum corneum* is the actual physical barrier to many substances that contact the skin, so it is the main barrier for drug and other active ingredients penetration [1,2].
The study's main goal is to design, prepare, and characterize a new class of materials to improve the penetration of drugs and active ingredients into the skin. The project is based on the hypothesis that it is possible to obtain materials based on microspheres or microcapsules incorporated in the polymer matrix with activity towards the skin's stratum corneum as its crucial protective barrier.
Materials created due to incorporating microparticles in the polymer matrix will promote trans-epidermal transportation of the active ingredients, ensuring their dual-action. Therefore, in the first stage, the contact of swelled polymer matrices modified by adding penetration enhancers with the skin will decrease its barrier properties and, consequently, in the next step, owing to slow degradation of microparticles, the active ingredient will be gradually released. Pot marigold (*Calendula officinalis*) flower extract as an active compound was loaded into the microspheres made from sodium alginate. This plant extract possesses multiple antioxidants, antibacterial, antifungal, antiviral, anti-inflammatory, and wound healing activities [3]. Then microspheres were incorporated into a polymer matrix based on gelatin and isolated whey protein.
These materials were characterized (structure, mechanical properties, swelling properties, moisture content). The results suggest that our materials may become the basis for new cosmetics or dermatological formulation.
Acknowledgment. Financial support from the National Science Centre (NCN, Poland) Grant No UMO-2016/21/D/ST8/ 01705 is gratefully acknowledged.

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POLYMER-BASED NANOSYSTEMS FOR ANTITUMOR PHOTODYNAMIC AND CHEMOTHERAPY

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The investigation of nanosystems for photodynamic therapy (PDT) is in the focus of current biomedical research. Thanks to the achievements of nanotechnology, it is possible to develop complex therapeutic composites to increase the effectiveness of cancer treatment. Such multi-component drug delivery nanosystems may contain simultaneously several components, for example, metal nanoparticles, photosensitizer, and chemotherapeutic agent incorporated into the polymer matrix. However, the use of multicomponent nanosystems requires serious study of the processes that occur during their preparation and storage to avoid some aggregation.

The water-soluble star-like dextran-graft-polyacrylamide copolymer was used as a matrix for the creation of polymer-based multi-component drug delivery systems for photodynamic and combined (photodynamic+photothermal+chemotherapy) antitumor therapy. The three-component nanocomposites with incorporated gold nanoparticles and Chlorine e6 and the four-component ones additionally loaded by Doxorubicin into polymer matrix were studied in the region of physiological temperatures. It was shown that the three-component nanosystem Polymer, Au nanoparticles and Chlorine e6 demonstrated high efficacy in PDT, but the addition of the fourth component Doxorubicin to this composite resulted in a decrease of anti-tumor efficacy. However, four-component nanocomposite, prepared “ex tempore”, demonstrated higher efficacy in comparison with the previously prepared nanocomposite with the same content of ingredients. It may be due to the fact, that the molecules of Doxorubicin added “ex tempore” are not completely incorporated into polymer in such short period of time. The formation of great aggregates in the previously prepared four-component system Polymer, Au nanoparticles, Chlorin e6 and Doxorubicin seem to cause a decrease in the therapeutic effect in cancer treatment.

Acknowledgement. This publication is supported in part by National Research Foundation of Ukraine, Project 2020.02/0022 “Plasmon hybrid nanosystems "metal-polymer-fluorophore" with enhanced optical response for photonics and biomedical applications”.

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Abstract

TEMPERATURE-RESPONSIVE SMART NANOCARRIERS FOR DRUG DELIVERY IN ONCOLOGY

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Modern advances in nanotechnology contribute to the solution of numerous critical medical and biotechnological problems. Cancer treatment is in the focus of biomedical research because of its great importance for the health and quality of patients' life. Last decades, the different innovative approaches using nanosized materials were studied. A promising trend in the treatment of malignant tumors is the use of complex nanomaterials, which include several components with special functions, potentially enhancing the therapeutic effect.

Water-soluble polymers with special characteristics can be used therapeutically as drug carriers in which the active ingredients are entrapped, encapsulated, adsorbed or chemically attached. The thermosensitive star-like Dextran-graft-Poly-N-iso-Propylacrylamide (D-PNIPAM) copolymer was used as a matrix for synthesis of nanocomposites for photodynamic therapy. This polymer has LCST (33,4˚C) in the region of physiological temperatures. The nanosystems were characterized by DLS and UV-vis at 25 and 37˚ C and tested *in vitro* for their photodynamic anticancer activity. The understanding of the processes occurring during the formation of multicomponent nanosystem consisting of polymer nanocarrier, gold nanoparticles (AuNPs) and photosensitizer Chlorine e6 (Ce6) is the urgent tasks for synthesis of antitumor nanocomposites.

It was shown that in Hank's saline solution at 25 °C D-PNIPAM/AuNPs and D-PNIPAM/-AuNPs/Ce6 nanosystems didn't not undergo drastic changes in compared to the same systems in water. Just a slight compactification of the macromolecular coil registered. It was found that an aggregation process become more evident at the presence of Ce6. At 37° C the size of AuNPs does not change, but a compactification of aggregates of macromolecules took place.

In vitro testing of photodynamic activity of D-PNIPAM/AuNPs/Ce6 nanosystems on the culture MT-4 of malignified lymphocytes of human showed that after laser irradiation the death of cells incubated with nanocomposite was only 4% higher than the cells incubated with free Ce6 of the same concentration. Thus, the aggregation processes, as well as the compactification of the polymer nanocarrier after LCST leaded to decreasing of the photosensitizer activity.

WOOD POLYMER COMPOSITES ON THE BASIS OF NEW COUPLING AGENT

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Among the different coupling agents widely used the organosilane (*R-Si-*(*OR*')3). These tri-functional molecules are used to modify the surface of natural fibers with their alkoxysilane groups. Which after hydrolysis are capable of reacting with surfaces rich in OH groups forming chemical bonds with the surface of the fibers through a siloxane bridge, organofunctional group bonds to the polymer matrix. This group is responsible to improve the compatibilization between the fibers and the polymer matrix by establishing covalent bonds between them. Therefore, the silane coupling agents' function as a bridge between the fibers and the matrix [1-3].

The new wood composite materials (WPC) has been obtained on the basis of pine sawdust, trie-thoxysilylated styrene, styrene and fire retardend agent aluminium hydroxide. Impre-gnations using triethoxysilylated styrene and styrene prior to in situ polymerization is a way which will be improve several unfavorable features in woods. In this procedure, light-weight and permeable solid woods will be impregnated with using monomer with low molecular weight, low viscosity and/or high reactivity, which must be capable of fill intra- and/or intercellular spaces in wood and/or chemically bond themselves to certain polysaccharides and lignin present in the wood cell wall. During formation of WPC in situ poly-merization of triethoxysilylated styrene and styrene take place in the presence of initiator [4], the obtained co-polymer simultaneously acts both as coupling agent as well as a reinforcement agent.

The surface structure of the new wood composite materials was studied by means of Scanning Electron Microscopy and Energy Dispersive X-ray Micro-analysis, thermal, physical-mechanical properties. For composites tensile strength at bending, impact viscosity, thermogravimetric stability and water absorption coefficient have been examined. Optimal conditions for obtaining new, environmentally safe composites have been established. The obtained composites are characterized by high mechanical properties, thermal resistance, ecological purity and low water absorption capa-city, which is one order of magnitude smaller than the water absorption of existing particle board.

Acknowledgments. The financial support of the Georgian National Science Foundation (Grant ##FR-19-795) is gratefully acknowledged.

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Abstract

BIODEGRADABLE POLYMER COMPOSITE MATERIALS MADE FROM INORGANIC FILLERS AND FIBERS

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Because of the rapidly raising ecological problems, it is crucially important to develop biodegradable polymer materials with enhanced mechanical characteristics. Materials are designed in a way that they will not have negative effects on the environment after its exploitation period. The chemistry and technology of biodegradable polymers are one of the most important and rapidly developing fields of modern polymer science. A lot of biodegradable polymers (BPs) were created mostly for medical applications as surgical materials and drug delivery systems. Only small amount of the BPs possesses mechanical characteristics suitable for constructive materials. Such kind of strong biodegradable materials include poly(ester urea)s (PEUs) composed of naturally occurring α-amino acids. It was shown that the PEUs possess outstanding mechanical characteristics up to 6.1±1.1 GPa. These are the first degradable polymeric constructs with modulus in the range of 6.0 GPa, which is substantially higher than the moduli of other, commercially available biodegradable polyesters. In the research polyester urea was used, which had been synthesized by R. katsarava [1-2], as a biodegradable additive, and polyester resin. The biodegradable matrix had been prepared where the ratio of PEU to polyester was 2:98. The resistance of the matrix was tested at different pHs and its mechanical properties were evaluated. The polymer composite was made on the basis of the above-mentioned matrix. The method for obtaining polymer composites has been developed, which involves the use of the above-provided matrix, inorganic fillers, and fibers. The size of the composite was 60x60 cm, with its protective armor. It should be noted that the explosion resistance was evaluated as well and the research has not been finished yet.

Acknowledgment. This work was supported by Shota Rustaveli National Science Foundation of Georgia (SRNSFG) under GENIE project CARYS-19-836.

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Abstract

INVESTIGATION OF COMPLEX FORMATION PROCESS OF NICKEL WITH GEOPOLYMERS (FULVIC ACIDS)

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Fulvic acids are one of the first macromolecular organic substances taking an active part in complex formation processes proceeding in natural waters and stipulate migration forms of heavy metals in natural waters (1). Experimental data on stability constants of complex compounds of FA with heavy metals are heterogeneous and they differ in several lines from each other (2). One of the reasons of such condition is ignoring an average molecular weight (Mw) of the associates of FA, which finally causes the wrong results.

The complex formation process between nickel (II) and FA was studied by the solubility method at pH=9,0. The suspension of nickel hydroxide was used as a solid phase. FA were isolated from Paravani Lake by the adsorption –chromatographic method. In balanced solutions correlation $[Ni(II)_{total}]:[FA_{total}]$ on average equals to 1:0,25. This means, that during the complex formation process, the associate of FA, which average molecular weight at pH=9 equals to 7610 divides and every 1/4 part of this associate inculcates into nickel's (II) inner coordination sphere, as an integral ligand. So it may assume, that the average molecular weight of the associate of FA which takes part in complex formation process equals to 1903. This part of the associate of fulvic acids was conventionally called the "*active associate"*. The average molecular weight of the *„active associate"* was used for determination the free ligand, the composition of nickel (II) fulvate complex and stability constant (3). The numeral value (m) of the stoichiometric coefficient or the number of ligands in the inner coordination sphere of complex equals to tangents of tilt angle of straight line built in coordinates $\log([Ni(II)_{total}]-[Ni(II)_{free}])-m\log[FA_{total}]$

To calculate the exact value of tangents tilt angle of straight line, for this purpose was used the least square method. After the calculation, was obtained the numeral value of stoichiometric coefficient (m), which equals to 1,0. So in $Ni(OH)_2$(solid) —Ni(II)(solution) —FA—H_2O system at pH=9.0, dominates nickel fulvate complex with the structure 1:1

For the calculation of stability constant of zinc fulvate at pH=9,0 was used Laden function

$$F(L)=[Ni(II)_{total}]-[Ni(II)_{free}]/([FA_{free}][Ni(II)_{free}])=\beta_1+ +\beta_2[FA_{free}] \quad (1)$$

where $[FA_{free}]=[FA_{total}]-[NiFA]=[FA_{total}]-([Ni(II)_{total}]-Ni(II)_{free}])$ (2)

When $[FA_{free}]$ aspires to zero, the stability constant could be found by the graphical method. The section which is cut on the ordinate by the straight line built in coordinates F(FA)—$[FA_{free}]$ equals to the stability constant. The value of stability constant was calculated by the square method: $\beta = 1{,}07\text{x}10^7$; lg β= 7,03; $\bar{\beta} = (7{,}5\pm4{,}28)\text{x}10^6$

The work was done by supporting the World Federation of Scientists and the World Laboratory.

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THERMOSTABLE COMPOSITION MATERIALS BASED ON IMIDE AND ANHYDRIDE OF 4-SULFOISOPHTHALIC ACID AND ED-20

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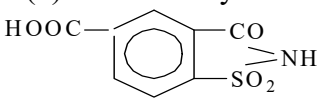
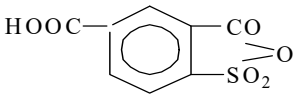
The epoxide compositions based on ED-20 resin are most widely used as coatings, lacquers, glues [1]. The industrial aliphatic and aromatic diamines used for curing in the chemistry of epoxide resins are toxic, volatile. The composition materials based on them have low viability, and their use as hardeners is accompanied by considerable self-heating, which hinders to obtain large-sized products. The aromatic diamines containing amide, imide and sulfo-groups in its composition are less toxic. The epoxide resins cured with such hardeners are self-extinguishing and possess higher heat- and thermal resistance [2]. Considering the above-stated one, with the aim of preparation of the effective and low-toxic hardeners for epoxide resins, the imide (1) and anhydride of 4-sulfoisophthalic acid (2) have been synthesized:



(1)



(2)

These compounds have been used as hardener of epoxy diane resin ED-20. It has been established that the compounds (1) and (2) cure the epoxide resin ED-20 in the high temperature conditions: 100°C/1h+140°C/2h+160°C/2h and 160°C/1h+220°C/2h+250°C/2h, respectively, in this case a degree of curing is reached 90% and 85%. For increase of the curing temperature, a widespread accelerator, UP 606/2 (2.4.6-tridimethylaminomethyl phenol) has been tested. UP 606/2 accelerator is more technological and economical (1 mass p.) Its application decreases the curing temperature of the epoxide composition with the compound (1) to 120°C, and with the compound (2) to 150°C. The obtained results are presented in Table 1.

Table 1. Some kinetic parameters of curing for epoxide compounds on the basis of resin ED, cured with compounds (1) and (2).

System	$E_{act.}$ cured., kJ/mol	Reaction order	Degree of curing, %
ED-20+comp.(1)+UP 606/2	97.31	1.7	95
ED-20+com.(2)+UP 606/2	89.11	1.69	95

The developed composition materials have thermal stability, heat resistance, and also thermogravimetric indices (TGI), which allow us to judge the temperature, at which the composition material does not lose its operational properties for 20 thousand hours.

Thus, the synthesized imide (1) and anhydride (2) of 4-suloisophthalic acid allow to expand the assortment of hardeners for epoxide resins and to obtain new composition materials with improved heat-physical and physical-mechanical properties.

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Abstract

ELECTROCHEMICAL COMPOSITE COATINGS OF COPPER CONTAINING CARBON MATERIAL

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In functional electroplating, special attention is paid to the production of electrochemical composite coatings based on various metals. The use of particles of various dispersed phases in the formation of composite electrochemical coatings makes it possible to obtain materials with improved operational properties [1].

Recently, carbon materials of various origins with unique properties have become the subject of active research [2, 3].

Carbonaceous material with high specific surface area is obtained from nectarine kernel. The physical parameters and composition of the obtained carbon material have been determined.

Composite copper-carbon coatings are obtained from suspensions based on copper sulphate by an electrochemical method in the presence of a second phase of various concentrations. The optimal conditions for obtaining composite coatings are experimentally determined.

It was found that the introduction of a carbonaceous material into composite coatings causes an increase in the grain size. The content of the second phase in the composite coating is 2.58-3.67 (wt.%) and does not correlate with the amount of carbon material introduced into the suspension. The upper layers of the composite coating contain more carbon material. The wear of the obtained samples was studied and it was found that the introduction of a carbon material increases the wear resistance of the composite coating and depends on the number of dispersed phase inserts into the matrix.

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Abstract

COMPOSITION MATERIALS ON THE BASIS OF NORYL AND POLYVINYL CHLORIDE

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Currently, the intensive investigations on acquisition of new polymer materials and reduction of their cost are carried out. In this case, the main purpose is to keep the properties of the obtained composition materials as they are, or to change them slightly. Noryl is one of the most interesting polymer materials. Noryl is mainly obtained as a result of modification of polyphenylene oxide with such polymers as polystyrene, polyamide, polypropylene and it is a valuable thermoplast with high physical-mechanical, impact resistance and thermal stability, and also high dielectric properties. Depending on the composition and properties, Noryl is used in electrotechnics, electronics, household appliances, automobile production and machine construction [1].

However, one of its main disadvantages is its high cost, which limits its use. With the aim of reduction of the cost of Noryl, the investigations on preparation of its compositions with various polymers and polymer wastes have been carried out [2]. The use of polymer wastes as a filler in the creation of such compositions is economically effective, and also ecologically profitable for the utilization of the polymer wastes. In the course of the investigation, Noryl compositions with the used polyvinyl chloride (PVC) in various compositions have been obtained and their physical-mechanical properties have been studied depending on their composition. The filler and Noryl were mixed at ratio 60:40; 50:50; 40:60, respectively, the standard samples were obtained by pressing. The physical-mechanical properties of the samples have been studied. It has been determined that these properties of the compositions are changed depending on the quantity of filler contained in them. The IR spectra of the obtained composition materials were taken and it has been revealed that the chemical changes were not occurred; only a technical mixture was obtained. The results of TGA and DTA of the obtained composition materials showed that the composition of Noryl and PVC obtained at ratio 60:40 has the best physical-mechanical properties, and according to the main operational indices it is almost at the Noryl level.

The developed composition materials can be used both individually and as semi-finished products in the creation of new polymer materials, due to their physical-mechanical properties.

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Abstract

BIOPOLYMERS FOR BIOMEDICAL AND PHARMACEUTICAL APPLICATIONS: RECENT ADVANCES AND OVERVIEW ON POLYSACCHARIDE-BASED SYSTEMS

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In the area of biomedical applications, biocompatible polymers are gaining particular interest. The term biocompatibility applies to a polymer's feasibility for exposure to body and body fluids. Biocompatible polymers are natural or synthetic and help in the near vicinity of a living system or operate with living cells in intimacy. The use of new polymers for medical and pharmaceutical applications has increased rapidly over the last quarter of the century. Polymers are ideal candidates for applications in the medical field due to their flexibility, biocompatibility, bio absorbability and lack of cytotoxicity. New polymer covers nearly every facet of industrial life. In reality, along with other medical hi-technology sources, such as biotechnology, this technology will also be a significant driver of innovations. In general, along with other medical hi-technology sources, such as biotechnology, this technology will also be a powerful driver of growth. Nowadays, emerging polymers include new capacity polysaccharides such as alginate, chitin/chitosan, hydrogels, hydrocolloids, superabsorbent polymers.

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SYNTHESIS OF SPIROPYRANS COMBINED WITH THE AZO DYES

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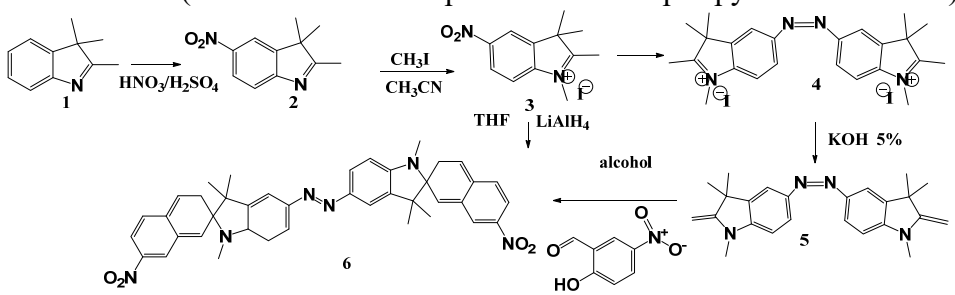
Perspectives of spiropyrans to design new photo controlled molecular equipment and biological materials, logic valves and sensors are not exhausted. Therefore, today, active investigation to design and study compounds with new properties are underway [1].

Recently, carbon nanoparticles have occupied a large place in the scientific literature due to their unique electrical, thermal and other properties. The works appeared on photochromic compounds (spiro-compound and azo derivatives), which are combined with carbon nanoparticles and their use in technology is introduced due to their improved properties. Both sides of a two-dimensional graphene are π-π^* electron clouds that are active electrophilic and nucleophilic substituents. The exposed flat conjugated dye will be interacting with the graphene-electronic system, which will adjust in features of spiropyranes such as time of interconverting, action of environmental factors, dipole moment, relaxation, etc. It is noteworthy that the spiropyranes are already used in biological materials. Graphene nanoparticle can be used as a container due to its large surface.

For this purpose, it was selected to carry out synthesis and research of spirochromes containing azo dyes and then conduct their functionalization with graphene nanoparticles.

A new azo- and spiro-group containing photochromic compound was synthesized according to the given scheme. Initially was synthesized starting compound - 5-nitro-2,3,3-trimethylindolenine (2) by nitration of 2.3.3-trimethylindolenine (1). The quaternization of the compound 2 with CH_3I was performed in a shallow ampoule at 80-82 ˚C in the acetonitrile area and quarternized salt 3 was isolated. With further reduction of compound 3 with $LiAlH_4$ in tetrahydrofuran compound 4 was formed. By the treatment of obtained compound 4 with alkaline solutions forms compound 5, which reacts with 5-nitro salicylic aldehyde and gives a compound 6, the maximum absorption of which in the alcohol area is 660 nm (the maximum absorption of similar spiropyranes is 540 nm).



The molecular structure of the synthesized compounds was established by spectroscopy analysis, including IR, UV, ^1H, ^{13}C NMR and LC-MS.

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COMPARATIVE STUDY OF TBCCO SUPERCONDUCTORS PREPARED BY SOL-GEL AND SOLID-STATE REACTION METHODS

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Thallium- and mercury-based superconductors, generates considerable interest because these systems set records in transition temperature in superconductivity state. The formula unit and crystal structure of the $TlBa_2Ca_{n-1}Cu_nO_{2n+2+\delta}$ similar to that of the $HgBa_2Ca_{n-1}Cu_nO_{2n+2+\delta}$ systems, where (n) is the number of adjacent Cu-O layers. Mercury- and thallium are very toxic, volatile at high temperature, and what is more important for this family, to achieve high purity superconductivity phase, critically depends on the used precursor and synthesis conditions.

The paper presents the comparative analysis of the Sol-gel (SG) and solid-state reaction (SSR) route for the synthesis of precursors for thallium-based superconductors. Samples were prepared a two-step method and by sealed quartz tube technique in ambient pressure. We could conclude that the, using the wet chemistry offers some advantages in comparison with the classical solid-state ceramics processing, especially, better chemical homogeneity and higher reactivity of the precursor powder.

Acknowledgements: This work was supported by Shota Rustaveli National Science Foundation (SRNSF), grant number: FR/261/6-260/14, Project title: Sol-gel Methods and Polymerization for synthesized Tl-based Polycrystalline Superconductors.

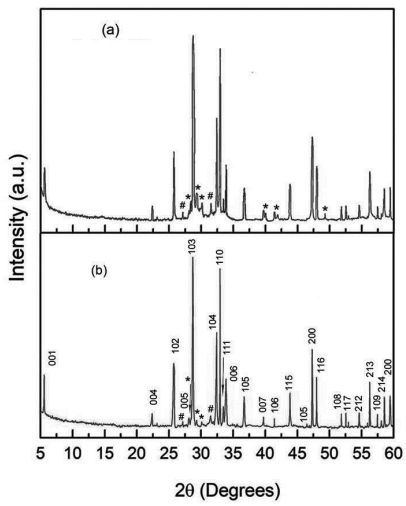

Fig. 1: XRD patterns of the $TlBa_2Ca_2Cu_3O_{8+\delta}$ samples, prepared on both methods: (a) SSR synthesized at 945°C and (b) SG synthesized at 915°C

Abstract

SILYL MODIFIED NANOCELLULOSE FOR NATURAL RUBBER REINFORCEMENT

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With the urge to reduce the carbon footprint and the awareness of the environmental implications of conventional reinforcing fillers, researchers are focusing more on technology developments that are both sustainable and environment-friendly. Nanocellulose from many sources finds use in natural rubber engineering since they are renewable, sustainable, abundantly available, biodegradable, has a high aspect ratio, excellent mechanical properties, and low in cost. The difference in nanocellulose and natural rubber properties renders a significant challenge in attaining synergistic properties resulting from their combination. The surface treatment of nanocellulose by silane coupling agents was found to be one of the most acceptable methods to achieve better compatibility between nano-filler and the rubber matrix. The studies show that silyl modification of nanocellulose effectively disperses the filler, reduces the agglomeration of filler, and enhances compatibility.Some of the common organosilanes used for nanocellulose modification include 3-Aminopropyltriethoxy-silane(APTES), Bis-(3-triethox-ysilylpropyl)tetrasulfide(TESPT), 3-isocyanatepropyltriethoxysi-lane (IPTS). According to the literature, these modifying agents could reduce the hydrophilic nature of hydroxyl-rich nanocellulose. Silane moietieswere grafted on the surface of nanocellulose via a chemical reaction between hydroxyl groups of nanocellulose and the end functional group of silane. The silane modification could provide strong chemical bonding between rubber matrix and na-nocellulose. This change has been reflected in the improved properties of nanocomposites, making them suitable for a variety of value-added products.

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SYNTHESIS AND STUDYING OF POLY(O-TOLUIDINE)

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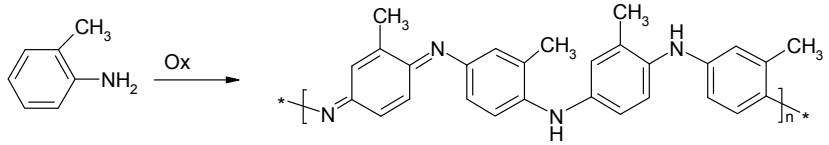
Polyaniline (PANi) has its unique place among conductive polymers [1]. Due to controlled conductivity and chemical stability to the environment it started to be used in electrical, electro-chemical and optical applications [2]. Nowadays, PANi is already used in the smartphones, lithium ion batteries, biosensors, electrodsand in LCD applications [3]. But, the areas of the usage of PANi are limited because of poor solubility. One way to solve this problem is the synthesis of substituted derivatives of PAN ieither by (co)polymerization of corresponding monomers or chemical modification of PANi itself. Synthesis of substituted polyanilines by first method is more succesfull for monomers with electronodonor substituents and often methyl, methoxy group containing anilines have been used. It should be mentioned, that mostly orto-substituted derivatives have been widely discussed and there is no systematic metha- substituted anilines [4]. The common method for the synthesis of mentioned polymers is oxidative polymerization in acidic medium by means of chemical and electrochemical oxidation. Ammonium peroxidisulfate was used as the main oxidizer during the chemical oxidation [2]. The oxidative polymerization of o-toluidine was carried out by ammonium peroxidisulfate in the glacial acetic acid - methanol mixture. On the base of UV spectral data approximately equal amount of quinonediiminic and phenylenediaminic groups were stated. (Scheme 1).



PoTn

Scheme 1

Obtained poly(o-toluidine) (PoTn) is soluble in DMFA, DMSO, NMP. The electrical conductivities of different acids doped PoTn samples were between10^{-4}-10^{-2} S/cm,but it was approximately 1-2 order lower compared tothat of inorganic acid doped samples of PANI. It means that methyl groups some how affect on the conductivity of polymer backbone.

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DEVELOPING AND CLASSIFYING NEW POLYMER MATERIALS USING ARTIFICIAL INTELLIGENCE (AI) TECHNIQUES

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Briefly describing, a polymer is a material that consists of macromolecules that compose many repeating subunits. Both natural and synthetic polymers play crucial roles in everyday life thanks to their broad spectrum of properties [1]. Polymers count over 500 billion dollars in the goods shipment and this amount is expected to grow at twice. The polymer community would be well served by organizing and exploiting experimentally and computationally generated data. The problem of nomenclature is exacerbated in sequenced defined polymers especially when it comes to a synthetic polymer.

A synthetic polymer is not a single entity. An individual polymer samples can be described by distributions which with complicated monomeric structures leads to nonstandard naming conventions. Moreover, commercial trade names complicate matters. For instance, polystyrene can be described by 1800 different names. Even the International Union of Pure and Applied Chemistry (IUPAC) naming conventions and Chemical Abstracts Service Registry Numbers created its own numbering system.

The emerging field known as polymer informatics is a new direction and subfield of materials informatics deeply gaining acceptance among the classes of materials. In our case, we focus on polymer science with a series of challenges using Artificial Intelligence (AI) techniques such as machine learning and deep learning approaches to design new materials. We analyse the challenges faced in polymer science through a huge amount of datasets and give new research methods to solve the issues through computational algorithms which can reduce the time and cost of developing new types of polymers [2].

Deep learning or deep neural network is a subfield of an artificial intelligence (AI) that mimics the functions and workings of the human brain in processing data and creating patterns for use in decision making. The word "deep" in deep learning means the use of multiple layers in Artificial Neural Networks (ANN). Early research works showed that deep learning is concerned with an unbounded number of layers of bounded size, which permits practical and optimized implementation retaining theoretical universality. We'll use recommendation systems to extract meaningful features. Our proposed model uses a hybrid content-based and collaborative approach to enhance recommendations in multiple tasks such as polymer classification and nomenclaturization.

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Abstract

METAL-CARBON NANOCOMPOSITES BASED ON THE HIGH PRESSURE POLYETHYLENE

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For recent years, there has been considerable interest in composite materials based on polymer matrices and nanosized metal particles, which is related to a widespread application - from catalysis to nanotechnology in information technology. The unique properties and improved characteristics of nanomaterials are related to their size, surface structure, and interfacial interaction. Metal-carbon nanocomposites are of great interest as new-generation materials with a set of valuable practical properties[1, 2].

The presented work is devoted to preparation and study of the properties of nanocomposites based on the high-pressure polyethylene using metal-containing nanoparticles stabilized by a polymer matrix and multi-walled carbon nanotubes used as a nanofiller.

High-pressure polyethylene grade 15803-020 (PE), as nanofillers (NPh) was used cobalt-containing nanoparticles stabilized by a polymer matrix of high-pressure polyethylene, obtained by a mechanochemical method (NPhCoO) [3] and multi-walled carbon nanotubes MWCNT (CVD -179, purified from resins and Fe, hydrocarbon feedstock - cyclohexane).

Nanocomposite polymer materials are obtained from mixing PE with a cobalt-containing nanofiller and MWCNT on laboratory rollers at a temperature of 130-135 ° C for 15 minutes. For mechanical tests, the resulting mixtures were pressed in the form of 1mm thick plates at 170°C and a pressure of 10 MPa for 10 minutes.

A necessary condition for obtaining the best properties of carbon nanomaterials in a polymer composite is to achieve the maximum degree of dispersion of the filler and its optimal orientation in the polymer matrix.

The introduction of 0.01-0.1 wt.% MWCNTs into the composition leads to a significant decrease in physical and mechanical parameters: σ_p from 11.39 to 10.05 MPa, ε_p from 400 to 220%, but the Wick heat resistance increases by 10°C.

To overcome the low affinity of MCNTs for the polymer, it is necessary to use low molecular weight compounds or polymers with functional groups. We have used PE as a functionalized polymer, modified with cobalt oxide nanoparticles.

The combined use of both NPhCoO and MWCNTs in the PE composition increases the ultimate strength at break to 11.83 MPa, relative elongation to 680%, and Wick heat resistance from 130 to 145°C. Thermal analysis studies have shown that the joint insertion of NPs of cobalt oxide and MWCNTs into the composition of the composition improves the thermal-oxidative stability of the obtained nanocomposites: E_a from 191.45 to 291.38 kJ / mol.

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Abstract

TRIETHOXYSILYLATED STYRENE AS A NEW COUPLING AGENT IN WOOD COMPOSITES

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In recent years great interest in the development of new composites derived from thermoplastic polymer matrices reinforced with wood filler, because of their environmental and economic benefits [1, 2]. Their renewability, biodegradability, low density, high stiffness and relatively low price [3]. Among of these various thermoplastic matrices mainly used in the manufacture of plastic / wood composites was polystyrene [4], which is very popular because of its inapparency, fluidity and good electrical insulating properties [5].

Ecologically friendly new composite materials with high-technical characteristics are made on the basis of wood sawdust and triethoxysillylated styrene. These composite materials are obtained on the basis of a new binder triethoxylated styrene (at different pressures and temperatures). The binder used simultaneously acts as both a binder and a reinforcement agent.

Structural investigations by means of FTIR show that with higher physical mechanical, thermal and hydrophobic properties are characterized the materials, in which takes place a formation of new chemical bonds in result of chemical reactions between active groups of composite's ingredients and binder.

The surface structure of the new composite materials was studied by means of Raster Electron Microscopy and Energy Dispersive X-ray Micro-analysis, thermal, physical-mechanical properties.

For composites tensile strength at bending, impact viscosity, thermogravimetric stability and water absorption coefficient have been examined. Optimal conditions for obtaining new, environmentally safe composites have been established. The obtained composites are characterized by high mechanical properties, thermal resistance, ecological purity and low water absorption capacity~4%, which is one order of magnitude smaller than the water ab-sorption of existing particle board.

Acknowledgements. The financial support of the Georgian National Science Foundation (Grant #FR-19-795) is gratefully acknowledged.

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Abstract

ROLE OF GREEN TEA EXTRACTED SILVER NANOPARTICLES IN ENHANCING THE HUMIDITY SENSING PERFORMANCE OF POLYPYRROLE/ SILVER NANOCOMPOSITE

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In this work, the humidity sensing performance of Polypyrrole/Silver (PPy/Ag) nanocomposite has been reported. The green tea extracted Ag nanoparticles were used to prepare the PPy/Ag composite by employingan in-situ polymerization technique. XRD and FTIR resultsof the composite confirmed good interaction between PPy and Ag. The SEM image of the composite showed an agglomerated porous morphology. The TEM results revealed the Ag particles were entirely encapsulated by PPy forming core-shell structure. The humidity sensing properties of the composite was studied by measuring its resistance at various relative humidity (from 11% RH to 97% RH). The composite has shown remarkable real sensitivity of 0.043 Ω/% RH, linearity of 0.9775, low limit of detection (LOD) of 10 %RH.The mechanism of sensing in the composite has been discussedbased on chemisorption, physisorption, and capillary condensation processes. The humidity sensing results of PPy/Ag composite make it a potential candidate to be used in devising an efficient humidity sensor.

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SEMI-INTERPENETRATING POLYMER NETWORK HYDROGELS BASED ON CHITOSAN AND POLY(ACRYL AMIDE)

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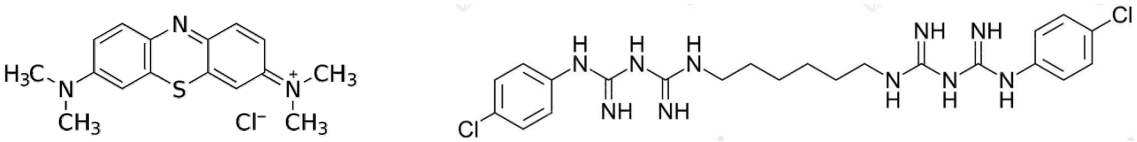
Semi-interpenetrating polymer networks are defined as compounds in which one or more polymers are cross-linked. Chitosan is a high molecular weight carbohydrate polymer that is manufactured from chitin. Chitosan is more useful in biomedical applications and for the dehydration of aqueous solutions since it has both hydroxyl and amino groups that can easily be chemically modified. The key properties of chitosan are: its biocompatibility, nonantigenicity, nontoxicity, its ability to improve wound healing and/or blood clotting, its ability to absorb liquids, its ability to form protective films and coatings, and its selective binding of liquids.

Semi interpenetrating polymer networks composed of chitosan and polyacrylamide (PAA) have been prepared by using N, N'-methylene-bis-acrylamide as cross-linker during radical polymerization of two component system. In this work, redox initiator such as CAN (ceric ammonium nitrate) was used to initiate polymerization

The effect of changing pH, temperature, ionic concentration, and composition on the swelling of the hydrogels was investigated. The hydrogels exhibited a relatively high swelling ratio. It increased with decreasing pH below pH=7 due to the dissociation of ionic bonds. The swelling ratio was pH, ionic concentration, temperature, and electric field dependent. Differential scanning calorimetry (DSC) was used to determine the volume of free water in the semi-interpenetrating hydrogels, which was found to increase with increasing PAA content. Sorption/desorption properties of hydrogels in relation to the biologically active chlorhexidine and methylene blue were studied. These compounds may be used both to disinfect the skin of the patient and the hands of the healthcare providers. Released concentration and desorption rate of chlorhexidine and methylene blue were investigated as an important factors for regulation of therapeutic concentrations of the active substances in bacteria medium. It was found the grater chitosan content in hydrogels the slower desorption process and lower released concentration of the adsorbate molecules.



Methylene blue Chlorhexidine

Figure 1. Chemical structures of the adsorbate molecules.

The obtained results permit the conclusion that semi-interpenetrating polymer networks composed of chitosan and polyacrylamide have the potential to be used wound-healing management and targeting drug release studies.

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AEROBIC OXIDATION OF DIESEL FRACTIONS USING NANOCARBON CATALYST DENOTED AS CVD 4

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Nanocatalytic oxidation of hydrocarbons is one of the salient tends of contemporary chemistry. It provokes new investigations to produce and implement completely new types of the compounds with extraordinary catalytic properties. Within this stream we installed and put into operation new CVD device for synthesis of multi-walled carbon nanotubes (MWCNTs) from fuel gas raw materials (propane-butane, methane, household gas). The device was optimized, the initial products were obtained, the structure of catalysts was confirmed by the SEM analysis method. Iron atoms were fixed in the MWCNTs chanells to be a residue of ferrocene precursor-catalyst used in the CVD synthesis. The research was conducted to determine a capacity of the Fe(8.3%) @MWCNTs to accelerate the aerobic oxidation process of diesel fuel and their naphthenic-paraffinic fraction. The oxidation process was carried out in a laboratory gasometric setup. Kinetic regularities of catalytic aerobic oxidation processes were studied. The rates calculation was accomplished on the basis of the absorbed reactive oxygen (Figure 1).

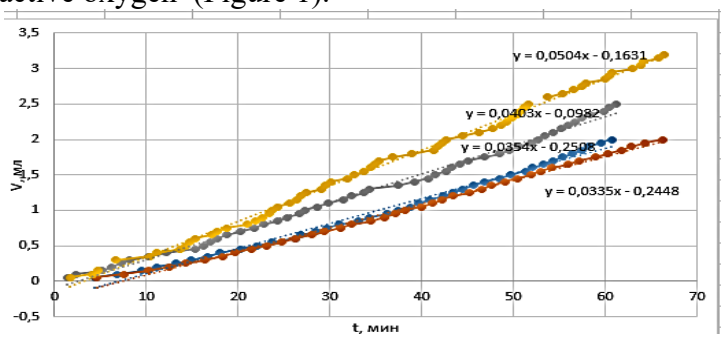

Figure 1. Kinetic curves of oxygen absorption during oxidation of diesel and naphthenic-paraffinic fractions, 130°C. ● - diesel fraction without catalyst, ● — diesel fraction with CVD4 catalyst, ● - naphthenic-paraffinic fraction without catalyst, ● - naphthenic-paraffinic fraction with CVD4 catalyst.

The following conclusions can be drawn from the data obtained:1) all fractions are oxidized in the specified conditions with different degrees, 2) the catalytic oxidation of the diesel fraction does not exceed the reaction rate of the control sample 3) in all cases the naphthenic-paraffinic fraction is oxidized more intensively than the diesel fraction 4) CVD4 Fe(9.8%)@MWCNTs additions accelerate the oxidation of naphthenic-paraffinic fraction.

The work was supported by the Science Development Foundation under the President of the Republic of Azerbaijan - Grant №EİF-MQM-ETS-2020-1(35)-08/05/4-M-05.

THERMAL BEHAVIOR OF THE POLYMER COMPOSITES BASED OF POLYSTYRENE

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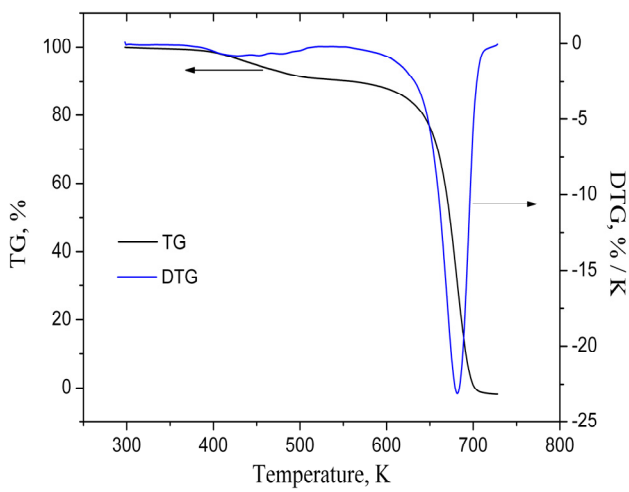
The development of the polymer composites with controllable properties is one of priority areas in the modern chemistry and materials science. A promising method for modifying polymers is the incorporation of inorganic particles into a polymer matrix. The produced composites can acquire novel physical and chemical properties: thermal, electrical, strength, etc.
In the present paper, we describe the study results of the thermal behavior of polymer composites based on polystyrene (PS). Inorganic particles such as fullerenes, silica, bentonite, and bentonite-magnetite were chosen as fillers. A solvent casting of perspective components from solutions was employed for preparing the PS/filler film composites containing 0~7 wt. % of filler. Pure PS films and PS granules were researched, too.
Using differential scanning calorimetry (DSC), the phase transitions from the glassy state to elastic one were studied for the examined polymeric materials. New data relating to the effect of filler (in low weight fraction) on the glass transition temperature, T_g, of composites were found.
Thermogravimetry (TG) method was used to study the thermal stability of PS/filler composites at high temperatures. The dependences of the characteristic temperatures of thermal destruction on nature and concentration of the filler in the composite were found. Using the van Krevelen method, kinetic analysis of the recorded thermogravimetric curves was carried out. The main parameters determining the rate constant of the process (activation energy, pre-exponential factor) were found, and their dependences on the composition of the composites were analyzed.



Thermogravimetric curves (TG and DTG) for the polystyrene/silica composite (1 wt % of SiO_2)

Abstract

ALKYLATION REACTION OF STYRENE WITH VINYLTRIETHOXYSILANE

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First information about functionalization of styrene with vinyl containing siliconorganic compounds in the presence of Lewis acid ($FeCl_3$ and $AlCl_3$) in solution was reported by the authors [1]. It was shown that the yields of alkylation reaction of styrene with vinyltriethoxysilane in the presence of $AlCl_3$ is higher, than in the presence of $FeCl_3$. Trialkoxy(4-vinylphenethyl)silane ($StSi(OR)_3$) type monomers were synthesized via two step reactions: Hydrosilylation reaction of 1.4-divinyl benzene with trichloro silane, Followed by esterification reactions with primary alcohols [2, 3]. The yield of trialkoxy group containing compounds is about 50%.

Alkylation reaction of styrene with vinyltriethoxysilane in the presence of aluminum chloride as a catalyst has been carried out and corresponding addition product tiethoxy(vinylphenethyl)silane have been obtained. The structure and composition of obtained product were proved by means of determine molecular mass, molecular refraction and ^1H and ^{13}C NMR spectra data. It was found that the addition reaction proceeds both as in ortho-position as well as in para-position. For a detailed study of the direction of the alkylation reaction, we studied quantum-chemical calculations, which were performed using the non-empirical density functional theory (DFT). For this calculation the program "Priroda-04" was used [4].

Acknowledgments. The financial support of the Georgian National Science Foundation (Grant #FR-19-795) is gratefully acknowledged.

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POLYMER STENTS USED IN CHRONIC SINUSITIS

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Chronic sinusitis (CRS) is a common disease with global prevalence which causes severe symptoms that lead to poor quality of life. CRS is chronic inflammatory nasal disease and is diagnosed with or without polyps [1]. Endoscopic sinus surgery (ESS) is used during chronic sinusitis, it improves ventilation, drainage and gives better access of local anti-inflammatory treatment. Despite appropriate and complete sinus surgery, there can be issues after sinus surgery such as synechiae formation and recurrence of polyps, to avoid this, stents are used. Sinus stents are designed to insert into the sinuses following an ESS to preserve sinus openings during the postoperative healing period [2]. At the beginning stents were made of a firm rubber tube however the stenosis rate remained high at 30%, but the next implants which used silicone rubber sheets were more promising long-term outcomes [3]. Rubber and silicone rubber are elastomers – that is, a polymer that has the ability to regain its original shape after being deformed. Currently used Food and Drug Administration-approved steroid-eluting sinus implants are Propel family products and SINUVA. Propel is composed of a bioabsorbable polylactide-co-glycolide (PLGA) polymer coated with the corticosteroid mometasone furoate (MF) in a lattice pattern that expand in a spring-like fashion to conform to the walls of a dissected ethmoid cavity. PLGA is an amorphous biodegradable and biocompatible copolymer which is synthesized by means of ring-opening co-polymerization of two different monomers, the cyclic dimers of glycol acid and lactic acid. Polylactide-co-glycolide is an anti-inflammatory and anti-protein barrier that affects water retention and promotes tissue biocompatibility. It also helps to control the rate of MF elution from implants [1,2,4]. First-generation of Propel stents can give dose of drugs in a controlled manner within approximately 30 days, second-generation can give dose of topical steroid for about 3 months witch improvs the postoperative symptoms [5]. Propel family is designed as a short-duration product to be used immediately after sinus surgery to optimize healing and decrease surgical failure. SINUVA is a longer-duration product, delivering more corticosteroid over a longer timeframe to address polyprecurrence after surgery slow release of drugs in about 6 months [6,7]. The implants have made a significant contribution in reducing postoperative interventions and providing effective management after surgery.

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Abstract

LIQUID PHASE SHOCK ASSISTED CONSOLIDATION OF TA-AL BASED COMPOSITES

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The main purpose of the work presented herein is to combine hot explosive consolidation technology (HEC) with Self-Propagating High-Temperature Syntheses processes (SHS) to obtain Ta-Al based cylindrical billets with low porosity and improved physical and mechanical properties.
In the first stage of the investigation we carried out the explosive consolidation of powders at room temperatures to obtain billets with increasing density without cracks and activated surfaces of consolidated particles. In the second stage of the investigation the consolidation was conducted at hot conditions above and below the SHS reaction temperatures of the composite materials. The loading intensity was under 10GPa. The heating temperature was up to 950°C. The heating time before loading was under 30 minutes.
Our investigation showed that the initiation of SHS process and a complete reaction in the Ta-Al powder composites starts at 940°C. In order to fabricate billets at or near the theoretical density with a near-perfect structure and correct cylindrical geometry, it was necessary to load the billets prior to reaching 940°C. Consolidation of the billets above 940°C led to cracking throughout the entire volume of the HEC billet. The application of B_4C additives and the HEC of Ta-Al-B_4C composites led to the dissolution of the B_4C phase, and the formation of TaB, $AlCTa_2$, and $TaAl_3$ phases behind the shock wave front. A reduction of the HEC temperature in the consolidation of Ta-Al precursors at 600°C provided only a partial reaction between the precursors the formation of aluminate phases on the surrounding surfaces of the Ta particles; this was observed in the entire volume of the HEC billets. The type of intermetallic compounds was found to depend on the percentage of the various precursor phases in the starting composition.
The aforementioned observations, other features of the structure-property-processing relationships for the consolidated Ta-Al based composites, depending on the loading conditions used, and the set-up and operation of the HEC device will be presented and discussed.

Abstract

SPIROPYRAN DOPED LIQUID CRYSTAL POLYMER FILM BASED PERSONAL REUSABLE UV DOSIMETER

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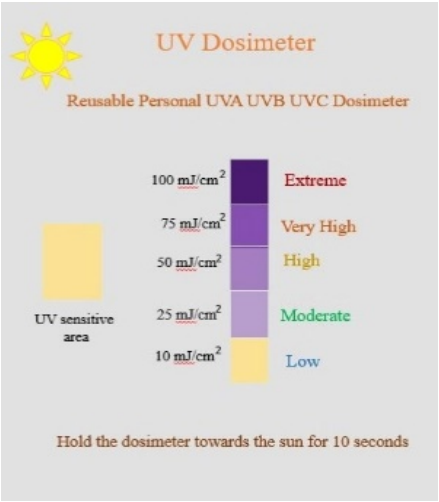

Ultraviolet (UV) radiation is a form of electromagnetic radiation that comes from the sun and man-made sources. UV radiation can damage the DNA (genes) in cells, which in turn may lead to cancer. Most skin cancers are a result of exposure to UV rays in sunlight [1]. We have developed a novel UV radiation dosimeter that allows a real-time estimation of the dose of harmful ultraviolet UV-A, UV-B, and UV-C radiations emitted by the sun and artificial sources. When exposed to UV radiation, our UV Dosimeter visibly change color from the starting light-yellow to blue to dark violet. The color change correlates to levels of accumulated UV irradiation. To fabricate a photochromic UV-sensitive liquid crystal polymer film, commercially available and certified compounds have been used. A spiropyran (SP) doped liquid crystal mixture was prepared mixing the nematic host and SP molecules with the following concentration ratio: 96 wt% BL-038 + 4 wt% SP. Thin films were prepared using a method for microencapsulation. By controlling all the parameters of microencapsulation, such as stirring speed, temperature, and concentration ratio of the constituents, microcapsules with desired sizes, packing, and spatial distributions have been obtained. The as-prepared film, with a thickness of about 40 μm, is freestanding and flexible. Furthermore, it is mechanically resistant to small stresses and, hence, it can be directly handled. It is not sensitive to humidity, and it can operate in ambient conditions and large temperature ranges. The proposed UV dosimeter enables users to control a skin sunburn level caused by UV light from the sun and artificial sources, and visually monitor how much harmful radiation has been delivered to a surface, which helps them see if surfaces have received enough energy to kill bacteria, viruses, and spores – including Covid-19. The proposed UV dosimeter is environmentally safe, exhibits excellent photochromic properties, improved photosensitivity, high spatial resolution. It can be efficiently reused over 200 cycles without compromising its readability.

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Abstract

PHOTOELECTRIC PROPERTIES OF POLYVINYL BUTYRAL BASED FILM COMPOSITES DOPED WITH CU/M (M = SR, BA) HETEROMETALLIC COMPLEXES

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New heterometallic complexes $[Sr\{Cu(HL)_2\}_2(CH_3OH)]I_2$ and $[Ba\{Cu(HL)_2\}_2(CH_3OH)_2](SCN)_2$, where H_2L = 2-{[(2-hydroxyethyl)imino]methyl}-6-methoxy-phenol, have been synthesized and structurally characterized. Photosensitive polymeric film composites were prepared on the basis of non-photoconductive polyvinyl butyral doped with the corresponding Cu/Sr or Cu/Ba complex, and their spectral, electrical and photoconductive properties were studied. Photoelectric properties were investigated using the Kelvin probe method for measuring the surface electric potential. The composites have been shown to exhibit photoconductivity and photovoltaic effect when illuminated by light from the appropriate absorption region. Peculiarities of the photoconductive and photovoltaic properties of the obtained composites will be discussed, as well as possible mechanisms of photovoltaic effect and photogeneration of charge carriers. A phenomenological model of the internal photoeffect in the studied film composites will be proposed.

POLYMERS CREEPING IN SPIRITS

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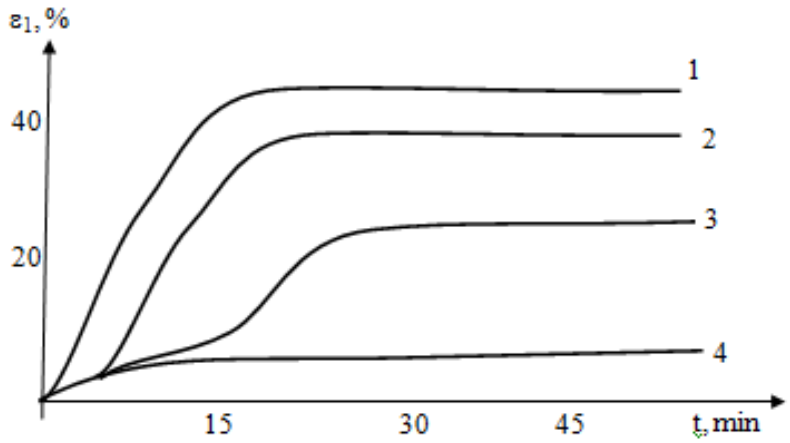
We have learnt polymers creeping in water and electrolities' liquid solution. Polymers creeping took place without diffusion limitation. It was interesting to study polymers creeping in such cases when liquid area diffusion speed is commensurate with highelastic deformation speed.
We have taken as areas saturated spirits liquids, which molecules have got big sizes rather than water and it was possible that spirits diffusion coefficients in polymers were bigger than water's.
The object of research was taken polyarylate F-2 as for areas, they were etanol's different consentration liquid solutions. As it's known, the polymers creeping in liquid areas is connected to the area nature, temperature and the polymer's spread tension.



Figutre 1. Polyarylate F-2 pellicle creeping curves in spirits liquid solutions 20 °C, σ= 20 mpa: -60% C_2H_5OH; 2) -50% C_2H_5OH; 3) -330% C_2H_5OH; 4) -16% C_2H_5OH

Is given Polyarilat F-2 creeping curves in spirits liquid solutions on the picture. It was possible after raising spirits concentration is increasing sharply polymers creeping size and mainly expressed with S alike curve.
To raise creeping with spirits concentration increase is mainly coursed by between molecule interaction weakening, as for S alike curve, this is connected with spirits liquid solutions F-2 diffusion regularity.

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Abstract

COPPER-CONTAINING NANOCOMPOSITES BASED ON BUTADIENE-NITRILE RUBBER AND ISOTACTIC POLYPROPYLENE

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The creation of thermoplastic elastomers (TPE) is a priority area of work in the field of polymer materials science. A distinctive feature of TPE is the combination of the properties of vulcanized rubbers during operation and thermoplastics during processing.

A large number of studies on TPE and TPV were obtained using polypropylene (PP) as a thermoplastic, and EPDM, natural rubber, butadiene nitrile rubber (BNR), etc. as elastomers, using various fillers or compatibilizers to improve compatibility, physical-mechanical and technological properties of the compositions[1, 2].

In the present work, we studied the effect of small NF additives containing NPs of metal oxides on the properties of mixed TPEs based on isotactic PP and BNR.

The nanoparticles (NPs) of copper oxide I (Cu_2O) stabilized by a high-pressure polyethylene polymer matrix obtained by the mechanochemical method in a polymer melt were used as NF. The content of nanoparticles is 5 wt. %, size 26 ± 1.0 nm, crystallinity 35 - 45. The ratio of the components of the composition (wt. %): PP / BNR/ NF = 50/50 / (0.5; 1.0; 2.0).

Nanocomposite polymeric materials were obtained by mixing PP with BNR and copper-containing NF on laboratory rollers at a temperature of 160-165 ° C for 15 minutes. For mechanical testing, the resulting mixtures were pressed in the form of plates 1 mm thick at 190 ° C and a pressure of 10 MPa.

It was shown that the introduction of metal-containing NF into PP / BNR leads to an increase in the strength index from 5.04 to 5.90 MPa and to an increase in the rupture strain of the composite by 1.5–2.0 times. A study of the Vicat softening point of the obtained compositions showed that the introduction of a nanofiller into the composition of PP / BNR leads to an increase in the heat resistance index from 87 to 127°C. The melt flow index (MFI) increases from 0.089 to 0.155 g / 10 min, which indicates an improvement in the yield strength of the composition and the possibility of processing it by injection molding and extrusion.

Derivatographic studies have shown that the introduction of NF containing NPs of copper oxide into the composition contributes to an increase in the half-decay temperature of the samples: T_{50} from 300 to 375°C; the half-decay time $\tau_{1/2}$, increases from 62.8 to 66 min., the activation energy (E_a) of the decomposition of the thermooxidative destruction of the obtained nanocomposites increases from 124.48 to 166.49 kJ / mol, while T_{melt} remains at the level of 150°C.

The obtained results indicate that small amounts of nanofillers (0.5 – 2.0 wt%) introduced into the polymer obviously play the role of structure-forming agents -artificial nuclei of crystallization, which contributes to the emergence of a fine-spherulite structure in the polymer, characterized by improved properties of the resulting nanocomposite.

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Abstract

STUDY OF INFLUENCE OF KOSMOTROPIC AND CHAOTROPIC SALTS ON MICROENVIRONMENT OF POLYOXYETHYLENE (4) LAURYL ETHER REVERSE MICELLES AT DIFFERENT pH OF WATER POCKETS

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Reverse micelles are very tiny self-associated structures attracting interest because of their ability to dissolve or draw water into the core or pockets. This provides an unique opportunity to study the properties of water aggregates directly with polar heads without an interface. All these parameters are directly related to the spectral changes of the solubilized substance, viz. molecular probes in both the ultraviolet and visible regions [1]. Structure of water confined in reverse micelles is strongly influenced by the presence of electrolytes in the aqueous nanopockets. According to Hofmeister series ions are classified as kosmotropes (structure makers) or chaotropes (structure breakers) according to their relative abilities to induce the structuring of water. The additives of ionic kosmotropes (sulfate, phosphate, chloride) and chaotropes (bromide, thiocyanate, perchlorate) because of ion-water interactions influence the water structure in water pockets of reverse micelles [2].
The microenvironment of reverse micelles of polyoxyethylene(4) lauryl ether (Brij-30) was investigated by UV-visible spectroscopy via methyl orange (MO) as optical probe. The influence of both additives of water and water solutions of some kosmotropic and chaotropic salts on the association degree of methyl orange with reverse micelles was studied at different pH values [3]. Association degrees of MO with Brij30 reverse micelles were calculated by absorption data of MO at wavelengths of 408 and 416 nm in 0.125 M Brij30 solution in hexane at different water/surfactant molar ratio (W).
Different effects of kosmotropic and chaotropic anions on the ratio of [bound] / [free] methyl orange fractions in reverse micelles of Brij-30 were observed at different pH of the aqueous core of reverse micelles. The transition of methyl orange molecules from a bound to a free state at pH = 3.8 is facilitated in the presence of kosmotropic acetate additives and is suppressed by chaotropic perchlorate. In contrast, acetate ions interfere with the transition of methyl orange molecules from a bound to a free state, while chaotropic perchlorate ions promote this transition at pH = 7.8.

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Abstract

STUDY OF PROCESS OF DRUG RELEASE FROM MICROEMULSIONS PREPARED ON THE BASIS OF NONIONIC SURFACTANTS

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Delivery of drugs in organism using supramolecular systems such as microemulsions is one of the most effective ways to improve their bioavailability [1]. Therefore microemulsion drug delivery is especially important for drugs characterized by considerable hepatic first-pass metabolism or presystemic metabolism.

The release profile of antihistamine promethazine hydrochloride from microemulsions was studied with a dialysis method. Microemulsions were prepared on the basis of nonionic surfactants: polyoxyethylene (20) cetyl ether, polyoxyethylene (4) lauryl ether, polyoxyethylene (23) lauryl ether and polyoxyethylene (20) sorbitan monooleate. A phosphate buffer (pH = 7.4) was used as a release medium i.e. as a receptor solution, and the donor phase was a drug dissolved in a microemulsion. Experiments were carried out using cellulose membranes. The released drug was determined at certain intervals of time by treatment of samples with sodium persulfate [2]. The absorbance of the samples was measured half an hour after the solution turned pink-red with a photocolorimeter at 490 nm.

The degree of promethazine hydrochloride release differs from microemulsions prepared on the basis of different surfactants, viz. the percentage of released drug from microemulsion mixture of polyoxyethylene (4) lauryl ether with polyoxyethylene (20) sorbitan monooleate is the lowest, then from microemulsion mixture of the same polyoxyethylene (4) lauryl ether with polyoxyethylene (23) lauryl ether. The percentage of released promethazine hydrochloride is higher in case of microemulsion mixture of polyoxyethylene (4) lauryl ether with polyoxyethylene (20) cetyl ether. The values of diffusional exponent (n) and kinetic constant (k) for promethazine hydrochloride release from different microemulsions were calculated on the basis of Kosmeyer-Peppas model [3]. Results indicate that non-Fickian or anomalous diffusion is responsible for the release of promethazine hydrochloride from microemulsions mixtures.

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Abstract

IR- SPECTROSCOPIC STUDY OF POLYMER COMPLEXES OF DIPOTASSIUM-TETRASUBSTITUTED ARSONIUM TETRAIODOCUPRATES (I) AND ARGENTATES (I)

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The structure of synthesized tetrasubstituted arsonium tetraiodocuprateswas determined by IR spectroscopy. The infrared spectra of the final products are almost identical to the tet-rasubstituted arsonium iodides yielded which in turn indicates that arsenic is also present in the cation of the study substance. No Cu - I bond absorption band is observed in the spec-trum.It is beyond the sensitivity of the device. The spectra of the synthesized substances are similar to each other. The infrared spectra of dipotassium-triphenylmethylarsonium tetraiodo (I) and dipotassium-triethyla-midearsonium Cuprates (I) are given. No intense absorption band is observed in the spectra of any of the compounds in the 3600-3000 cm^{-1} spectral region which indicates that the study substances do not contain water, i. e. they are not hydrate compounds despite the fact, that these compounds were formed in aqueous solutions.In the spectra of amide products, the absorption band of C=0 bond is observed in the 1750 cm^{-1} region while N-H bond of amide group in the 1620 - 1590 cm^{-1} region.As it has been mentioned, the IR spectra of this type of compounds is similar to the IR spectra of theiodides yielded, which confirms the cationic-anionic structure of the synthesized subs-tances.

In the spectrum of study substances, the absorption band is observed in the 620 - 625 cm^{-1} region, which is due to the As-C bond. Such absorption is characteristic of quaternized arsenic and is similar to that of initial arsenic iodides.It can therefore be concluded that in synthesized complex compounds as well as in iodides yielded arsenic is in the tetrasubstituted form and is part of the cation.Absorption bands: 750, 1600, 3000-360cm^{-1} indicate the presence of benzene nucleus and the content of aromatic groupsin general.

From the infrared spectra of dipotassium-allyltriphenylarsonium tetraiodo and dipotassium-iso-propylarsonium tetraiodo argentates (I) it is clear that the absorption bands in the 860, 180 and 1000 cm^{-1}regions indicate the presence of vinyl = As – CH_2-CH = CH_2 group.The frequency of the valence vibration = C-H bond is indicated by the absorption band in the 800 cm^{-1}region.

PREPARATION OF GRAPHENE OXIDE-BASED BIOCIDAL COMPOSITES AND STUDY OF THEIR ANTIBACTERIAL ACTIVITY

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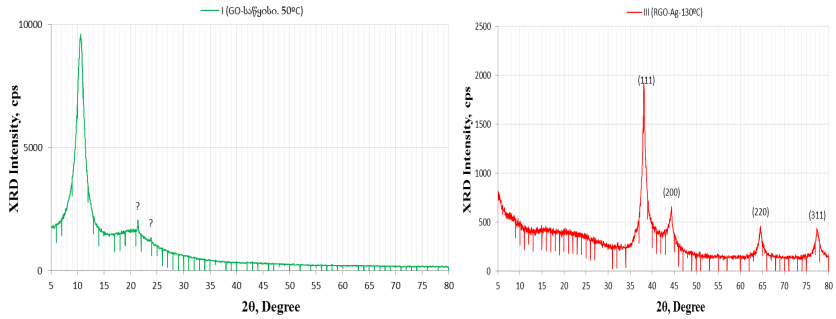
Compounds of carbon 2D and 3D structural forms have antibacterial activity against a broad spectrum of bacteria, fungi, and viruses. Graphene oxide (GO) and reduced graphene oxide (rGO), which have been obtained from two precursors: flake graphite and graphite foil powder, are highly active in this regard. [1,2]. Composites based on graphene oxide, which contain nanosized (1-50 nm) metals and metal oxide particles, are characterized by high antibacterial (as well as anticancer) properties. We synthesized GO-AgNPs composites by various methods. The rGO-AgNPs XRD patterns obtained by the vacuum blasting method are given in Figs. 1. The sol-gel method is used to obtain a titanium oxide sol from titanium alkoxides from which the biocidal composite PVA-GO / TiO_2 / NPs was made.



I II

Figure 1. XRD patterns of GO (I) and a biocidal composite derived from it rGO-AgNPs (II).

Although the antimicrobial effect of AgNPs and GO is known, the development of hybrid materials of GO-AgNPs has considerable interest in various applications since they may exhibit synergistic bactericidal properties [3].

The antibacterial properties of both graphene oxide and GO-AgNPs composites were studied against indicator bacterial strains of Gram-negative *Escherichia coli* ATCC 25922 and Gram-positive *Staphylococcus aureus* 4399311-124 by viable cell count and agar diffusion method. Isolates were incubated with 20 µ/ml and 40 µ/ml of GO and GO-AgNPs for 2 and 24 h to evaluate the antimicrobial effect. Results demonstrated that the GO-AgNPs exhibited a significant anti-bacterial activity compared to GO. GO, and GO-AgNPs significantly reduced both microorganisms' growth at 2 and 24 h in a time-dependent way compared to the respective time controls.

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SYNTHESIS, CHARACTERIZATION, AND LUMINESCENCE PROPERTIES OF COPOLYMERS BASED LANTHANIDE COMPLEXES AND STYRENE

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A very promising class of compounds are metal-containing polymers, which are characterized by a wide range of useful properties in terms of practical application [1]. At the same time, the issues of synthesis of the original monomers and their polymerization and copolymerization remain poorly understood. In recent decades, luminescent lanthanides have attracted a tremendous amount of interest due to their potential applications in optoelectronics and as sensors and luminescent probes [2]. In [3], the potential prospects of compounds based on lanthanide metal complexes with β-dicarbonyl ligands and their homopolymers as precursors of luminescent materials are shown. The studies of copolymers based on these compounds were selective [4].
The complexes of Eu^{3+} with 2,6-dymethyl-hepten-1-3,5-dion and 2,6-dymethyl-hepten-1-3,5-dion were synthesized. The copolymers with styrene in ratio 5:95 were obtained by free-radical polymerization at the first time. The complexes were fully characterized using FTIR and thermal analyses. Using physicochemical methods of analysis, the composition of the complexes and the structure of the nearest coordination environment of the metal ion in the complex were determined. It was shown that the ligands are coordinated to c.a. bidentate-cyclic with a delocalized system of π-bonds in the chelate ring. Absorption, diffuse reflectance and emission spectra for the complexes were recorded. The luminescent spectra of obtained metal complexes in solid state are investigated. The luminescence intensity depends on the nature of the ligand and the industrial monomer used for the copolymerization.
The high emission intensity of polymeric and, in particular, copolymer compounds, the low cost, high thermal and chemical stability make them promising as precursors of luminescent materials

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Abstract

CYCLOPROPANE-CONTAINING POLYMER HYDROGELS ON THE BASIS OF COPOLYMERS OF SUBSTITUTED VINYLCYCLOPROPYL ETHERS WITH MALEIC ANHYDRIDE

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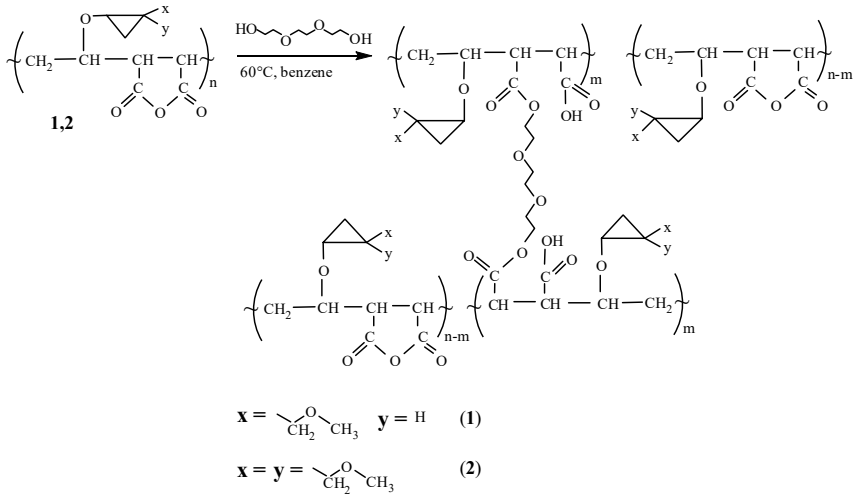
It was known that the stimulus-sensitive polymers (thermo- and photosensitive polymers, polymer gels, materials with shape memory effect, etc.) combine several physical or physical-chemical characteristics changing under the influence of external actions (temperature, pressure, pH of medium, electric and magnetic fields, humidity, etc.). Such "intellectual" or "smart" polymers have found application in bio-and nanotechnology, microelectronics, new methods of separation of components of the mixture, medicine, instrument making, etc [1, 2].

In this work the properties of thermo-sensitive copolymers on the basis of vinylcyclopropyl ethers have been synthesized and investigated. The copolymers having equivalent composition and alternating structure have been obtained by free radical copolymerization from mono- and *gem*-dimethoxymethyl-substituted cyclopropylvinyl ethers and maleic anhydride. The netlike polymers with various degrees of cross-linking have been obtained by action of diethylene glycol (DEG) and triethylene glycol (TEG), and also ethylenediamine (EDA) and hexamethylenediamine (GMDA).



The influence of temperature, pH of medium on the thermal behavior of the obtained polymers has been studied. It has been established that the synthesized copolymers have hydrophilic properties and are capable of abrupt changes in the physicochemical state in accordance with the environment temperature, i.e. in the solution the copolymers undergo thermally induced phase transitions, similar to protein denaturation. For netlike polymers, the thermal sensitivity is appeared in the collapse-decollapse phenomenon, stipulated by the conformational transition of the polymer chains containing both hydrophilic and hydrophobic links. The synthesized polymer gels react on small changes in the temperature and pH of medium. In addition, they are photosensitive polymers, since their structure includes stressed cyclopropane rings.

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Abstract

GEOPOLYMER BINDERS BASED ON CLAY ROCKS OF GEORGIA

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Geopolymer binders are a new direction in creating technology for producing energy-efficient building materials.

Geopolymer materials are considered as binding systems obtained on the basis of finely ground aluminosilicate materials, which are mixed with alkalis or solutions of their salts (as a rule, hydroxides, silicates or carbonates of sodium or potassium) with an alkaline reaction. After dissolution of aluminosilicates in alkalis, they recondense and form an amorphous three-dimensional framework structure. That is, geopolymer is a three-dimensional aluminosilicate mineral polymer [1]. Geopolymers are also considered nanomaterials.

Geopolymer binders, in comparison with Portland cement, are characterized by environmental friendliness, durability and low carbon dioxide emission during their production. When 1 ton of geopolymer binder is obtained, 0.18 ton of CO_2 is released into the atmosphere, which is 5 times less than in the production of Portland cement [2]. Therefore, geopolymers are considered as an alternative to Portland cement. Earlier, we have developed a regime for thermal modification of shale in order to obtain metakaolin, which is one of the main components for the synthesis of geopolymer [3].

The aim of this work is to develop a technology for producing geopolymer binders based on thermo-modified clay rocks of Georgia, for which local rocks were used: clay shale, mudstone and low-melting clay. Research has made it possible to develop different compositions of geopolymer binders. It was found that the mechanical strength of the synthesized binders after heat treatment significantly increases after 3 days of hardening, which is caused by an increase in the density of the structure of the system [4, 5].

Acknowledgementst This work was supported by the Shota Rustaveli National Science Foundation of Georgia (SRNSFG) [grant number FR-18-783].

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COPOLYMERS ON THE BASIS OF ACRYLATE OF PYRROLO[3,4-C]PYRIDINES AND STYRENE

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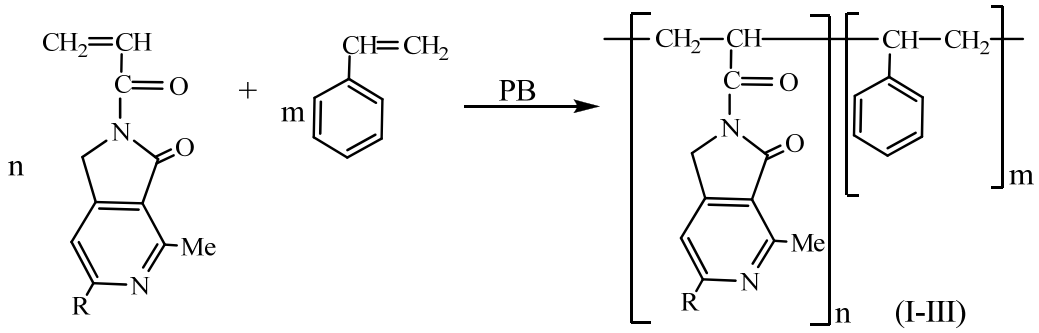
The synthesis of biologically active polymers and polymer compositions developed on their basis, possessing wide range of actions, as carriers of acting substances, as well as polymers with their own biological activity attract more and more attention of researchers. Biologically active polymers present a unique possibility for creation of some almost type of drug of the future. Among such polymers, the polymers or composition materials with biologically active heterocyclic fragments occupy a special place.

Taking into account the above-mentioned one in this work, for preparation of copolymers we have used a monomer pair of acrylamide of pyrrolo[3,4-c]pyridine and styrene, in which styrene is more active (rSt = 1.25, rAA = 0.22. The copolymerization was carried out at 70°C in the presence of benzoyl peroxide and molar ratio of styrene : AA= 80.6 : 19.4 in the solution of dimethylformamide. Under the chosen conditions, the pyrrolo[3,4-c]pyridine fragment is not affected and the chain structure is not disturbed.



R= Me (I), Et (II), Ph(III)

The composition of forming copolymers was determined by a method of IR spectroscopy.

For estimation of the polymerization activity of APPy, the relative activity constant values of monomers have been calculated on compositions of the initial monomer mixture and copolymers – on Mayo-Lewis method.

Abstract

REACTION HYDROSILYLATION OF ALLYL-2,3,4-TRI-O-ACETYL-β-L-ARABINOPYRANOSE WITH METHYL CYCLODISILAZANES

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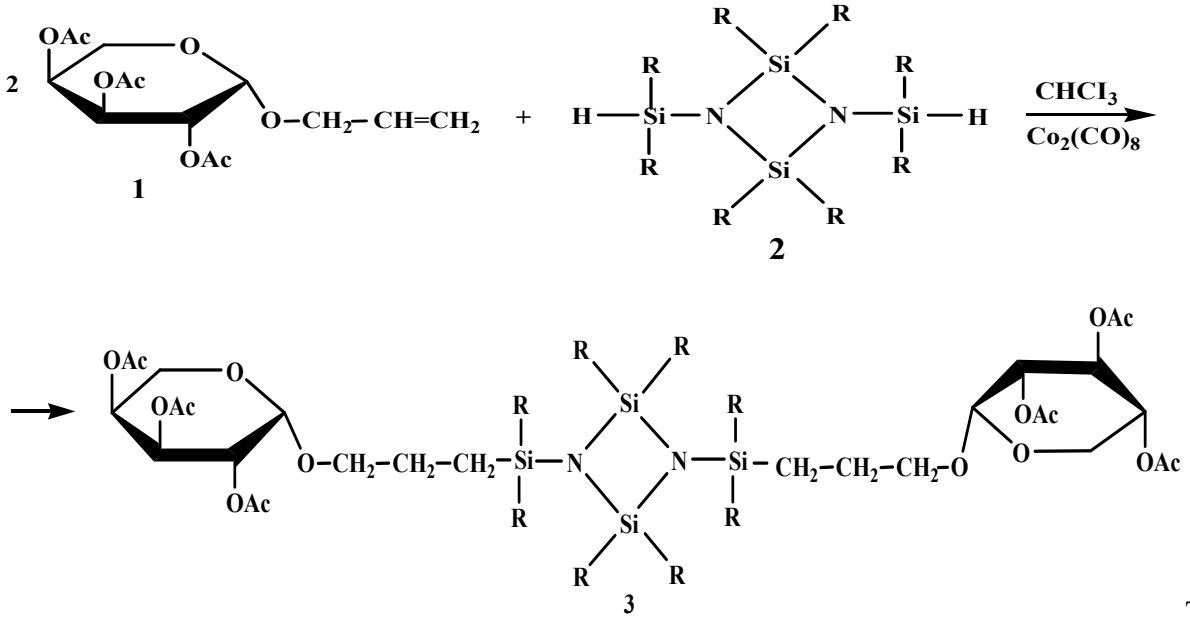
Research in recent years has shown that the synthesis of low-toxic compounds is becoming relevant in biological and pharmacological research. Therefore, it is of interest to use carbohydrates for the modification of some heterocyclic compounds, which can lead to a significant change in the nature of the action of drugs [1].

In a number of studies carried out earlier [2,3], the reactions of hydrosilylation with derivatives of hexoses (D-glucose, D-galactose, D-mannose, L-rhamnose) were studied. The corresponding 1,2-trans-glycosides were synthesized.

In continuation of these works, we studied the reaction of hydrosilylation of 1-0-allyl-2,3,4-tri-0-acetyl-β-L-arabinopyranose (1) with 1,3-bis-(dimethylsilyl)-2,2,4,4-tetramethyl-cyclodisilazane (2). The reaction was carried out in dry chloroform at a molar ratio of 3: 1 at a temperature of 60-650^{0}C in the presence of a catalyst Co_2 (CO) $_8$. The corresponding product was obtained - [1,3-di- [3-(2,3,4-tri-0-acetyl-β-L-arabinopyranosyloxy)propyldimethylsilyl]-2,2,4,4-tetramethylcyclodisilazane (3). The reactions mainly occurs according to Farmer´s rule, although a small amount of the Markovnikov addition product is alsonformed.



The structures of obtained compounds were established by physical-chemical methods of analysis.

MUTUAL INFLUENCE OF CYANATE ESTER AND BENZOXAZINE MONOMERS ON KINETICS OF THEIR LOW TEMPERATURE POLYMERIZATION

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Conventional temperature ranges for polymerization of cyanate ester and benzoxazine is between 150 and 270 °C. In this work, the kinetic peculiarities of dicyanate ester of bisphenol E (DCBE) polycyclotrimerization in the presence of bisphenol A based benzoxazine (BOA) and BOA ring-opening polymerization in the presence of DCBE at temperature of 100 °C during 600 min were investigated by FTIR spectroscopy. The DCBE/BOA ratio was equal 75/25 wt.%. For comparison, kinetics of neat polycyanurate from DCBE and neat polybenzoxazine from BOA formation were studied under the same conditions. First of all, it was found that the polymerization of both neat DCBE and neat BOA are characterized by significant induction period, 50 and 60 min, correspondingly, on the curves of conversion of their functional groups (cyanate groups and oxazine cycles, correspondingly) *versus* time. Contrary, the induction period disappears for conversion of both the monomers on the kinetic curves of the DCBE/BOA=75/25 wt.% blend (Fig. 1).

The value of conversion of cyanate groups after heating 600 min at 100 °C increased from ≈ 73 % (for neat DCBE) to ≈ 84 % in the DCBE/BOA mixture and the value of conversion of oxazine cycles increased from ≈ 33 % (for neat BOA) to≈ 68 % in the DCBE/BOA blend. Thus, both DCBE and BOA have a mutual catalytic effect on their polymerization in the presence of each other, because according to the FTIR investigations both the components of the system significantly accelerate the conversion of functional groups (cyanate groups for DCBE and oxazine cycles for BOA) in the early stages of chemical reactions. Moreover, the chemical grafting of two networks (polycyanurate and polybenzoxazine) due to reaction of cyanate groups of growing polycyanurate network with phenolic groups appeared at transformation of BOA to polybenzoxazine is evidenced by FTIR spectroscopy technique.

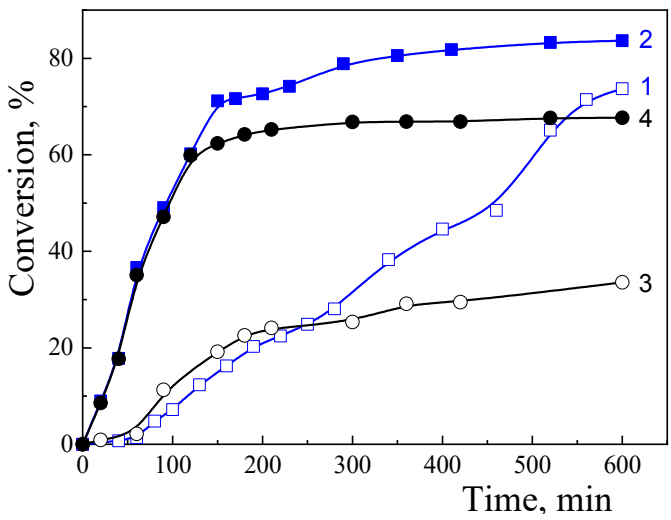

Figure 1. Conversion *versus* time for: cyanate groups of neat DCBE (*1*) and DCBE in the DCBE/BOA=75/25 wt.% mixture (*2*); oxazine cycles of neat BOA (*3*) and BOA in the DCBE/BOA=75/25 wt.% mixture (*4*).

HYDROBROMINATION REACTIONS OF ALLYLATED COMPOUNDS

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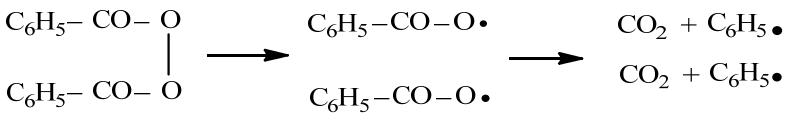
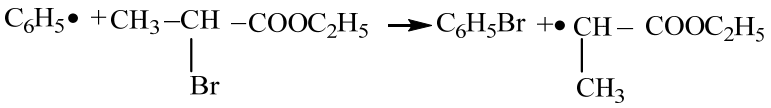
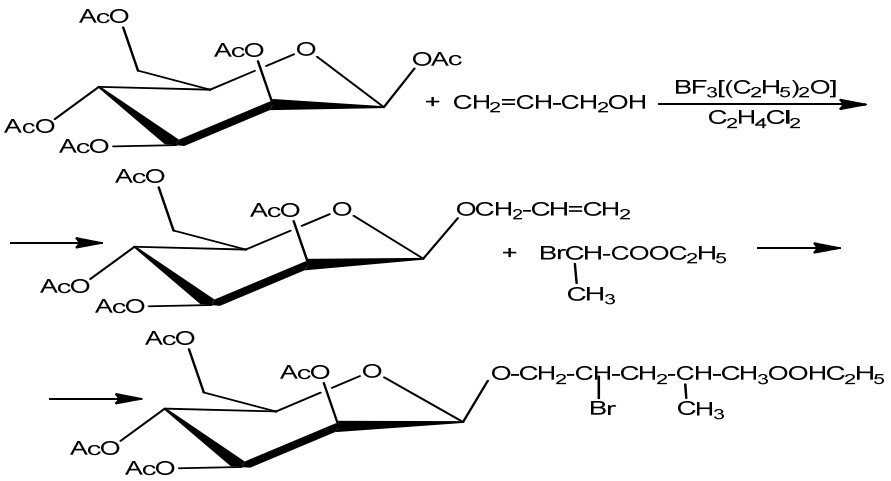
The halogenations of organic substrates is one the most important transformations reactions in organic synthesis.
The structure of the compounds obtained proves that the reaction proceeds by a radical mechanism. Benzoyl peroxide (initiator) decomposes under the influence of temperature and forms a free radical, which, in turn, easily decomposes into CO_2 and aromatic radicals:



The resulting radical easily attacks the bromine atom of α-bromopropionic acid. Bromobenzene and isopropyl radical are formed:



The following radical acts with allyl glycoside:



The synthesized compounds are interesting initial compounds for obtaining hydrocarbon polymers

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Abstract

BIODEGRADABLE PSEUDO-PROTEIN-BASED NANOPARTICLES AS OPHTHALMIC DRUG DELIVERY VEHICLES

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Ophthalmic drug delivery to treat ocular diseases still is a challenge in ophthalmology [1]. One way to achieve drug delivery that is investigated currently is topical administration of drug-loaded biodegradable polymeric nanoparticles (NPs) that are able to penetrate ocular barriers [2].
The purpose of this study is optimal preparation of NPs made from pseudo-proteins and evaluation of their ability to penetrate ocular tissues. Biodegradable NPs of various types were prepared by nanoprecipitation of pseudo-protein composed of L-leucine, 1,6-hexanediol and sebacic acid (8L6). Arginine-based cationic polyester amides 8R6 and comb-like polyester amide containing lateral PEG-2000 chains along with 8L6 anchoring fragments in the backbones were used to construct positively charged and PEGylated NPs. They were loaded with fluorescein diacetate (FDA) or rhodamine 6G (Rh6G) as fluorescent probes. Suspensions of the NPs were given to cultivated microglial cells and RPE cells as well as topically on eyes of C57BL/6 mice. Penetration of NPs into the eyes was checked by fluorescence analysis.
NPs were prepared, and their properties were characterized. Cultured microglial cells and RPE cells took up the NPs. After topical administration, penetration of NPs into the cornea of the eyes could be clearly shown. Small amounts of fluorescent dyes were also found in the lens, the retina and the sclera depending on the type of NPs. The results show that the new pseudo-protein-based NPs penetrate ocular tissues after topical administration and are internalized by the cells. This raises confidence that the NPs may be useful carriers of therapeutic agents for ocular delivery..

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Abstract

SYNTHESIS OF NEW 1,2,3-TRIAZOLE CONTAINING POLY(ESTER AMIDE)S AND POLY(ESTER ETHER AMIDE'S

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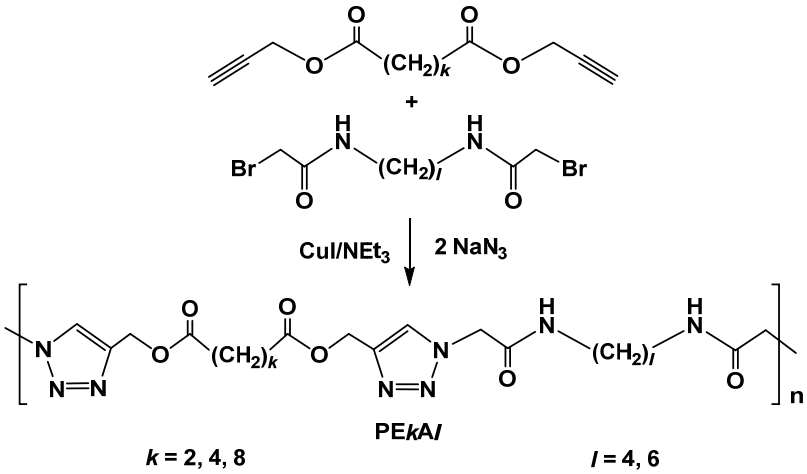
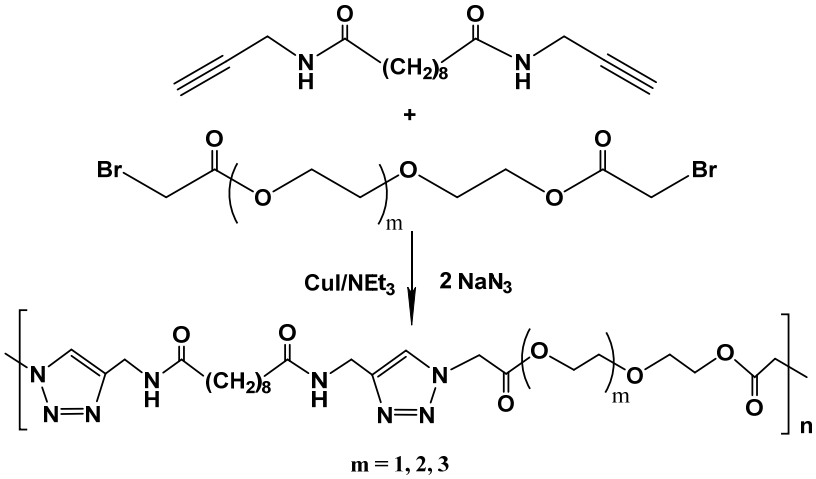
In this work, new AA-BB-type 1,2,3-triazole containing aliphatic poly(ester amide)s (see Scheme 1) and poly(ester ether amide)s (see Scheme 2) were synthesized *via* three-component two-step Cu(I)-catalyzed click step-growth polymerization process using dibromide and diyne monomers in the presence of sodium azide according to the new synthetic strategy that we had previously developed [1]. The structure of the obtained new biodegradable ester polymers was confirmed by standard methods such as FTIR and NMR techniques, and solubility behaviour of the „click" polymers was studied.



Scheme 1. Synthesis of poly(ester amide)s

As it was anticipated, „click" poly (ester amide)s showed very poor solubility in common organic solvents due to the presence of rigid amide bonds along with triazole rings in the backbone. Introduction of additional ether bonds in the polymeric main chain significantly improved the solubility of the new triazole polymers: click poly(ester ether amide)s revealed quite good solubility in common organic solvents like DMSO, DMF, DMA, and NMP. The obtained results underline the suitability of our new synthetic strategy for obtaining various classes of 1,2,3-triazole containing hetero-chain biodegradable „click" polymers with triazole rings in the backbone that are promising for wide range of biomedical applications.



Scheme 2. Synthesis of poly(ester ether amide)s

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Abstract

THE THEORETICAL DESCRIPTION OF THE ELECTROCHEMICAL DETERMINATION OF SUCRALOSE, ASSISTED BY POLY(SAFRANIN)-MODIFIED ELECTRODE

Volodymyr V. Tkach[1,2], Nataliia M. Storoshchuk[1], Sílvio C. de Oliveira[2], Yana G. Ivanushko[3], Olga V. Luganska[4], Petro I. Yagodynets´[1] Zholt O. Kormosh[5]

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Sucralose is one of the most used sugar substitutes in the world. It is three times as sweeter as aspartame, twice as sweeter as saccharin and 800 to 1000 times sweeter than the sucrose.

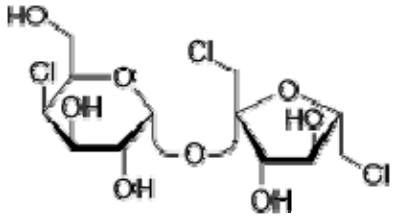

Figure 1. Sucralose

It has been approved for use in the USA, in Canada, in Australia and in the European Union [8]. Its chemical composition is related to that of the carbohydrates. But, containing three chlorine atoms, it may present different toxic effects, reason why the development of an efficient method for sucralose detection is really actual.

In this work, a cathodic determination over a poly(safranine)-modified electrode has been analyzed from the theoretical point of view. By this, safranin, being a salt, reacts with sucralose, yielding a biquaternized salt, which is thereby reduced (Fig. 2)

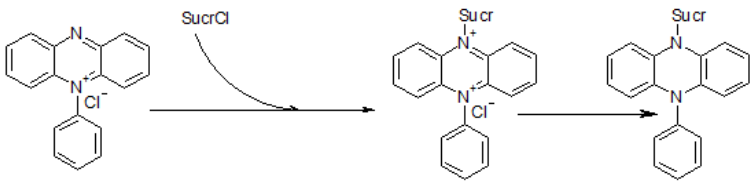

Figure 2. Sucralose electrochemical determination scheme

Analyzing the correspondent mathematical model, we confirm that the steady-state stability range is wider than in the most system of electrochemical determination over the pyridinic nitrogen-containing conducting polymer. Moreover, the oscillatory behavior is less probable. Therefore, poly(safranine) is an efficient electrode modifier for sucralose electrochemical determination.

THE THEORETICAL DESCRIPTION OF THE ELECTROCHEMICAL DETERMINATION OF vareniclin, ASSISTED BY COBALT (III) OXYHYDROXIDE

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Vareniclin (Fig. 1) is one of the drugs widely used in tobacco dependence treatment. Its action is based on agonist effects on cholinergic receptors α4β2, producing the similar effects to nicotine, reason why the development of efficient methods of its determination is really actual.

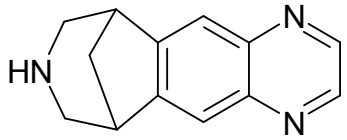

Figure 1. Vareniclin

In this work, vareniclin electrochemical determination on the CoO(OH)-modified electrode will be analyzed. Two parallel scenarios for vareniclin electrooxidation over CoO(OH) may be possible, yielding a low- and high-molecular oxidation product. The low-molecular oxidation product also participates in the polymer formation (Fig. 2):

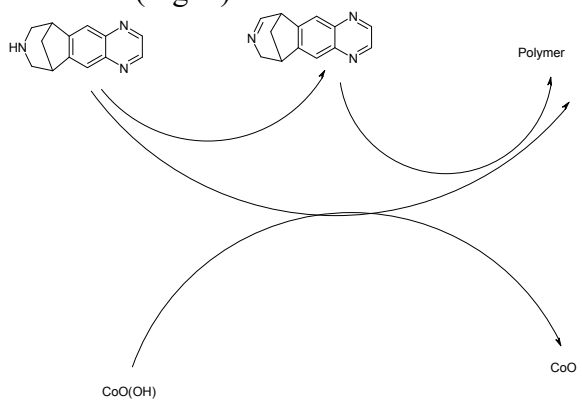

Figure 2.Scheme of electroanalytical process.

The analysis of the model confirms the efficiency of cobalt(III) oxyhydroxide-modified electrode as an efficient tool for vareniclin electrochemical determination. Also, the resulting polymer may also be used as electrode modifier for the electrochemical determination of different compounds.

THE THEORETICAL DESCRIPTION OF THE ELECTROCHEMICAL OXIDATION OF SUDAN DYES, ASSISTED BY COPPER (II) SULFIDE NANOPARTICLES

Volodymyr V. Tkach[1,2], Marta V. Kushnir[1], Sílvio C. de Oliveira[2], Yana G. Ivanushko[3], Olga V. Luganska[4], Petro I. Yagodynets´[1] Zholt O. Kormosh[5], Lucinda Vaz dos Reis[6]

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The group of Sudan dyes [1] is the group of azodyes, widely used in histological investigations. Moreover, being fat-soluble, they are used to color vax, oils, petrol derivatives, solvents and polishes in bright colors – red, orange and yellow. In some countries, these dyes are used (mostly illegally) in the food production. The most dangerous is that these dyes may present high toxicity level reason why their use in food is banned in 32 countries.. Therefore, the development of a rapid and efficient method for their quantification is really actual.
In this work, the possibility of Sudan dyes electrochemical determination, assisted by CuS nanoparticles, stabilized by the squaraine dye, has been evaluated. On the electrochemical stage, CuS nanoparticles are oxidized, yielding the trivalent copper derivative:

$$CuS + OH^- - e^- \rightarrow CuS(OH) \quad (1)$$

As trivalent copper is a strong oxidant, it may either provide a polymerization of azodye, or N-oxidize it, yielding an azoxy compound, which is thereby oxidized by azobond destruction and nitrocompounds formation:
Therefore, the system´s behavior will be described by the trivariant system as:

$$\begin{cases} \frac{ds}{dt} = \frac{2}{\delta}\left(\frac{d}{\delta}(s_0 - s) - r_p - r_N\right) \\ \frac{ds_N}{dt} = \frac{2}{\delta}\left(r_N - r_p - r_d\right) \\ \frac{dc}{dt} = \frac{1}{C}\left(r_N + r_p + r_d - r_1\right) \end{cases} \quad (2)$$

The analysis of the model confirms that the oscillatory behavior probability will be greater than for the simplest case. Moreover, its probability will be highly dependent on the pH (more probable in the acidic solutions). Nevertheless, the copper sulfide nanoparticles, deposited over the squaraine dye, are efficient electrode modifier for copper sulfide determination

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Abstract

ZINC TETRAPHENYLPORPHYRIN / DEXTRAN-GRAFT-POLYACRYLAMIDE / GOLD NANOPARTICLES NANOSYSTEM FOR PHOTODYNAMIC THERAPY: OPTICAL PROPERTIES AND BACTERICIDAL ACTIVITY

O.A. Yeshchenko[1], N.V. Kutsevol[2], A.V. Tomchuk[1], P.S. Khort[1], P.A. Virych[2], V.A. Chumachenko[2], Y.I. Kuziv[2], A.P. Naumenko[1], A.I. Marinin[3]

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The Zinc TetraPhenylPorphyrin photosensitizer / Dextran graft PolyAcrylAmide copolymer / Au NanoParticles (ZnTPP/D-g-PAA/AuNPs) triple hybrid nanosystem were synthesized in water solution as a nanodrug for potential use in photodynamic therapy applications.
The dynamic light scattering has been shown the system to be aggregatively and sedimentationally stable during several days after preparation. The changes in absorption and fluorescence spectra of ZnTPP after its mixing with water solutions of D-g-PAA and D-g-PAA/AuNPs have proved the binding of ZnTPP molecules both with bare D-g-PAA and D-g-PAA/AuNPs macromolecules. The dependence of fluorescence intensity of ZnTPP in ZnTPP/D-g-PAA/AuNPs nanosystem on the gold concentration has been obtained to be non-monotonic with maximal 2.2 times enhancement at the concentration of 0.005 mg/ml. Such dependence has been explained to be caused by two competing processes, namely the plasmonic enhancement and FRET, indicating an existence of optimal concentration of Au NPs providing the highest plasmonic enhancement of the electronic processes involving the ZnTPP photosensitizer. The 3.2 times enhancement of singlet oxygen photogeneration under resonant with localized surface plasmon wavelength excitation has been detected for ZnTPP/D-g-PAA/AuNPs that proves the plasmonic origin of such phenomenon. The high rapid bactericidal efficiency of ZnTPP/D-g-PAA/AuNPs water solution at 530 nm light irradiation was revealed for wild strains of Staphylococcus aureus.
These data indicate that ZnTPP/D-g-PAA/AuNPs hybrid nanosystem is quite promising for photodynamic therapy, the open wounds in particular.

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FORMATION OF TRIMETHINE CYANINE OF THE DIPYRROLOBENZOQUINOXALINE SERIES UNDER THE CONDITIONS OF THE VILSMEIER REACTION

Sh.A. Samsoniya, M.V. Trapaidze, N.N. Nikoleishvili

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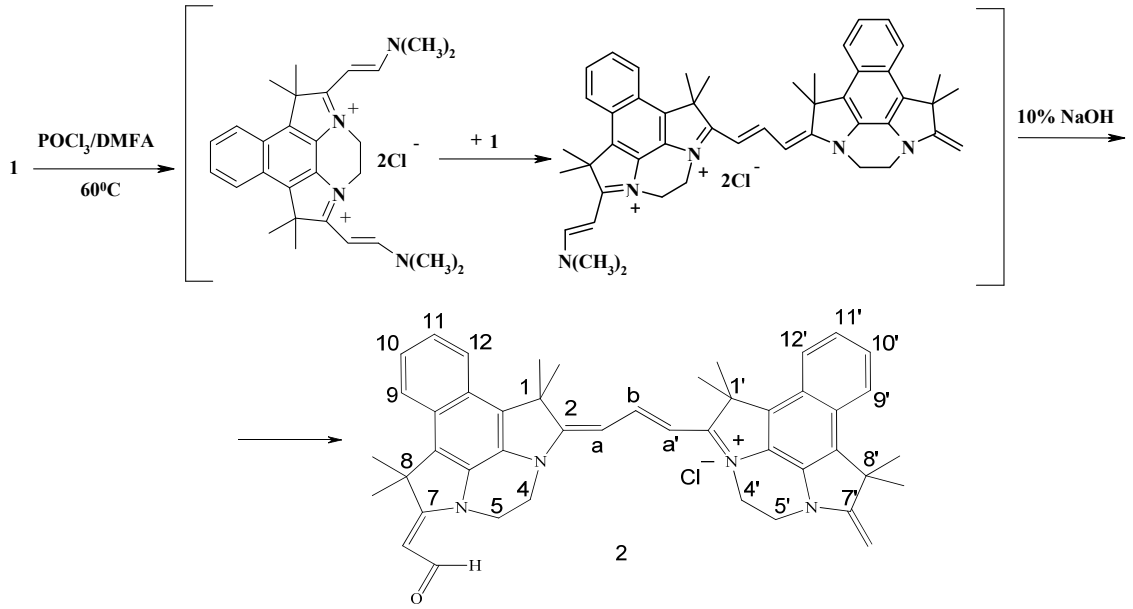
Fischer's aldehyde is an important intermediate product for the preparation of cyanine and hemi cyaninedyes [1]. In this work, we studied the formylation reaction of the previously obtained bifunctional analogue of the Fischer base of the dipyrrolobenzoquinoxaline series 1 [2, 3] at different ratios of the substrate and the Vilsmeier complex (CV).

In the formylation of 1,4,5,8-tetrahydro-1,1,8,8-tetramethyl-2,7-dimethylidenedipyrrolo [1,2,3-d,e:3,2,1-i,j]benzo[g]quinoxaline (**1**) at a molar ratio of Fischer base and Vilsmeier complex of 1: 5, after stirring for 30 minutes at 40^0C, along with the formation of the expected formylation product, chromatographically observed in the reaction medium still the presence of the original base **1**.A further increase in temperature at 60^0C causes a sharp change in the color of the reaction medium. The initially yellowish-red solution acquires an intense blue coloration. As a result of the reaction, blue crystals were yielded, which, on the basis of spectral data (UV, PMR-1H, and Mass spectra), were assigned the structure of the anomalous reaction product, trimethine cyanine **2**, by analogy with the compound, which is formed by the interaction of Fischer's indoline base with Fischer's aldehyde [4].

Scheme for the formation of compound **2**:



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Abstract

SYNTHESIS OF MORPHOLINE-CONTAINING METHACRYLATE AND ITS RADICAL COPOLYMERIZATION WITH METHYL METHACRYLATE

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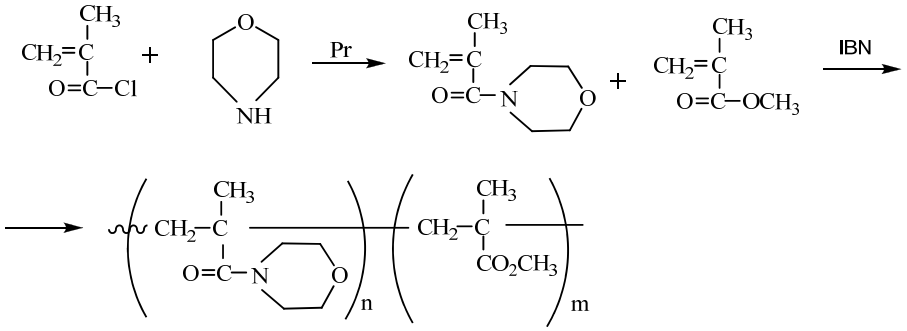
The polymers containing functionally active groups [1, 2] in its composition have a wide range of medical-biological activity and are used as the bactericides, fungicides and drugs. Most often, the monomers of the vinyl and new monomer series containing carbonyls and amino groups in the structure were used for preparation of such polymers.

The purpose of this work is the investigation of synthesis of morpholine-containing methacrylate and its radical copolymerization with methyl methacrylate (MMA). The task of the work was also the investigation of the biological activity of the synthesized copolymer.

Based on the data of IR and PMR spectroscopy and elemental analysis, one can assume that the synthesized monomers and polymers have the following structures:



The identification of structure of macromolecules of copolymers has been established by a method of IR and PMR spectroscopy. The composition of the synthesized copolymers was determined on nitrogen content. The corresponding copolymerization constants are r_1=0.70 (morpholine methyl methacrylate) and r_2=0.50 (MMA).

The biological tests showed sufficiently high bactericide (E. coli – 0.7, St. aureus – 0.9) and fungicide (Candida albicans – 1.2) activity of the synthesized copolymers. It has been revealed that the biocide effect has been primarily connected with availability of a morpholine fragment in the chain.

As a result of the carried out investigations, it has been firstly obtained the sample of a copolymer (morpholine methyl methacrylate), and it has been also established that this copolymer exhibits high bactericidal and fungicidal properties.

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SYNTHESIS OF 5(6)-(1-ADAMANTYL)-1H-2-R-BENZIMIDAZOLES BASED ON ADAMANTYLDIAMINOBENZENE

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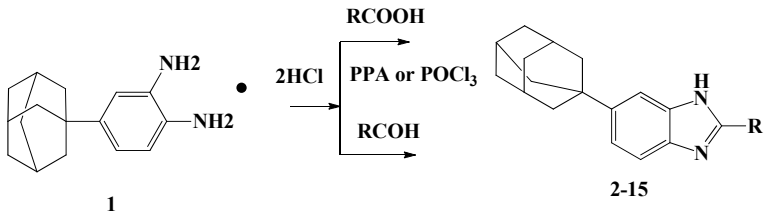
It is known that benzimidazoles and adamantanes have high level of bioactivity and are used as drugs against variety of diseases and infection [1,2], therefore the synthesis of new derivatives of adamantane containing benzimidazoles and study their biological activity is interesting.
The present work aims to synthesis some of new 5(6)-(1-adamantyl)-1H-2-R-benzimidazoles based on adamantyldiaminobenzene.
For this purpose, cyclisation of 4-(1-adamantyl)-1,2-diaminobenzene dihydrochloride with some aromatic carboxylic acids and aldehydes were conducted according to the scheme.



R=o-C_6H_4OH (2), 2–OH-3,5-$Br_2C_6H_2$ (3), 2-OH-3,5-$I_2C_6H_2$ (4), 4-$NH_2C_6H_4$ (5), 3-$NH_2C_6H_4$ (6), 3-$C_6H_5CONHC_6H_4$ (7), R=o-C_6H_4OH (8), 2–OH-3,5-$Br_2C_6H_2$ (9), 2-OH-5-Br-C_6H_3 (10), 2-OH-5-NO_2-C_6H_3 (11), 4-NO_2-C_6H_4 (12), 3-NO_2-C_6H_4 (13), p-$C_6H_4N(CH_3)_2$ (14), p-$C_6H_4NEt_2$ (15).
The condensation reaction of 4-(1-adamantyl)-1,2-diaminobenzene dihydrochloride (1) with carboxylic acids in PPA or $POCl_3$ medium was conducted. It was found that by heating a mixture of compound 1 with aromatic acids (salicylic-, dibromo-, and diiodsalicylic-, 3- amino- and 4-amino-benzoic acids) in a ratio of 1: 1, 1: 2 in the presence of PPA, the corresponding benzimidazoles 2, 5, 6 were isolated in different yields, but isolation of benzimidazole derivatives 3 and 4 with dibromo- and diiodosalicylic acids under the same conditions failed, due to the grinding of the reaction mixture and the removal of iodine and bromine. Preparation of benzimidazoles 3, 4, 7 were possible by heating the reaction mixture in $POCl_3$ medium (107°C).
The condensation reaction of compound 1 with aromatic aldehydes was studied. By boiling the equimolar ratios of diaminobenzene 1 and aldehyde (salicyl-, 3,5-dibromosalicyl-, 5-bromosalicyl-, 5-nitrosalicylaldehydes, 3-nitrobenz-, 4-nitrobenz-, 4-diethylaminobenzal-dehydes) in abs. alcohol and by oxidizing the obtained Schiff bases in nitrobenzene, the corresponding adamantylben-zimidazoles 8-15 were synthesized in high yields.
The molecular structure of the synthesized compounds was established by spectroscopy analysis, including IR, UV, ^1H, ^{13}C NMR and HRMS.
It is perspective to place the nanoparticles of synthesized compounds (2-15) on the polymer matrix to impart prolonged effects of biological activity.

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TEMPERATURE DRIVEN PLASMON-EXCITON COUPLING IN THERMORESPONSIVE DEXTRAN-GRAFT-PNIPAM / AU NANOPARTICLES / CDTE QUANTUM DOTS HYBRID NANOSYSTEM

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The temperature driven plasmon-exciton coupling in thermoresponsive dextran-graft-PNIPAM / Au nanoparticles / CdTe quantum dots (D-g-PNIPAM / Au NPs / CdTe QDs) hybrid nanosystem was studied. A significant (0.84 eV) splitting of the absorption peak was observed in the absorption spectrum of the nanosystem, which reflects the fact of formation of plexcitons, occurring due to strong plasmon-exciton coupling. An increasing with time plasmonic enhancement of the photoluminescence of CdTe QDs was revealed, as a result of the penetration of quantum dots into the volume of the D-g-PNIPAM / Au NPs hybrid nanosystem and bonding to it. The heating-cooling cycle of the aqueous solution of the studied nanosystem leads to a reversible quenching-recovery alteration of the QD photoluminescence. The quenching was rationalized as a result of an increased probability of nonradiative resonance energy transfer (RET) from CdTe QDs to Au NPs, which occurs due to shortening of the NP-QD distance, caused by shrinking of the macromolecule due to cooling-induced lower critical solution temperature phase transition. Increasing the NP-QD distance in the heating stage recovers the QD PL intensity. The observed effect opens up opportunities for the controlled reversible temperature-driven tuning of the photoluminescence intensity of D-g-PNIPAM / Au NPs / CdTe QDs nanosystem, which is highly important for its potential use in photonics and biomedical applications.

Acknowledgments. This work was supported in part by National Research Foundation of Ukraine (project 2020.02/0022) and Ministry of Education and Science of Ukraine (projects 0119U100300, 0119U100319).

ALTERNATIVE COPOLYMERIZATION OF SUBSTITUTED METHYLENEDIOXOLANES WITH MALEIC ANHYDRIDE

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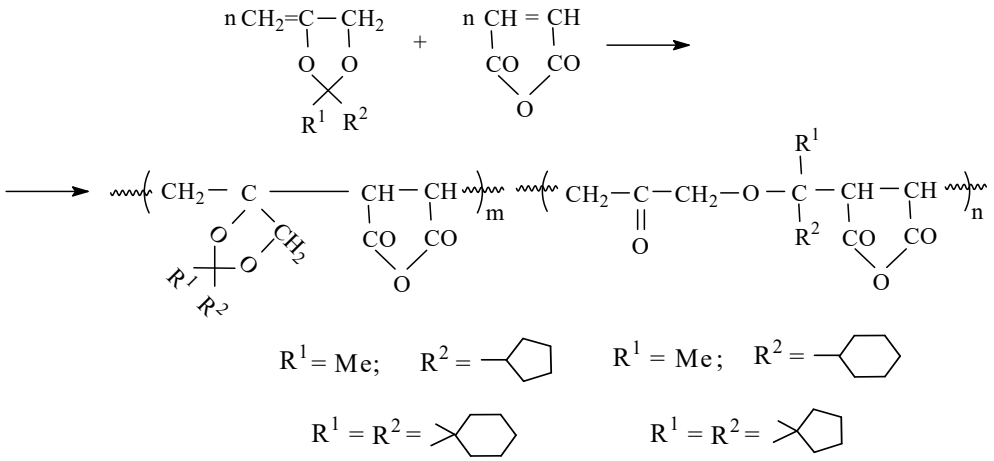
In this paper the results of the copolymerization of alkyl and cycloalkyl substituted methylenedioxolanes with MA are presented. The synthesis of these monomers has been carried out by us earlier [1].

The copolymerization of the synthesized methylenedioxolanes with MA has been carried out under the conditions of free radical initiation in the presence of AIBN at 60°C in benzene solution. The structure of the obtained copolymers has been studied by a method of IR and PMR spectroscopy and it has been established that the copolymers contain MA-cyclic and MA-linear fragments in the macromolecular chain:



It has been established that the composition of the obtained copolymers practically does not depend on the ratio of the initial monomers and is close to equimolar one at copolymerization of the selected comonomers with MA. The calculated copolymerization constant values and Q-e parameters also confirm the equimolar composition of the obtained copolymers.

The complex-formation between comonomers has been investigated by a method of PMR spectroscopy and it has been established that the composition of forming complex corresponds to 1:1, and the obtained equilibrium constant values of the molecular complexes for the studied systems have values in the range of 0,36 – 0,46 l/mol, which characterizes the formation of weak molecular complexes in these systems.

It has been studied the dependence of the initial copolymerization rate on the molar fraction of methylenedioxolane in a mixture of monomers and it has been revealed that the maximum copolymerization rate is reached at equimolar ratio of the initial monomers.

Some physical-chemical and physical-mechanical indices of the obtained copolymers have been determined.

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Abstract

NEW NANOMATERIALS BASED ON NATURAL ZEOLITE

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Antibiotics are considered to be anthropogenic environmental pollutants and represent a serious danger to humans and living organisms [1]. A special problem is the presence of antibiotics and their metabolites in water. Zeolites - nanoporous materials possess a unique spectrum of physicochemical, adsorption and ion exchange properties, due to which they find wide application in practice of wastewater treatment [2]. Natural zeolites are potentially industrial mineral raw materials for Georgia, and their complex evaluation allows to fully use the mineral wealth and to increase their investment attractiveness [3]. The purpose of the present work was to study the possibility of using clinoptilolite (Handaki, Kaspi region, Georgia) as an adsorbent of the β-lactam antibiotic ceftriaxone (CEF – $C_{18}H_{18}N_8O_7S_3$) from the group of cephalosporins. For this, by chemical means, purpose, the nanomodification of natural clinoptilolite was carried out. To obtain a modified H-form, clinoptilolite was treated 2N and 5N HCl solution. The structure of zeolite – clinoptilolite was determined by infrared spectroscopy. Infrared spectrographic analysis was performed on the Agilent Cary 630 FTIR Spectrometer. The IR spectra of the zeolite were recorded in the region of vibrations of the aluminosilicon framework of the middle and far regions. In IR-spectra of clinoptilolite the zeolite structure is characterized by Si–O–Si(Al) intertetrahedral deformation and valence oscillations in the region of 1040cm^{-1}, 593,6 cm^{-1}, 520,9 cm^{-1} and 465 cm^{1}. After treatment of the sample with 2N acid (HCl) solution, various impurities are removed and the zeolite structure improvement takes place. This is indicated by the disappearance of bands in the spectrum of initial clinoptilolite in the areas of 1430,4 cm^{-1} and 875,0 cm^{-1}. These bends are typical for CO_3^{-2} and SO_4^{-2}. In addition, dealumination of zeolite begins. This is indicated by the change of frequencies in the spectrum of aluminosilicate carcass of intra-tetrahedral valence vibrations Si–O–Si(Al) from 1040.9 cm^{-1} to 1052.0 cm^{-1}. Worth mentioning, that in the characteristic spectrum of clinoptilolite structure the intensity of Si–O–Si(Al) intertetrahedral bands of oscillations has changed insignificantly. Treatment of zeolite with the 5N solution of acid (HCl) has significantly reduced these vibration bends and accordingly, the intensity of intra-tetrahedral valence Si–O–Si(Al) vibrations has increased to 1065,1 cm^{-1}, indicates an increase of silicate module of Si/Al in zeolite. Thus, acid treatment of the zeolite does not destroy its structure, but partial deformation occurs. The resulting zeolite nanomaterial can be used as an environmentally friendly sorbent for water purification.

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Abstract

SYNTHESIS OF BIOMIMETIC POLYMERS BASED ON NONPROTEINOGENIC α-AMINO ACIDS

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Nonproteinogenic amino acids (NPAAs) represent promising building blocks for constructing biologically active and functional polymers. From this point one of the most promising are NPAAs containing unsaturated bonds in the lateral chains [1-3]. Among biologically active and functional polymers an increased attention was attracted by pseudoproteins (PPs) – a family of biomimetic biodegradable polymers made from bis-(amino acid) alkylene diesters (diamine-diesters, DADEs) [4,5]. The present work deals with the first successful synthesis of PPs of poly(ester amide) (PEA) class (PP-PEAs) on the basis of unsaturated NPAAs such as allylglycine (AlG) and propergylglycine (PrG). The high-molecular-weight PP-PEAs (M_w up to 51,300) were obtained using a method of step growth polymerization - Interfacial Polycondensation (IP) of AlG/PrG based di-p-toluenesulfonic acid salts of DADEs (TDADEs) with sebacoyl chloride (SC). The obtained polymers were insoluble in water but soluble in a number of organic solvents. The PP-PEAs synthesized are of interest as prolonged acting biologically active materials (e.g. nanoparticles) as well as precursors for subsequent chemical modifications, e.g. to prepare biodegradable hydrogels by photo-crosslinking or *via* alkyne-azide click reactions, etc. In general, the construction of biomemetic polymers on the basis of NPAAs substantially expands a set of available functionalities which are less accessible for naturally occurring polymers – proteins.

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Abstract

TECHNOLOGICAL METHOD OF INCREASING EFFECTIVE PHOTOSENSITIVITY IN PHOTOCHROMIC LIQUID CRYSTAL POLYMER FILMS

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The photochromic liquid crystal polymer films (SPLC) with qualitatively new optical parameters are obtained based on the composition containing photochromic spiropyran (SP) doped nemato-chiral liquid crystal (LC) matrix. SPLC films made using the technological process of the innovative microencapsulation method developed by the authors. Controlling the technological characteristics of SPLC films (microcapsules size, film thickness, stretched and unstretched film) by regulating the stages of the microencapsulation process influences the effective photosensitivity of the polymer films [1].

Presented work describes a technological method of microencapsulation to increase effective photosensitivity by changing the size of microcapsules containing the polymer films. By controlling the stirring speed, during the preparation process of the encapsulated emulsion (layer) of the technological process, it is possible to change the size of the microcapsules containing the films, which has a significant impact on the effective photosensitivity of the SPLC films. Spectral and microscopic studies have shown that a decrease in the size of the microcapsules increases both: the peak of absorption characteristic of spiropyran and the intensity of reflection of the nemato-chiral matrix. In Figure 1 shown absorption spectra of SPLC polymer films after irradiated with ultraviolet (UV) light: 1-film with the size of microcapsules of 40-50 microns; 2-film with the size of microcapsules of 20-25 microns.

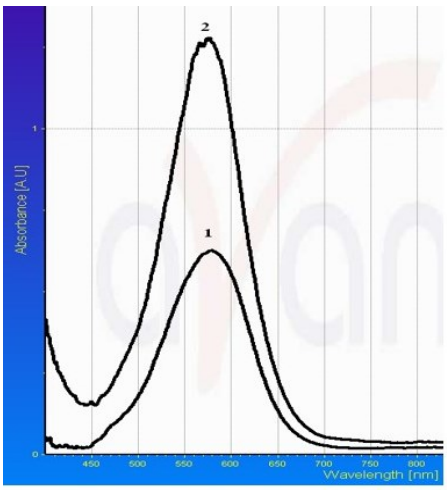

Fig.1

The proposed polymer films are promising for the preparation of new multifunctional, rewritable polymer materials with enhanced photosensitive, which are important for the fabrication of high-performing photonic optical devices [2].

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Abstract

RECENT ADVANCEMENTS IN AGROSPENT BASED POLYMER COMPOSITES AND BIONANOCOMPOSITES

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This study aimed at utilizing industrial agro waste materials to produce polymer composites and bionanocomposites for various applications. The agrospent fillers are gaining more attention in composite manufacturing fields as a substituent to inorganic fillers due to its biodegradable and biocompatible nature. The effect of various factors such as length, composition, orientation, size, loading etc. will impart various physical as well as chemical property enhancement of composites. In this paper, several surface modifications of agrospent fillers were studied in order to enhance its adhesion with polymer matrix. The detailed characterization study of agrospent based polymer composites and advanced materials were also included. The main objective of this paper is to promote the utilization of agro wastes in different polymer composite manufacturing sectors.

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KERATIN BASED ENGINEERED COMPOSITES FOR TAILORED APPLICATIONS

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Keratin, the most abundant bio polymer protein with its exceptional capabilities for developing cost-effective and sustainable fibrous green composites in view of the circular economy. High cysteine concentration, amino acid residues and presence of disulfide bonds made keratin a stable, tough, and insoluble structure, strongest among the non-mineralized tissues. Keratin is commonly found as α and β forms. α- keratins rich in cysteine are normally found in sheep wools, skin and hair, whereas β keratins with high contents of amino acids like alanine and glycine is found in fish scales, bird feathers, nails etc. Good compatibility of keratin with natural and synthetic polymeric materials, its strong structural and bio degradable properties has made it a promising bio material for self-assembled scaffolds, dental applications, for drug delivery and for tissue engineering applications. Addition of nanofillers and other reinforcements with various compatibilizer could improve the overall mechanical properties of keratin based composites. In this article, we will review the various types and sources of keratin, different methods of keratin extraction and production, its purification, blending of keratin with different synthetic & natural polymers, blending of keratin with various reinforcements and the characteristic features of these blends. Also this work reviews various applications of keratin used in clinical, industrial and various high performance sectors.

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PMMA MATERIALS FOR HOLOGRAPHIC RECORDING MEDIA OBTAINED USING 4.4`-SUBSTITUTED 3-HYDROXYETHYL-PENTAZA-1,4-DIENES AS INITIATORS

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The poly(methylmethacrylate) PMMA is the most commonly used polymer for the fabrication of the polymer optical fibers and it is widely used as a host polymer in numerous composites. Through the advantages of PMMA the high optical transparency, good mechanical and film-forming properties can be listed. Also, processing technology are attractive for new optical fibre constructions and recording media development. The application of new initiators for the free-radical polymerization of MMA, makes it possible to achieve an improvement and/or change in the rheological characteristics of the polymer.

This work deals with the synthesis of 4.4`-substituted 3-hydroxyethyl-pentaza-1,4-dienes (Fig. 1), their further application as free radical polymerization initiators and, finally, examination of the obtained PMMA as a recording media for holographic recording.

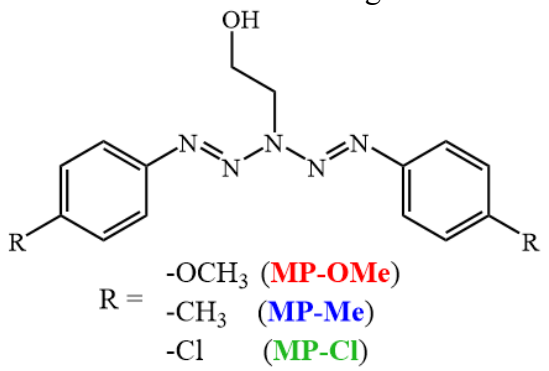

Fig. 1. 4,4`-substituted pentaza-1,4-dienes

In the case of MP-Me the highest polymerization rate R_p and the highest yield of polymer for a certain period of time (200 min) were obtained. The rate of polymerization decreases synchronously with an electron donor property of the substituent in 4.4'-position to the azo-group in the MP-OMe→MP-Me→MP-Cl series. The number average molecular weights (*Mn*) of the polymers were 34644, 36711 and 49003 kDa respectively.

The holograms of a plane wavefront for parallel (e1||e2) and perpendicular (e1⊥e2) orientations of the electrical vectors of the object (e1) and reference (e2) light waves were recorded using a 532 nm wavelength laser.

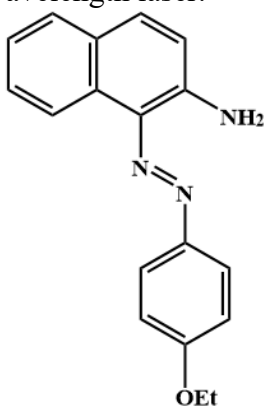

Fig. 2. Guest azo-molecule

The diffraction efficiency for every type of light waves polarization orientation ($\eta_{||}$ and $\eta_{\perp}$) were found as a function of time.

A 1-(4-ethoxyphenyl)diazenyl)naphthalen-2-amine (Fig. 2) was selected as photoactive dopant. The diffraction efficiency in case of (e1||e2) decreases with an increase in the electron-acceptor properties of the substituent in the initiator. Also, for all samples, the value of $\eta_{||}$ is greater than $\eta_{\perp}$. It should be mentioned that for the samples of polymers obtained with donor-substituted initiators MP-Me and MP-OMe, when the recording cycles were repeated with a 1-minute interval, a gradual increase in the $\eta_{||}$ signal was observed, while the values of $\eta_{\perp}$ remained unchanged.

IN VITRO AND *IN VIVO* WOUND HEALING AND BIOCOMPATIBILITY OF CURCUMIN INCORPORATED BIOPOLYMER MEMBRANES

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Chronic nonhealing wounds are mainly due to the inadequate cell migration, cell proliferation and angiogenesis. Incorporation of curcumin in wound dressings can be a promising traditional approach to promote healing and angiogenesis of wounds [1-4]. In this poster, we report the development of a novel curcumin containing solvent cast algal polysaccharide-based bioplastic membrane for wound healing applications. *In vitro* MTT (3-(4,5-dimethylthiazol-2-yl)-2,5-diphenyl tetrazolium bromide) assay, wound contraction (scratch) assay and in vivo biocompatibility (subcutaneous implantation) and wound healing studies were performed to assess the metabolic function, cellular health, cell migration, proliferation, angiogenesis and wound healing potential of the developed membranes. The experimental results showed that curcumin incorporated biopolymer membranes do not exert any toxicity, and can promote cell proliferation and cell migration when used as wound dressings. For 5% curcumin containing biopolymer composite membranes showed a two-fold increase in *in vitro* wound closure as compared to the control sample after 24 hours. *In vivo* wound healing study in Sprague Dawley rats confirmed the wound healing potential of the fabricated biopolymer membranes by reducing inflammatory cell, high number of fibroblasts, epithelization and formation for hair follicle as compared to negative control wounds. Thus, the study suggests that curcumin-biopolymer-based bioplastic membranes have strong potential as wound dressings to enhance cell proliferation and vascularization, and can be used as excellent biomaterials in wound healing and tissue regeneration applications.

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FLAME RETARDANT POLYOLEFIN BLENDS

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Potential mechanisms to reduce polyolefin blend's flammability include:
a) Heat absorption as a result of endothermic decomposition of flame retardants; in this case aluminum and magnesium hydroxides are commonly used, with the synergy of layered silicates (nanoclays), borates, phosphorus derivatives, carbon modifiers (expanded graphite) [1].
b) Limiting radical reactions in the gas phase by using modifiers from the chloro- and bromo derivatives group together with synergistically acting borates or antimony trioxide. c) Creating a solid phase/charcoal barrier on the material's surface, limiting access to the flame zone of the gaseous polymer decomposition products. For this purpose, ammonium polyphosphate or expanded graphite are used, and this process is supported by phosphorus derivatives, melamine, triazine derivatives, and metal oxides [2, 3].
The developed in this work polyethylene blends intended for the production of heat-shrinkable products are multi-component systems containing, in addition to polyolefins and flame retardant additives, also cross-linking activators, compatibilizers, antioxidant stabilizers, and pigments that affect the flammability of the product. For this reason, optimization of the composition of flame-retardant polyolefin blends was associated with a considerable amount of experimental work, especially in the period of approaching the goal defined by a parameter that is difficult to achieve while maintaining appropriate strength parameters.
As a result of tailoring the composition of the blends, a polyolefin product with increased thermal resistance, resistance to aging processes, halogen-free, and with high flame resistance was obtained, meeting the requirements of:
- minimum breaking strength 7.0 MPa,
- elongation at break min. 200%
- OI oxygen index min 32%.
- OIT oxidation induction time min 360 minutes.

Acknowledgment. This work was supported by the National Centre for Research and Development, under a project co-financed from the European Regional Development Fund entitled: "Development and implementation of technology for the production of innovative radiation-crosslinked heat shrink tubes for thermal transfer printing, made of polymeric materials with increased thermal resistance to aging processes, halogen-free flame propagation retardants, low smoke emission, 2: 1 shrinkage ratio: 3: 1; 4: 1 ".

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Authors' index

Abashidze G. S. 61
Abbaszade G.N. 1
Abduharmanova N.A. 53
Abuashvili T. 2
Akhalbedashvili L. 31
Akhmedova R.A. 1
Akhobadze Sh. 22, 81
Alekseeva O. V. 77
Alexishvili M. 86
Alimirzoeva N. A. 84
Alkhazov T. I. 40
Amiranashvili L. 10
Aneli J. 3, 73
Annmi P. 111
Antia G. P. 107
Archuadze T.N. 54
Archvadze K. T. 4, 41
Areshidze M. 81
Arveladze E. 81
Arziani B. 9
Asadov R. V. 5
Gakhramanova A. Ya. 5
Askerov O. B. 5
Aslanova E. T. 6
Astakhova O. 13
Avaliani M. A. 7, 91

Baduashvili L. 8
Banyan L.S. 50
Barbakadze Kh. 9
Barbakadze N. 11, 89
Barbakadze V. 10
Barnovi N.V. 7
Bendeliani B.G. 68
Berezhnytska A. 89
Berulava M. 29
Berulava S. 30
Bestaeva L.G. 12
Bezarashvili G. 85
Bokuchava G.V. 54
Borzakovskiy A. 43
Bratychak M. 13, 39, 52
Brostow W. 9, 14, 32
Bukia T. J. 67, 104
Butkhuzi T. 86
Çatiker E. 15, 16
Chachava I. R. 4
Chalabiyeva A. Z. 17
Chaladze R. 86
Chandrima K. 110
Chanishvili A. 81, 109
Chedia R. 11, 89
Chelidze A. 41, 55
Chikhladze Sh. 18
Chikovani M. 87
Chikvaidze I.Sh. 19
Chitrekashvili I.A. 20, 42
Chkhaidze E. 108
Chkhartishvili L. 11
Chubinidze K. 21
Chubinishvili Z. 4, 11
Chumachenko V. 58, 59, 101
Colton Breyer 37

Darakhvelidze N.I. 54
Davidenko N.A. 112
Demchuk Yuriy 39
Devadze L. 22, 81, 109
Dgebuadze G.N. 68
Dokhturishvili N.S. 20, 41
Dolidze G. 55
Donadze M. 23
Dostuyeva V. M. 24
Douglas B. Grotjahn 37
Dughashvili D.T. 25
Dumbadze N. 26
Dundua T. 88
Dunyamalieva A. I. 27
Durgaryan N.A. 28, 70
Dzagania M.A. 107
Dzebisashvili N.L. 25
Dzhafarov V. A. 5
Dzhagan V. 105
Dzidziguri D. 21, 29, 60
Dzuliashvili K. 30

Ebralidze K.G. 41
Edisherashvili G. 3
Elizbarashvili E. 30
Eprikashvili L.G. 107
Esakia N.A. 7
Esartia I. 2
Espuche E. 36

Fainleib A. 36, 43, 94
Fałtynowicz Hanna 14
Fifielski Karol 114
Formela K. 49

Gabelaia D.J. 33
Gabunia T.I. 19
Gabunia V.M. 68
Gachechiladze M.P. 64
Gagniashvili N. 31
Gakhokidze R.A. 93
Gakhutishvili M. 32
Gamkrelidze N. 88
Gavashelidze E. Sh. 4, 41
Gejadze I. 91
Gelashvili N. S. 4, 20
Ghibradze G. 21
Gigauri R.I. 33
Giorgadze K. 87
Giorganashvili G.R. 68
Gnatowski P. 34
Godibadze B. 80
Gogilashvili L. 10
Gotsiridze R. 35
Gouanve F. 36
Grande D. 36, 43
Grigoryan G. K. 51
Grigoryan N. H. 51
Grigoryeva O. 36, 43, 94
Gulbani D. B. 95
Gulieva T. M. 38
Guliyev A. M. 90
Guliyev K. G. 103
Gurbanov M. Sh. 40
Gurgenishvili M.B. 41-42
Gusakova K. 36, 43
Guseynov S. S. 77
Gventsadze D. 3

Haponiuk Józef 44, 45, 47, 48,49, 66, 69, 110, 111, 113, 114
Hayrapetyan M.S. 50
Hayrapetyan S.S. 50
Heiduschka P. 96
Hovhannisyan A. A. 51
Hrynchuk Yurii 39, 52
Huseynov A.B. 53, 76

Inmaculada Cañadas 14
Iosava J. D. 67
Ischenko N. Ya. 38
Ismailova Ch.O. 1
Ishchenko A.A. 112
Ivanushko Yana G. 98, 99, 100

Jalabadze N. 11
Jalagonia N.T. 54
Jalalishvili S.I. 33
Janik H. 34, 79
Japharidze M. 88
Jerin V. George 113
Jobin Joy 44
José Rodriguez Garcia 14

Kozlowska Justyna 56, 57
Kakalashvili L. 18
Kalatozishvili L.A. 54
Kantaria T. 8, 96, 97, 108
Kapush O. 105
Karchkhadze M. 55
Katsarava R. 8, 61, 96, 97, 108
Kervoelen A. 45
Khadidja Taleb 45
Khitiri G.Sh. 19
Khort P.S. 101, 105
Khotenashvili N. Z. 20, 42
Kiedrowska Bożena 114
Kiknadze N.O. 12
Kurzelewska Urszula 114
Kirtadze L.B. 61
Kobidze G. 55
Kokilashvili R.G. 19
Kokozay V.N. 82
Kordzakhia T.N. 107
Korkia T. 11
Kormosh Zholt O. 98, 99, 100
Kovalinska T. 43
Kuchukhidze T.V. 54
Kucińska-Lipka J. 34, 79
Kupatadze N. 108
Kurbanova N. I. 27, 38, 72, 84
Kurtanidze M. 85
Kutsevol N. 58, 59, 75, 101, 105
Kurdyukova I.V. 112
Kuziv Yu. 58, 59, 101
Kvartskhava G. 88
Kvinikadze L.Z. 25
Kvinikadze N. 60
Kvinikadze S.M. 61

Lekishvili G. 9
Lekishvili N. 9
Leverashvili T. 29
Levinskas R. 14
Liparteliani R. G. 4, 42

Lobzhanidze T.E. 68
Lomidze M.O. 104
Londaridze L. 2, 29, 60, 73, 78
Lucinda Vaz dos Reis 100
Luganska O. V. 98, 99, 100

Magerramova M.Y. 53
Magradze G.T. 7
Maisuradze J. 22
Maisuradze V. 91
Makhaldiani N. 23
Makharadze D. 97
Makharadze G.A. 62
Makharadze T.G. 62
Mamedaliyeva F. M. 63
Mamedov B. A. 1, 17, 24, 65
Mamedova A. F. 103
Margaryan L.A. 50
Maria J. Hanna 44
Marinin A.I. 101
Markarashvili E. 2, 73, 78
Marsagishvili T.A. 64
Marta V. Kushnir 99, 100
Martiryan A. I. 50
Marynin A. 58
Mashayeva S. S. 65
Matarashvili I. 55
Megrelidze N. J. 12
Megrelishvili Z. N. 12
Meladze S. 88
Mereena Luke 48, 66
Merlani M. 10
Meskhishvili T. N. 67
Metreveli J.A. 64
Metskhvarishvili I. R. 68
Metskhvarishvili M.R. 68
Miguel Ibanez 37
Mikeladze A. 11
Milanta Tom 69
Minasyan P.G. 28
Miraqyan N.A. 70
Mirtskhulava L. 71
Mirzoeva N. A. 72
Mkheidze N. 35
Mkrtchyan A. 108
Mohamed P.K. 69
Mskhiladze A. 55
Mukbaniani O. 2, 18, 60, 73, 78
Murickan Rony Thomas 111
Mzareulishvili N. 85

Nadareishvili L.G. 62
Nadaryanm A. G. 51
Nadimashvili T. 30
Nadirashvili M. 91
Nadtoka O. 75
Naghiyev Ya.M. 76
Nakhutsrishvili G. 29
Nasuhbeyoğlu M. R. 16
Naumenko A.P. 101
Neparidze N. 108
Nikoleishvili N.N. 102
Noskov A. V. 77
Nurullayeva D. R. 5, 17
Nutsubidze M.O. 93

Otiashvili D. 2
Otinashvili G. 108
Ovcharuk Ihor 52
Ovdenko V.N. 112

Pachulia Z. 78
Pacler M. 34, 79
Papava G.Sh. 20, 41, 42
Papava K.R. 20, 41, 42
Papava Sh.R. 41
Papuashvili N. 86
Pavlov V.A. 112
Peikrishvili Ak. 80
Petriahsvili G. 21, 81, 109
Petriashvili A. 21
Petriashvili G. Sh. 67
Petriashvili T. 91
Petrusenko S. 82
Phalavandishvili G.A. 67
Pillin I. 45
Pirtskhalava N.B. 107
Pirtskhalava T. 32
Plyuta N. 82
Poghosyan A. 108
Poliak Olha 13
Ponjavidze N. 109
Porchkhidze A.D. 83
Pratibha Kumari 37
Praveen K.M 44, 45, 110, 111
Prysiazhnyi Yuriy 39
Prus-Walendziak Weronika 56, 57

Rafalska Izabela 114
Ragimova S. K. 84
Ramazanov G.A. 106

Ramana V.V.
Ramya C.H 46
Ravikiran Y.T. 46, 74
Rubie Mavelil-Sam 113
Rukhadze M. 85-86
Rurua L. 11
Russia M. 87
Rzayeva S. A. 40

Sachaneli T. 88
Saghyan A. 108
Sakhno V. 43
Salimova A. A. 40
Samkharadze Z. 3, 64
Samsoniya Sh. A. 102, 104
Sanikidze G. 81
Sarajishvili K. 88
Sarath P. S. 47
Sarno M. R. 54
Sasidhar N. 46, 74
Savchenko I. 89
Sepashvili N. 22, 81, 109
Shahnazarli R. Z. 90
Shamanauri L. 3
Shapakidze E. 91
Shapakidze E.V. 7
Sharashidze L. 81
Shatirova M.I. 92
Shengelia N. 3
Shengelia N.G. 95
Sheydayeva Sh.K. 92
Shulzhenko D. 94
Shyshchak O. 13, 39, 52
Sidamonidze N.N. 93
Sidun I. 52
Silpa Mary John 113
Sílvio C. de Oliveira 98, 99, 100
Soney George C. 47
Sreenivasan S. N. 110
Stachowiak N. 57
Starostenko O. 36, 43, 94
Storoshchuk N. M. 98
Studzinsky S. L. 82
Sulashvili N. 32
Suremya M.S. 11

Tabatadze L.V. 95
Tabukashvili Z.Sh. 20
Tatarishvili M.Z. 95
Tatrishvili T. 2, 18, 73, 78
Tavdishvili E. 29
Thomas Sabu 44, 45, 46, 47, 48, 66, 69, 74, 110, 111, 113
Timothy Douglas 57
Titvinidze G. 26
Todradze G.V. 7
Tomchuk A.V. 101
Tomy Muringayil Joseph 48, 66
Trapaidze M.V. 102, 104
Trunova E. 89
Tsagareishvili O. 11
Tsintskaladze G.P. 107
Tskitishvili S. 18
Tsurtsumia M.D. 19
Tsverava D.T. 61
Tugushi D. 8, 96, 97, 108

Ümit Keleş 15

Vadachkoria Z. 21
Vakhabova V. A. 103
Vanishvili A.L. 61, 104
Vardiashvili R.O. 93
Vibliani M.B. 7
Virych P.A. 59, 75, 101
Volodymyr Gunka 39, 52, 98-101
Volodymyr V. Tkach 98-100
Vyshnevsky D.G. 112

Wenliang Zhang 96

Xvitia B.D. 54

Yagodynets Petro I. 98, 99, 100
Yeshchenko O. 58, 101, 105
Yogesh B. Dalvi 113
Youssef B. 36
Yusifli F.Kh. 106
Yves Grohens 45

Zaqashvili N. 55
Zautashvili M.G. 107
Zavradashvili N. 97, 108
Zedgenidze A. 60
Zedler L. 49
Zeynalov E. B. 27, 53, 72, 76
Zurabishvili D.S. 104
Zurabishvili Ts. 22, 81, 109

Printed in Ivane Javakhishvili Tbilisi State University Press

Tbilisi, 2021

14, Ilia Tchavtchavadze Ave., Tbilisi 0179
Tel 995(32) 225 04 84, 6284/6279
https://www.tsu.ge/ka/publishing-house