



**Ivane Javakhishvili Tbilisi
State University**



**Batumi Shota Rustaveli
State University**

**6th International Symposium on
Polymers and Advanced Materials**

ICSP & AM 6

გათავილ
შოთა რუსთაველის სახელმწიფო
უნივერსიტეტი



BATUMI
SHOTA RUSTAVELI
UNIVERSITY

17-20 July

Batumi 2019



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Welcome

Dear Colleagues,

On behalf of the Organizing Committee I wish to extend cordial welcome to all participants of the 5th International Caucasian Symposium on Polymers and Advanced Materials. 12 years ago, 2007, this symposium took place in Tbilisi, Georgia. We are delighted to host you in this year country Georgia, in very beautiful town Batumi. This year is significant for Ivane Javakhishvili Tbilisi State University since we celebrated the 100th anniversary of the foundation. This year, Professor M. Abadie was awarded the title of honorary doctor of Ivane Javakhishvili Tbilisi State University. These meetings led to the fact that we cooperate with Polish Universities in the Erasmus+ program. We hope that this symposium will in the future lead to the strengthening of close scientific relations.

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 6" will help to introduce effectively innovative scientific researches of Georgian, Caucasian and neighboring scientific teams, which are less known for world scientific society. We hope that this year meeting, gathering almost 120 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 – Dr. Vazha Tskhovrebashvili

Co. Chair – Prof. Marc J.M. Abadie

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Marina Gakhutishvili -PhD, TSU

Lali Kemkhadze – PhD, TSU

Tamara Gokadze – TSU MA student

SYMPOSIUM SCHEDULE

17 July		
9.00-16.00	Registration	
18.00	Welcome part BSU	
18 July		
Invited Presentations		
9.00-9.25	Opening ceremony Rector of Shota Rustaveli Batumi State University	
	Co-chairmen: Prof. M. J.M. Abadie, Prof. A.A. Hovhannisyan	
9.25-9.50	Juoas V. Grazulevicius – „Glass-forming molecular materials containing donor and acceptor moieties for organic light emitting diodes”. <i>Department of Polymer Chemistry and Technology, Kaunas University of Technology, Kaunas, Lithuania</i>	1
9.50-10.15	Ramaz Katsarava – „Chemistry of pseudo-proteins and related synthetic amino acid based polymers”. <i>Institute of Chemistry and Molecular Engineering, Agricultural University of Georgia, Kakha Bendukidze University Campus, Tbilisi, Georgia</i>	2
10.15-10.40	Józef T. Haponiuk – „Crosslinking degree effect on shape memory properties of irradiated polyethylene”. <i>Polymers Technology Department, Faculty of Chemistry, Gdansk University of Technology, Gdansk, Poland</i>	3
10.40-11.05	Helena Janik – „Polylactide and its modification - biodegradation, composting, application”. <i>Polymer Technology Department, Chemical Faculty, Gdansk University of Technology Gdansk, Poland</i>	4
11.05-11.35	Coffee Break	
	Co-chairmen: Prof. R. Katsarava, Prof. R. Shahnazarli	
11.35-12.00	Michael Bratychak – „Coumarone-indene resins with functional groups”. <i>Lviv Polytechnic National University, S. Bandery St., 12, 79013 Lviv, Ukraine</i>	5
12.00- 12.25	Marc J.M. Abadie – „Photosensitive formulation for additive manufacturing – 3 D printing”. <i>AIME/ICGM CNRS, University of Montpellier, France</i>	6
12.25-12.50	Krzysztof Brzezinski – „Biochemical and structural characterization of an unusual cyanobacterial s-adenosyl-l-homocysteine hydrolase from <i>synechocystis</i> sp. pcc 6803”. <i>Laboratory of Biochemistry and Structural Biology, Institute of Chemistry, University of Bialystok, Poland</i>	7
12.50-13.10	Jimsher Aneli – „Investigation of microstructure of oriented electrical conducting polymer composites by spin probe method”. <i>R. Dvali Institute of Machine Mechanics, Tbilisi, Georgia</i>	8
13.10-14.10	Lunch Break	
	Co-chairmen: Prof. V. Grazulevicius, Prof. V. Tskhovrebashvili	
14.10-14.30	Kh. Barbakadze – „Improvement of durability and performance data of functionalized hybrid composite materials”. <i>Tbilisi State Medical University, Faculty of Pharmacy, Department of Medical Chemistry, Tbilisi, Georgia</i>	9
14.30-14.50	E. Çatiker – „Synthesis and characterization of novel poly(β -alanine-g-lactone)s copolymers”. <i>Ordu University, Department of Chemistry, 52200 Ordu, Turkey</i>	10

14.50-15.10	Ketevan Chubinidze – „Liquid crystal microspheres based light and ph controlled smart drug delivery systems”. <i>Faculty of Exact and Natural Sciences, Iv. Javakhishvili' Tbilisi State University, I. Chavchavadze 1, Tbilisi, Georgia</i>	11
15.10-15.30	Marina Gakhutishvili – „Arsenic in poly(vinyl chloride)”. <i>Department of Chemistry, Faculty of Exact and Natural Sciences, Ivane Javakhishvili Tbilisi State University</i>	12
15.30-15.50	Arnos Hovhannisyan – „Synthesis of monodisperse latexes to create immunodiagnostic drugs”. <i>Scientific-Technological Center of Organic and Pharmaceutic Chemistry NAS Republic of Armenia</i>	13
15.50-16.20	Coffee Break	
Co-chairmen: Prof. Michael Bratychak, Dr. Raul Gotsiridze		
16.20-16.40	Justyna Czyrko-Horczak – „Effect of monovalent cations on the activity of s-adenosyl-l-homocysteine hydrolase”. <i>Institute of Chemistry, University of Bialystok</i>	14
16.40-17.00	Sophio Kobauri – „Synthesis of new pseudo-proteins by interacting bisazlactones with diamine-diester composed of non-proteinogenic amino acids”. <i>Institute of Chemistry and Molecular Engineering, Agricultural University of Georgia, Kakha Bendukidze University Campus, Tbilisi, Georgia</i>	15
17.00-17.20	P. Kobedza – „Wood flour as a filler of elastomer blends containing chlorosulfonated polyethylene and styrene-butadiene rubber”. <i>Institute of Polymer & Dye Technology, Lodz University of Technology, Lodz, Poland</i>	16
17.20-18.40	Poster Presentation	1-60 pp.
19 July		
Co-chairmen: Prof. H. Janik, Prof. E. Çatıker		
9.00-9.20	Marc J.M. Abadie – „Semantics is elastic? semantics for the use of scientists”. <i>Institute Charles Gerhardt Montpellier – Aggregates, Interfaces & Materials for Energy (ICGM, UMR CNRS 5253), University of Montpellier, Montpellier Cedex 5 France</i>	17
9.20-9.40	Justyna Kozłowska – „Materials based on guar gum with the addition of polymer microspheres for medical and cosmetic applications”. <i>Faculty of Chemistry, Nicolaus Copernicus University in Torun, Torun, Poland</i>	18
9.40-10.00	Omar Mukbaniani – „Fluorine containing solvent-free polymer electrolyte membranes”. <i>Ivane Javakhishvili Tbilisi State University, Faculty of Exact and Natural Sciences, Institute of Chemistry, Department of Macromolecular Chemistry</i>	19
10.00-10.20	Milos Netopilík – „Prediction of the effect of injected mass in size exclusion chromatography”. <i>Institute of Macromolecular Chemistry, Academy of Sciences of the Czech Republic, Prague 6, Czech</i>	20
10.20-10.40	Anna Olejnik – „New fire-resistant elastomer blends containing chloroprene and butadiene rubbers”. <i>Institute of Polymer and Dye Technology, Lodz University of Technology, Lodz, Poland</i>	21
10.40-11.00	Michal Okraska – „Effect of acrylonitrile content on laser texturing efficiency of the NBR vulcanizates”. <i>Institute of Polymer and Dye Technology Lodz University of Technology, Lodz, Poland</i>	22
11.00-11.30	Coffee Break	
Co-chairmen: Prof. Marc J.M. Abadie, Prof. M. Netopilík		
11.30-11.50	Akaki Peikrishvili – „Thermo-chemical conversion of high molecular chemical wastes and fabrication of TiC-SiC based hard alloy composites by SHS technology”. <i>F. Tavadze Institute of Metallurgy and Materials Science, Tbilisi, Georgia</i>	23

11.50-12.10	Khadichahan Rafikova – „Desulfurization of fuels by metal-containing ionic liquids”. <i>School of Chemical & Biochemical Engineering, Satbayev University, Almaty, Kazakhstan</i>	24
12.10-12.30	Rita Z. Shahnazarli – „High-strength and heat-resistant rubbers based on chlorocyclopropane bsr”. <i>Institute of Polymer Materials of Azerbaijan National Academy of Sciences, Sumgait, Azerbaijan</i>	25
12.30-12.50	Nino Zavrashvili – „New cationic polymers composed of non-proteinogenic α -amino acids”. <i>Institute of Chemistry and Molecular Engineering, Agricultural University of Georgia, Kakha Bendukidze University Campus, Tbilisi, Georgia</i>	26
13.00-14.00	Lunch Break	
Co-chairmen: J. Haponiuk, Prof. M. Jastrzębska		
14.00-14.20	Volodymyr Tkach – „The theoretical description for VO(OH)-assisted electropolycondensation of 2,5-dibromoderivatives of furan, pyrrole and thiophene”. <i>Chernivtsi National University, Chernivtsi, Ukraine</i>	27
14.20-14.40	<u>Monika Tomczykowa</u> – „Phenol-formaldehyde polymeric network to generate organic aerogels: synthesis, physicochemical characteristics and potential applications”. <i>Department of Organic Chemistry, Faculty of Pharmacy with the Division of Laboratory Medicine, Medical University of Białystok, Białystok, Poland</i>	28
14.40-15.00	Jaroslav Stejskal – „Conducting polymers: polyaniline and polypyrrole”. <i>Institute of Macromolecular Chemistry, Academy of Sciences of the Czech Republic</i>	29
15.00-15.30	Coffee Break	
Co-chairmen: Prof. Marta Plonska-Brzezinski, Prof.K.S. Rafikova		
15.30-15.50	L. Bestaeva – „Using bentonite clay for recuperation system”. <i>Georgian technical university, Batumi Shota Rustaveli state university</i>	30
15.50-17.20	Poster presentation	61-118 pp
17.00- 17.20	Meeting of the Scientific Council. Award to the young scientists: 1 Prize - Petre Melikishvili, 2 Prize - Alexander Noghaidei and 3 Prize - Lotar Khananashvili.	
	20 July	
19.00	Gala dinner	

Abstract

PHOTOSENSITIVE FORMULATION FOR ADDITIVE MANUFACTURING – 3 D PRINTING

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UV curing is a photochemical process in which high-intensity ultraviolet light is used to instantly cure or “dry” coatings, inks, adhesives and thin film technology. It has been around as a coating for wood, paper and as a clear coating via photolithography process on printed circuit boards PCBs or integrated circuit boards ICBs for years. It is fast becoming one of the most popular techniques in the paint and coatings industry.

Most of the formulation use multifunctional acrylate monomer or oligomer or a mixture of them that crosslink under exposure to UV/EB radiations in a free radical process. We briefly present the advantages of EB vs. UV.

A new type of formulation based on multifunctional monomer of dicyclopentadiene epoxy derivative with additional diluent as co-reactive solvent will be described and evaluated. This formulation differs from the acrylate one by the use of a cationic photoinitiator. The final product present all the advantages of epoxy resins viz. better adherence, mechanical and thermal properties, compared to acrylates systems. Formulation has been optimized thanks to the photocalorimetry differential scanning calorimetry DPC. This type of formulation is developed for additive digital manufacturing - 3D P

Abstract

SEMANTICS IS ELASTIC? SEMANTICS FOR THE USE OF SCIENTISTS

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I have often observed, particularly in the correction of articles to be published, that scientists use inappropriate scientific terms and results with fanciful units.

Apart from the abbreviations of the units – The International System of Units [(SI) viz. *Le Système International des Unités*], I would discuss semantics of molecular or molar masses, as well as the presentation of spectra that also obey codified rules (FTIR).

Abstract

INVESTIGATION OF MICROSTRUCTURE OF ORIENTED ELECTRICAL CONDUCTING POLYMER COMPOSITES BY SPIN PROBE METHOD

Jimsher Aneli¹ and Levan Nadareishvili²

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The spine probe method based on electron spin resonance (ESR) is used for investigation of the free volume of the oriented polyvinyl alcohol films filled with high dispersive carbon black. After introduction of nitroxide stable radicals by diffusion in oriented with different degree polymer films the samples were tested by noted method via definition of the measuring of correlation times of rotation of stable radicals around their axes. It is established that the free radicals concentration and their correlation time in local regions of the films is the lower the higher is the orientation (stretching) degree of the films, which directly is connected with the volume of micro-empties in the polymer matrix. Noted processes correlate with analogical ones in the same polymer containing high dispersive electrical conducting filler (carbon black). In this case the diffusion of free radicals to the polymer matrix is more difficult than in pure polymer - the significances of correlation time and diffusion coefficients of stable radicals decrease because of additive interactions of these radicals with filler particles. It is made a conclusion about minimal empty of free volume in composites near the maximally oriented regions of the stretched films.

Abstract

EFFECT OF MICROSTRUCTURE ON THE ELECTRIC CONDUCTIVITY OF POLYMER ELECTROLYTES

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In our work the investigation of the dependence of ion-conductivity of some silicon-organic polyelectrolytes on their morphology with use of spin probe method has been performed. It was shown that the ionic conductivity of polyelectrolyte membranes significantly depends on the presence and average size of the free space between the macromolecules. This conclusion was made on the basis of an analysis of the electron paramagnetic resonance (EPR) spectra of stable low molecular weight nitroxide radicals. To this end, nitroxide radicals were introduced into the samples (membranes) of polyelectrolytes by diffusion, the EPR spectrum of which in the solid phase is a single absorption line (singlet), but after introduction to the solvent, or solid polymer material containing the voids with a certain volume, the singlet turns into a triplet, degree of symmetry of which essentially depends on the free volume between macromolecules. Using the special EPR atlas of the spectra of nitroxide radicals [1], in which theoretically calculated various variants of experimental spectra are given, ranging from strictly symmetric to highly anisotropic triplets, the diffusion coefficients of the rotational motion of the radicals and the corresponding so-called correlation times ones were estimated.

We have estimated the free volume in membranes based on some silicon-organic polyelectrolytes with use of spin probe method. It was established that the average value of free volume in the membranes is in correlation with electric conductivity of ones. Namely, the higher is this volume, the higher an electric conductivity of the membranes.

References:

1. Atlas of EPR spectra of spin probes. "Nauka", Moscow, 1977, 769.

Abstract

ELECTROMAGNETIC WAVE ABSORPTION BY THE POLYMER COMPOSITES BASED ON EPOXY RESIN WITH ELECTRIC CONDUCTING AND MAGNETIC FILLERS

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Effect of different technological factors on the electromagnetic wave (EMW) with frequencies (3-10 GHz) absorbing properties of polymer composites based on epoxy resin with electric conducting (carbon black, graphite) nanofillers have been investigated. It is experimentally shown that absorbing properties of these materials essentially depend on the type and concentration of the filler. It is established that the level of the EMW absorption may be regulated by change of cross section profile of the absorber and with collection of the sandwich type absorber contained several absorbing films with different distribution in the sandwich and content of these films. Relatively high absorption is manifested for composites containing 40 -50 wt% filler.

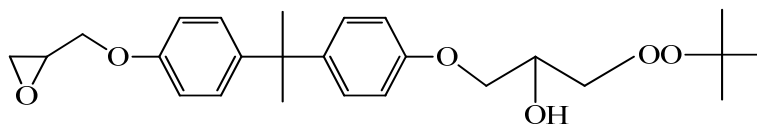
COUMARONE-INDENE RESINS WITH EPOXY GROUPS

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It is known [1, 2] that different additives are used to improve the operational characteristics of petroleum bitumen. Significant improvement in the quality of petroleum bitumen is achieved due to the introduction of polymers [1, 2]. The presence of various functional groups in the polymer structure contributes to the improvement of BPB adhesion properties [1]. The coumarone-indene resins with free epoxy groups (CIRE), which were described earlier in [3], may be also referred to the polymers with functional groups. Such resins are obtained via radical polymerization of monomers of the light fraction of coal tar in the presence of peroxy derivative of dioxydiphenylpropane diglycidyl ether (PO) [3]. Formula PO is given below:



The presence of free epoxy groups in (CIRE) allows to consider them as active additives to various mixtures. The aim of this paper is to study the possibility of using CIRE as additives to petroleum bitumen to create bitumen polymer blends.

Radical co-oligomerization of light fraction of coal tar using styrene, glycidyl methacrylate and PO was carried out in a 1.0 l metal ampoule. Radical cooligomerization proceeded at 393 K for 6 h. After cooligomerization, the ampoule was cooled to room temperature, the reaction mixture was transferred to a distillation flask and unreacted raw material was distilled under vacuum. The resulting product was dried in a vacuum-dryer at 313 K to a constant weight. CIRE with a molecular weight of 850 g/mol and content of epoxy groups 1.9 % were obtained.

The presence of indene, coumarone, styrene and epoxy fragments in the synthesized resins was confirmed by IR spectroscopy.

The addition of CIRE to pure bitumen BND 60/90 significantly improves its adhesion [4]. The optimum conditions for bitumen-polymer blends (BPB) preparation were determined: 99 wt % of bitumen BND 60/90 + 1 wt % of CIRE; the temperature of 463 K; the preparation time of 60 min. Under such condition the BPB adhesion is 89 %. The content of asphaltenes and resins in the modified bitumen increases with the simultaneous decrease in oils content by 3.9 %. The absence of absorption bands typical of epoxy and hydroxy groups in IR spectra of BPB indicates their chemical interaction during BPB formation.

References:

1. McNally T. (Ed.): Polymer Modified Bitumen. Properties and Characterization. Woodhead Publ., 2011.
2. Fang C., Li T., Zhang Z., Jing D.: *Polym. Composite*, 2008, **29**, 500.
3. Bratychak M., Ripak O., Namiesnik J. et al.: *Chem. Chem. Technol.*, 2018, **12**, 93.
4. Astakhova O., Shyshchak O., Zubal O. et al.: *Chem. Chem. Technol.*, 2019, **1**, 112.

Abstract

COUMARONE-INDENE RESINS WITH CARBOXY GROUPS

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It is well known that coumarone-indene resins (CIRs) are obtained via polymerization of mixtures of unsaturated compounds (primarily indene and coumarone), which have been extracted from the by-products of coal coking and aromatic high-boiling products of petroleum pyrolysis [1]. They are used in different branches of industry and may replace the expensive natural resins in the preparation of paint and varnish materials. On the other hand, CIRs with various functional groups may be used as additives for bitumen to improve their operational properties, adhesion in particular [2-4].

A series of researches regarding CIRs obtaining and application as polymeric components for polymers modified bitumen production was carried out at the Department of Petroleum Chemistry and Technology (Lviv Polytechnic National University, Ukraine).

The purpose of this work was to create new CIR with carboxy groups using light fraction of coal tar (LFCT) as a raw material and investigate the effect of various factors on its characteristics.

Styrene, maleic anhydride, glycidyl methacrylate and methacrylic acid were used as monomers. The initiator of the initiated cooligomerization was 2,2'-azobis(2-methylpropionitrile) in the form of 0.2 M solution in toluene.

The effect of cooligomerization temperature, time, monomers nature, and initiator amount on the CIR characteristics was studied. To determine the role of LFCT in the cooligomerization process the polymerization of the mixture without light fraction of coal tar was carried out. In order to examine the structure of the synthesized resin, the IR-spectroscopy was applied. Chromatographic investigations were carried out to determine the conversion of unsaturated compounds during synthesis and to establish the participation of the initial mixture components in the process of CIR formation.

The best results were obtained with the addition of styrene and methacrylic acid in the presence of 2,2'-azobis(2-methylpropionitrile). It was confirmed by the gas-liquid chromatography that only methacrylic acid completely undergoes a polymerization reaction. Styrene conversion does not exceed 50 %, coumarone – 37 %, indene – 46 %. The structure of the synthesized CIR with carboxy groups and the presence of free carboxy groups in its structure was confirmed by IR-spectroscopy.

References:

1. Sokolov V.: Indene-Kumaronovy Smoly. Metalurgia, Moskva 1978..
2. Pyshyev S., Grytsenko Y., Danyliv N. *et al.*: *Petrol. Coal*, 2015, **57**, 303.
3. Pyshyev S., Grytsenko Y., Nikulyshyn I., Gnativ Z.: *J. Coal Chem.*, 2014, **5-6**, 41.
4. Pyshyev S., Gunka V., Grytsenko Y., Bratychak M.: *Chem. Chem. Technol.*, 2016, **10**, 631.

Abstract

IMPROVEMENT OF GRAVIMETRIC DETERMINATION METHODS' OF INORGANIC POLYMERS, CONTAINING POLYVALENT METALS

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Earlier we have synthesized about 80 new formerly unknown double condensed phosphates, otherwise called inorganic polymers from solution-melts of polyphosphoric acids during investigation of multi-component systems $M^I_2O-M^{III}_2O_3-P_2O_5-H_2O$. The studied mixtures were investigated at the temperature range 100-600°C [1, 2]. This work is focused on synthesis of polymeric phosphates and on gravimetric determination methods' improvement in the cases of double condensed compounds. The main objective is the determination of polyvalent metals by 8-oxyquinoline. In the review paper, the opportunity of improvement of the gravimetric oxyquinoline method for quantitative analysis of gallium, indium, scandium and aluminium in samples of inorganic polymers, notably in the double condensed compounds was considered. A number of variations of proposed gravimetric methods was reflected and detailed analysed. Due to our numerous experiments the influence of a numerous factors, such as: temperature, quantity of buffer solutions and reagent-precipitant, initial pH of the solution, mixing time of the initial components etc. on the accuracy of the results were detailed and carefully studied and our experimental data were compared with the published literature documents [3].

Methodical recommendations for the deposition of trivalent metals of gallium, indium and scandium from condensed phosphate samples using the oxiquinoline method are proposed.

References:

1. Avaliani M.A., Shapakidze E., Barnovi N., Gvelesiani M., Dzanashvili D. *J. of Chem. Chem. Eng.*, 2017, **11**, 60-64
2. Avaliani M. *J. Nano Studies*, 2017/2018, 1 (**13**), 21-24.
3. Avaliani M.A., Kveselava V.M., Esakia N.A. *Georgia Chem. J.* 2017, **17** (**1**), 26-34.

Abstract

PHYSICAL PROPERTIES OF POLYMER COMPOSITES IRRADIATED BY LASER BEAMS

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The work is devoted to obtaining of the system of electric conducting channels on the surface of polymer material's plates based on some thermosetting polymers and fiber glass in result of infrared laser beam irradiation of these materials. The type and value of conductivity as well as geometry and sizes of the channels on the surface of the polymer plates depend on energy and diameter of the laser beam. The physical-chemical analysis of the material of channels shows that the clusters of poly-conjugated bonds in the polymer part of the composites are formed. The intensity of generation of these bonds increases with increasing of laser beam energy and last the formation of infinite clusters takes place, which define the electric conducting properties of the channels. At moderate doses of irradiation conductivity of the channels is a hole type. However, at more high doses this type transforms to electron one. The channel materials characterized also by magnetic properties – the paramagnetic centers as solvated unpaired electrons, free radicals, ion-radicals are formed.

Testing of laser-irradiated plates on scattering-absorption of short electromagnetic waves shows that such materials are capable to scatter and absorb these waves from range of several GHz (up to 60%). These properties are depended on the several factors: value of the conductivity of channels, their number and geometry. Program irradiation by laser beam of plates made from different polymer materials allow to obtain of diffraction lattice with desirable properties by very simple way and may be used in optical researches.

Abstract

FABRICATION AND CHARACTERIZATION OF ANTIBACTERIAL CMC FILMS BY INCORPORATION OF MONTMORILLONITE AND TiO₂ NANOPARTICLES

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In this research, a novel carboxymethylcellulose (CMC)-based nanocomposite films containing sodium montmorillonite (MMT) and titanium dioxide (TiO₂) nanoparticles (NPs) were fabricated. The study describes the antibacterial activities of a nanocomposite prepared by mixing titanium dioxide nanoparticles. Effects of different concentrations of MMT (1, 3 and 5% wt) and TiO₂ (1, 3 and 5% wt) on the functional properties of nanocomposite films (water-related properties, mechanical characteristics, and UV transmittance) were examined. SEM, XRD and FTIR assays were used to analyze the morphology, crystallinity and interactions of the films. Moreover, Thermal properties, interactions, surface morphology and crystallinity of the nanocomposites were measured by differential scanning calorimetry (DSC). Finally, analyzed samples were subjected to disc diffusion method at various concentrations to analyze their antibacterial activities against Gram-negative and Gram-positive bacteria, *Escherichia coli* and *Staphylococcus aureus*, respectively. The results showed synergistic effect of NPs on moisture uptake reduction ($\approx 40\%$) of films. Tensile strength of films reached from 5.12 to 7.13 MPa by 5% MMT, and then reduced to 5.9 MPa by 5% TiO₂. Nano-TiO₂ was strongly effective in UV-light blocking (The films containing 5% TiO₂ removed more than 99% of UV and more than 98% of visible lights). Formation of hydrogen bonds between the hydroxyl groups of CMC and nanoparticles was evidenced by FTIR spectroscopy. The result of XRD analysis conformed that clay nanolayers organized an intercalated structure in the nanocomposites, and a limited agglomeration of TiO₂ nanoparticles led to increase of the films crystallinity. SEM revealed well-dispersed TiO₂ nanoparticles inside the nanocomposite films. In summary, the CMC-based nanocomposite films showed good antibacterial effect against both *Staphylococcus aureus* (gram positive) and *Escherichia coli* (gram negative) bacteria.

Acknowledgment. This work was supported by the Office of Vice Chancellor for Research, University of Mohaghegh Ardabili, Ardabil, Iran. [grant number:584]

References:

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Abstract

IMPROVEMENT OF DURABILITY AND PERFORMANCE DATA OF FUNCTIONALIZED HYBRID COMPOSITE MATERIALS

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Development of functionalized polymeric hybrids with different structures has become one of the most attractive topics for scientists in composite materials and in materials science during the last years because of their progressive and wide-range applications.

Fluorinated polymers and copolymers display high thermal stability, excellent mechanical properties at extreme temperatures, resistance to oxidation and hydrolytic decompositions, weatherability, low flammability, unique inertness to solvents, hydrocarbons, acids, and alkalis, low dielectric constant and low surface energy. Due to such unique combination of exceptional properties fluoropolymers are widely used in advanced technology areas: architectural, optoelectronic, automotive, aerospace and aeronautic industries, microelectronics, and chemical engineering as well as in medicine, such as dental materials and artificial joint. The low refractive index and high optical transparency make amorphous perfluoropolymers a promising candidate for applications in protecting coatings, surface modifiers, and optical materials.

New multifunctional hybrid materials based on targeted functionalization of perfluoromethacrylates and by further modification of F_nMA with selected bio-additives have been produced. The investigation of tested transparent hybrids have shown: high viscoelastic recovery ($\varphi=82-97\%$); improvement with an increase in glass transition temperature; high thermal stability compared to the non-modified firms; good adhesion on various surfaces (plastic, wood etc.); lower values of wear rate at room temperature; no phase separation are shown in SEM micrographs of modified systems. Doping of bioactive components into polymer matrices improves stability of low temperature amorphous phase. The enhanced mechanical strength of obtained hybrid composites is useful for abrasion resistant and protection function necessary for protective and antibiocorrosive coating.

Thus, transition from fundamental researches to the broadening the fields of applications of inorganic-organic materials is expected to motivate future developments in the inspiring field of hybrid coatings.

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Abstract

OBTAINING OF GRAPHENE FROM GRAPHITE FOIL WASTES BY ITS OXIDATION AND REDUCTION

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Graphene is obtained by various methods. One of the most widely used method is the oxidation of graphite precursors by strong oxidizing systems (HNO_3 , HClO_4 , H_2SO_4 , H_3PO_4 , KClO_3 , NaNO_3 , KMnO_4 and etc.) and physical-chemical reduction of oxidized graphite oxide, by obtaining of graphene with defective structure. Oxidation degree, hydrophilicity and microstructure of graphene oxide (GO) depends on the nature of used graphite. GO and reduced graphene oxide (rGO) could also be obtained from graphite intercalated compounds and expanded graphite. Our earlier studies confirmed, that it is possible to obtain GO as well as rGO, by the oxidation of graphite foils and powders of its wastes (PGFW). Graphite foil is known under different names: Graflex, Grafoil, Perma-Foil, Carbonax and etc. Graphite foil manufacturer companies are available on web sites [<http://www.toyotanso.com/index.html>]; www.mersen.com; <https://www.graflex.ru/contacts/>; <http://www.geegraphite.com/>; <http://sealwiz.com/>]. Graphite foils are used in many fields; therefore, a large amount of wastes is accumulated. Obtaining of graphene from these wastes was implemented according to the following stages: Graphite foil wastes grindig (I) — PGFW oxidation (II) — Graphite oxide sonication (III) — Graphene oxide reduction (IV) — Reduced Graphene oxide thermal treatment (V) — Graphene. Each step requires some physical-chemical processes: I. Waste grinding and removal of impurities from powders using chemical reagents; II. Oxidation of PGFW and isolation of graphite oxide from reaction mixture by decantation and filtration; III. Exfoliation of graphite oxide by sonication to obtain GO; Its isolation from the solution; IV. Reductiuon GO to rGO by chemical reagents or physical methods; V. Thermal treatment of rGO in order to obtain graphene with defective structure. Currently obtaining graphene from powdered GFW by simple two-step method is under the development. By the thermal treatment and the presence of other chemical reagents graphenes are obtained, that contain heteroatoms. It is also confirmed, that unlike flake graphite, intercalation of PGFW by chromium compounds has lower degree at room temperature and does not exfoliate when using H_2O_2 .



Figure 1. High temeperature vacuum furnace (I) for thermal reduction rGO to graphene (II); (III) XRD patterns of rGO and thermally reduced graphene oxide (rGO).

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Abstract

USING BENTONITE CLAY FOR RECUPERATION SYSTEM

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The type of losses oil and oil products at oil reference factories, oil terminals and in oil handling terminal are the losses of caused by the evaporation. It is happening at reservoirs big and small breathing and during loading and unloading operations. The damage caused by these losses is, both economic and environmental.

The basic losses of oil and oil products are arising during loading and unloading operations. According to the United Kingdom sources, the evaporation of losses from rail tanker are 0,4-0,6% which equals 120 000 tone in a year. By the Russian information at the time of the transport operation annual losses are 9%. To minimize the losses of evaporation, it is used oil and oil products recuperation system, in which as a sorbent is used activated coal, the coal sorption peculiarity are well manifested when it is in a dry condition but in a wet condition, it blocks the recuperation working system. At the same time there are other natural recourses for example Bentonite clay which is chipper than coal. The researching stocks are 170 million/tones in Georgia. In recent years, as a result of the determination of new properties of Bentonite clay, the requirement of a world has grown, because with other qualities it has clearly expressed sorption peculiarity.

In order to determinate new features, it is investigated Georgian bentonite clay, namely Askan clay's ion-exchangeable characters. The experiments carried out showed that, working exchangeable volume is 234 g-eq/m³. Using bentonite clay instead of coal increases economic efficiency and makes it more rentability for small air device exploitations.

COUMARONE-INDENE RESINS WITH FUNCTIONAL GROUPS

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The known coumarone-indene resins (polymers) are polymerization products of coumarone, indene, styrene and their homologues containing in crude benzene, phenol fraction of coal tar, etc. [1]. The process catalysts are concentrated sulphuric acid, trifluorine boron, phosphoric acid and others. Taking into account the availability and low cost of the mentioned resins, they are widely used in paint, varnish, construction industries, as well as for road-building [2]. Despite good characteristics of the products with coumarone-indene resins, they have some disadvantages; in particular the resins insufficiently combine with other polymers.

Recent years a series of works concerning production of coumarone-indene resins with different functional groups (CIRF) have been carried out in Lviv Polytechnic National University (Ukraine). The light fraction of coal tar (LFCT) was a raw material. It contains coumarone (1.30–5.75 wt %), indene (3.90–44.45 wt %) and styrene (1.2–3.5 wt %). CIRF were synthesized via initiated polymerization. 2,2'-Azobis(2-methylpropionitrile) and peroxy derivative of dioxydiphenylpropane diglycidyl ether (PO) were used as initiators. To increase the yield of CIRF and to introduce corresponding functional groups into its structure, styrene, glycidyl methacrylate or methacrylic acid were added to LFCT.

The effect of initiator amount, reaction temperature and time on the yield and characteristics of CIRF was examined. The resins with epoxy [3], carboxy [4] groups and methacrylic fragments [5] were synthesized. The structure of resulting products was confirmed by chemical and spectral methods. It was proposed to use CIRF as additives for the production of polymer bitumen compositions.

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COUMARONE-INDENE RESINS WITH METHACRYLIC FRAGMENTS

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When building modern roads, petroleum bitumen and polymeric additives are used as components of road materials [1, 2]. It is recommended to use elastomers, thermoplastic and reactive polymers, as well as various resins as polymeric additives [1]. The introduction of the polymeric component into the composition of road bitumen significantly improves the performance characteristics of the coating, in particular adhesion to mineral fillers, elasticity and reduces brittleness [3, 4].

It is known [5] that a coal tar resin is a by-product of coal coking. As a result of the coal tar rectification, an indene-coumarone fraction (ICF) [6] and a light fraction of coal tar (LFCT) are obtained. Both fractions contain sufficient amounts of indene, coumarone, styrene and other unsaturated compounds, and therefore they are used to produce the so-called coumarone-indene resins (CIR) which may be used as polymer components for the creation of bitumen-polymer mixtures [7]. CIR with functional groups, namely epoxy and carboxy groups, are described by M. Bratychak et al. [8, 9]. Functional groups in the CIR structure increase the adhesion properties of the final products.

This work deals with the obtaining coumarone-indene resins with methacrylic fragments (CIRM). CIRM were obtained via cooligomerization of the light fraction of coal tar (LFCT) or its indene-coumarone fraction boiling within 423–463 K with the addition of methyl methacrylate. 2,2'-Azobis(2-methyl-propionitrile) was used as the initiator. The highest CIRM yield relative to LFCT was achieved at 353 K for 6 h with the initiator concentration of 0.0226 mol/l. The resulting CIRMs are characterized by the yield of 25.5%, the softening temperature of 364 K, and the molecular weight of 600 g/mol. The presence of methacrylic fragments was confirmed by the IR absorption band at 1725 cm⁻¹, which corresponds to the stretching vibration of C=O group in esters, and CH₃–O group in the ¹H NMR spectrum, confirmed by protons signals at 3.54–3.65 ppm, as well as in ¹³C NMR spectrum by chemical shifts at 45.23 and 52.04 ppm. Regarding the possibility of using synthesized resins as polymeric additives to bitumen-polymeric mixtures, it was found that the addition of 1 % CIRM to the mixtures does not substantially affect the softening temperature, penetration and ductility, but doubles the adhesion to glass.

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Abstract

BIOCHEMICAL AND STRUCTURAL CHARACTERIZATION OF AN UNUSUAL CYANOBACTERIAL *S*-ADENOSYL-L-HOMOCYSTEINE HYDROLASE FROM *SYNECHOCYSTIS* SP. PCC 6803

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A genome of the mesophilic cyanobacterium *Synechocystis* sp. PCC 6803 encodes *S*-adenosyl-L-homocysteine hydrolase (SAHase) of extremophilic origin. SAHases are crucial enzymes involved in the regulation of SAM-dependent methylation reactions that occurs in all living cells, usually active as homotetramers or less commonly as homodimers. A SAHase protomer is composed of two large domains, the cofactor (NAD⁺) binding domain and substrate (SAH) binding domain, connected by a hinge region that is also involved in coordination of an alkali metal cation, which influences the domain movement during the catalytic cycle. For most SAHases, the highest activity, as well as strongest ligand binding is observed in the presence of K⁺ ions. The SAHase from *Synechocystis* (SynSAHase) is an exception in this respect. Size exclusion chromatography, applied as the last step of purification of recombinant SynSAHase clearly showed that the protein was eluted in two distinct oligomeric forms, corresponding to its dimeric and tetrameric state. In solution, the enzyme exists as an equilibrium of dimers and tetramers, shifted in the direction of tetramer formation at higher concentrations. Biophysical studies demonstrated that in contrast to K⁺-dependent SAHases, the activity and ligand binding of SynSAHase is not affected by the presence of any particular alkali ion. To explain this phenomenon, crystal structures of SynSAHase were determined for the enzyme crystallized in the presence of various alkali cations. The structural data confirm that, while SynSAHase shares common structural features with other SAHases, there is no alkali metal coordinated by the cyanobacterial enzyme as a result of slightly different organization of the cation binding hinge region.

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Abstract

SYNTHESIS AND CHARACTERIZATION OF NOVEL POLY(β -ALANINE-G-LACTONE)'S COPOLYMERS

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In the study, novel poly(β -alanine-g-lactone)'s were synthesized and characterized by using spectroscopic and thermal methods. Basically, the “grafting from” approach has been applied to obtain the copolymers. As grafting template, poly- β -alanine (nylon-3) was obtained via hydrogen transfer polymerization (HTP) of acrylamide [1]. The white crystalline polymer was ground into fine particles and then treated with sodium hydride to create activated sites on the backbones of the poly- β -alanine for further modifications. Ring opening polymerizations of β -propiolactone, 2-methyl propiolactone, β -butyrolactone and δ -valerolactone [2] were conducted using the activated anionic sites on the backbone. The isolated products were investigated by using FTIR, $^1\text{H-NMR}$, elemental analysis, MALDI-MS, DSC and TGA. Evaluation of the total analyses revealed that polyester chains were grafted from the polyamide backbones.

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Abstract

SYNTHESIS AND CHARACTERIZATION OF STAR-TYPE TRIARM BLOCK COPOLYMERS INCLUDING POLY(β -METHYL β -ALANINE) BY RAFT POLYMERIZATION

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Synthesis of poly(β -methyl β -alanine-*b*-methyl methacrylate) star-type triarm block copolymers were achieved via reversible addition-fragmentation chain transfer (RAFT) polymerization of methyl methacrylate (MMA) using a novel RAFT macroinitiator (RAFT-macro agent). For this purpose, poly(β -methyl β -alanine) with olefinic end-group was obtained by hydrogen transfer polymerization of crotonamide [1]. Olefinic end-group were brominated by bromine to achieve terminally dibromo poly(β -methyl β -alanine) (PMBA-diBr) [2]. RAFT-macro agent was acquired by reaction of PMBA-diBr and potassium ethyl xanthogenate. By reacting RAFT-macro agent and MMA, the star-type triarm block copolymers were obtained. Characterization of the products was performed by using FT-IR, ¹H-NMR and MALDI-MS analyses. Thermal transitions and degradation features of the star-type triarm block copolymers were investigated by using DSC and TGA methods. Spectroscopic and thermal analyses revealed that both the group modifications and the RAFT polymerizations were successfully achieved.

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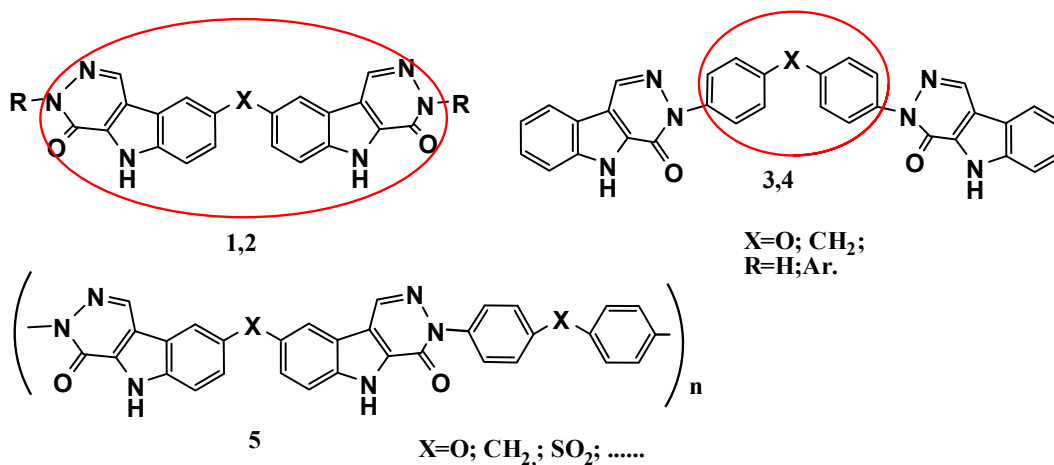
Abstract

NEW MONOMERS FOR POLYMERS CONTAINING PYRIDAZINOINDOLE RING

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Earlier we reported on the synthesis of bis-pyridazinoindoles of various structures (1-4) - bis-analogs of known DNA intercalators [1]. By combining the fragments of these substances new interesting polymers have been synthesized (5):



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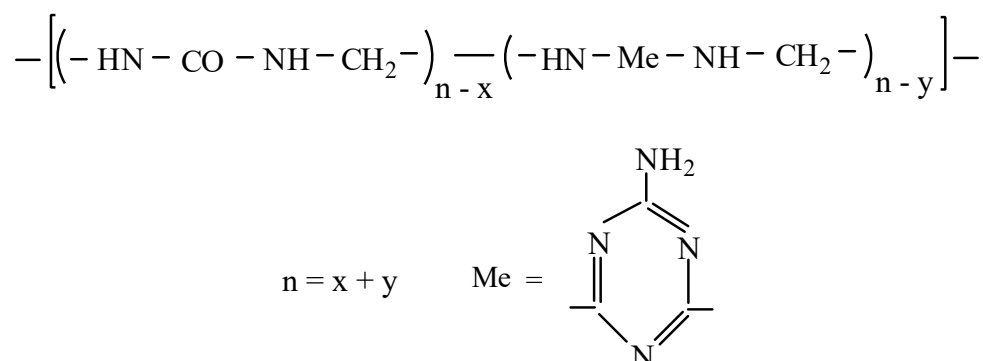
SYNTHESIS OF FUNCTIONAL GROUPS-CONTAINING AMIDE TYPE POLYMERS

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Synthesis of homo- and copolymers was implemented on the base of carbamide, melamine and formaldehyde. The process of formation of polymers and impact of various factors on the reaction progress were studied.

Chemical structure of element repetitive cycle/ring of copolymers is as follows:



In the process of copolymer synthesis, at simultaneous introduction of all components, the obtained polymer is non-homogeneous. Molecules of polymers formed at the first stage are enriched with more active components, then the second component enters and the polymer molecules are enriched with the second component.

At high temperature, at heating of the polymer in the solvent the exchange reactions between polymer molecules take place, which is accompanied by changes in polymer softening temperature. Finally a polymer will be formed with statistic spreading of monomers in its macromolecule.

Polymers properties were studied. Such polymers can be used as biodegradable nitrogenous fertilizers acting with the prolongation mechanism. Application of such polymers will enable us to avoid global environment pollution by nitrogenous fertilizers.

Copolymer contains functional $-\text{NH}_2$ groups, which enables us to carry out polymer-analogous conversions, in particular, for obtaining microelements-containing nitrogenous fertilizers.

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Abstract

EXTRACTION OF PECTIN FROM TANGERINE PEEL

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Georgia is a developing country, and over the past 15 years, the intensification of agricultural, livestock breeding, industrial and tourist activities has produced an immense increase in the production and accumulation of large amounts of wastes that increase disposal and pollution problems because of their high organic matter content.

The present study was focused on the potential of tangerine peel as a source of bioactive compounds, including pectin. Unlike gelatin, which is made from animal parts, pectin comes from fruit. As a result, any food with pectin listed as an ingredient is both vegetarian and vegan.

Pectin is a polysaccharide consisting mostly of two moieties. These are homogalacturonan, (1-4) linked, α -Dgalacturonic acid and its methyl ester; and rhamnogalacturonan I, (1-2) repeating linked, α -L-rhamnose-(1-4) α -Dgalacturonic acid disaccharide. Rhamnogalacturonan II contains arabinan, galactan and arabinogalactan side chains. These monosaccharide units comprise most of sugar units found in pectin.

A long list of various agents has been reported for the extraction of pectin from plant tissues. The most commonly used acidifying materials are mineral acids including, sulfuric, hydrochloric and phosphoric acids and organic acid –citric acid.

Extraction of pectin is one of the steps sequential stepwise extractions of bioactive compounds from tangerine peel. Pectin was extracted simultaneously with the distillation of the essential oil. Meyer's and Rouse reported the use of different type of zeolites for the extraction of pectin [1, 2].

Pectin was extracted from tangerine peel using H form of clinoptilolite as acidifying agent. Extraction conditions are $T = 80^{\circ}\text{C}$, $\text{pH} = 1.5-2$, extraction time = 1h. The percentage yield is 65-69%, equivalent weight of extracted pectin was 760, methoxyl content 6.5 %, total anhyrouronic acid content 78%, degree of esterification 47.3%. From the result obtained, the production of pectin from tangerine peel is considered the most reasonable way of utilization both from an economic and from an ecological point of view.

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Abstract

LIQUID CRYSTAL MICROSPHERES BASED LIGHT and pH CONTROLLED SMART DRUG DELIVERY SYSTEMS

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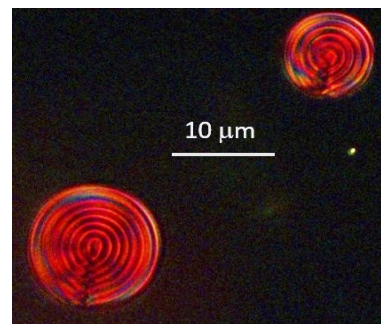
The development of a smart microencapsulation system programmed to actively respond to environmental stimuli is gaining increasing importance compared to the traditional forms of drug administration.

In this study, we introduce two new concepts of the drug delivery system, based on the light and pH-sensitive liquid crystal (LC) microspheres. The proposed system represents an emulsion formed by the immiscibility between the LC microspheres and a water environment.

The light controlled concept describes light activated drug delivery containers, based on spiropyran (SP) doped LC microspheres. Upon exposure to UV/violet light, the SP molecules entrapped inside the LC microspheres, interconvert from the hydrophobic, oil-soluble form, to the hydrophilic, water-soluble merocyanine (MR) one, which stimulates the translocation of the MR molecules across the LC/water barrier and results in their homogeneous distribution throughout in an aqueous environment[1].

Various types of pH sensors used today are based on optical, surface, chemical and biological modifications [2]. In this connection, we utilize an LC/water emulsion, but instead of SP molecules inside the LC microspheres were entrapped pH-sensitive fluorescent dye molecules that intelligently respond to the environmental pH change, resulting an immediate translocate across the LC/water interface.

In the coming future, the use of light and pH controlled LC microspheres based drug delivery systems can find versatile application in areas such as cancer therapy and treatment.



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Abstract

EFFECT OF MONOVALENT CATIONS ON THE ACTIVITY OF S-ADENOSYL-L-HOMOCYSTEINE HYDROLASE

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The *S*-adenosyl-L-homocysteine hydrolase (SAHase) controls a cellular concentration of *S*-adenosyl-L-homocysteine (SAH), a byproduct of methylation reactions that utilize *S*-adenosyl-L-methionine (SAM) as a methyl donor. SAH is a negative feedback inhibitor of SAM-dependent methyltransferases, therefore the enzyme serves as a key regulator of SAM-dependent biological methylation reactions. Selective inhibition of SAHases in targeted cells is an excellent possibility for a drug intervention at the molecular level of cell metabolism. SAHases are enzymes with almost identical organization of the active site.

Our research has been focused on bacterial SAHases from *Pseudomonas aeruginosa* (PaSAHase), *Thermotoga matitima* (TmSAHase), and *Synechocystis* (SynSAHase) and the goal was to elucidate a role and effect of monovalent alkali metal cations i.e. Li^+ , Na^+ , K^+ , Rb^+ , Cs^+ on the enzyme activity. Within the project, we used various experimental techniques, including X-ray crystallography, enzyme kinetics and isothermal titration calorimetry (ITC) studies were conducted in the presence or absence of alkali cations to investigate their influence on the enzymatic activity and ligand binding of SAHase.

The crystal structures revealed, that in the case PaSAHase, which was crystallized in the presence of adenine nucleosides, the ions K^+ and Rb^+ are bound in a close proximity of the active center¹. On the other hand, in the structure of SynSAH, where we observed that Na^+ and Rb^+ ions bind far away from the active center. The structure of Tm SAHase crystallized in the presence of the adenosine does not contain any metal cation in the substrate binding region². In the case of PaSAHase enzymatic and ITC studies confirm that among the alkali cations, the K^+ ion stimulates the highest enzymatic activity and strongest ligand binding. An important discovery was that only K^+ ion, enables unique dynamic properties (domain movement) of the enzyme to ensure its maximum catalytic activity¹. The K^+ ion stabilizes the enzyme-substrate complex in the closed conformation for a time interval required to complete the catalytic cycle. ITC studies were conducted in the presence/absence of alkali cations did not confirm their influence on the enzymatic activity of SynSAHase.

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Abstract

APPLICATION OF THE LOWS AND MODELS OF FRONTAL POLYMERIZATION FOR THE ESTABLISHMENT OF STABILITY LOSS BOUNDARIES FOR BIOLOGICAL PROCESSES

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Frontal polymerization is a non-traditional method for polymer synthesis. It is an autowave process of propagating polymerization heat waves. It is this phenomenon that determines the dependence of the wave stationarity on the heat loss and transition from a stable stationary state to a non-stationary one with an appearance of various non-linear phenomena, such as periodic stability loss, damping of polymerization waves, and up to its complete extinction, appearance of one and many-headed spin modes. It was discovered that, besides the effect of heat balance of the process stationarity, a significant role also play physical phenomena: mass transfer, polymer shrinkage, inert inorganic additives and so on [1].

For the technological implementation of frontal polymerization we studied experimentally and calculated theoretically different models of stability loss for frontal polymerization [1, 2]. We have found an analogy between biological reactions that occur by the Belousov-Zhabotinsky reaction mechanism (in autowave mode) and the frontal polymerization mechanism. Based on this analogy, we investigated various biological models occurring in human body: the diffusion-kinetic model of cancer cell growth, propagation of nerve impulses in according to the Fitz Hugh-Nagumo model, breakdown and reduction of adenosine triphosphate.

For the calculation of the frontal polymerization model was used the scheme of elementary reactions of the process in conjunction with the heat equation [2]. As in biological processes the stability loss is brought about by the loss of the concentrations of reactants, here, instead of heat equation, diffusion equation was used.

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RECRYSTALLIZATION OF GEORGIAN NATURAL ALUMINOSILICATES

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Zeolites have been the focus of intensive activity and growth in applications over the past 30 years in adsorption, ion exchange and catalytic technologies due to their excellent properties of uniform and precise nano-scale porosity, molecular shape selectivity, ion-exchange capacity, strong Brønsted acidity and high thermal and hydrothermal stability. Synthetic zeolites are obtained from various raw materials, including those based on natural aluminosilicates, zeolites and volcanic glasses. Our report concerns the production of some commercially valuable zeolites used as ion exchangers and catalysts.

Phase-pure zeolite NaA ($\text{Na}_{11.25(25)}(\text{K}, \frac{1}{2}\text{Ca}, \frac{1}{2}\text{Mg})_{0.7(1)}(\text{Al}_{11.95(25)}\text{Si}_{12.3(3)}\text{O}_{48}) \cdot 18\text{H}_2\text{O}$) was prepared in the form of cubic/rhombus crystallites with uniform micrometric (3-5 μm) dimensions by hydrothermal crystallization (95°C) of aged (72 hr) at room temperature gel (4.5Na₂O: 0.45Al₂O₃: 1SiO₂: 178H₂O) obtained from natural analcime (Chachubeti plot, Tedzami deposit, Eastern Georgia), treated with hydrochloric acid before suspending in water and mixing with sodium hydroxide [1]; the formation of the target product begins after 40 hours, complete hydrothermal crystallization at 95°C lasts up to 120 hours.

Zeolite NaX ($[\text{Na}_{66(3)}[\text{K}, \frac{1}{2}\text{Ca}, \frac{1}{2}\text{Mg}, \frac{1}{2}\text{Cu}, \frac{1}{2}\text{Zn}]_{12(1)}(\text{H}_2\text{O})_{248(10)}](\text{Al}_{78(3)}\text{Si}_{114(4)}\text{O}_{384})$) with high phase purity, specific surface area of 589 m²/g, and total pore volume of 0.578 cm³/g was prepared in the form of octahedral crystallites with uniform micrometric (2-7 μm) dimensions by hydrothermal crystallization (95°C) of aged (96 hr) at room temperature gel (2.9Na₂O:0.26Al₂O₃: 1SiO₂:150H₂O) obtained from water suspension of natural phillipsite (Akhaltzikhe field, Southern Georgia), treated with hydrochloric acid and mixed with sodium hydroxide [1]. The pore system includes micropores of the FAU structure (52%) and cylindrical channels with diameter up to 67 nm (48%).

The FER type zeolite materials are prepared by hydrothermal transformation of volcanic glass perlite (Paravani lake, Southern Georgia) treated by HCl water solution and suspended in presence of the Li ions [2]. The proposed method gives possibility to obtain monocationic ready-to-exchange Li-ferrierite without application of organic templates. Autoclave synthesis at 160°C during 140 hours results in finely dispersed (0.5 – 1.2 μm) product suitable for catalytic and other applications. The structure, as well as high phase purity and crystallinity of prepared samples was confirmed by their X-ray diffraction patterns and FT-IR spectra, the surface morphology was observed by scanning electron microscope, the micro- and mesoporous system are characterized by nitrogen adsorption-desorption isotherms measured at 77 K. The resulting zeolites in their characteristics are competitive with commercially available materials.

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Abstract

SOME ISSUES OF OBTAINING THE MEMBRANES FROM GRAPHITE OXIDES

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The present work discussed some issues of making membranes on the basis of graphene oxide (GO). GO has been obtained from two precursors: flake graphite and graphite foil powder. Their oxidation was carried out with the $\text{KMnO}_4\text{-H}_2\text{SO}_4$ system at 50°C . Isolation of GO from suspensions and purification from impurities was carried out by the decantation, treatment of sediment with diluted HCl, water and centrifugation. GO particle sizes vary widely within 50-6000 nm. Decanted solutions contain 20% (mass) GO, which particle size reaches 700 nm. Their reduction was carried out with hydrazine, ascorbic acid and zinc. In case of hydrazine reduction of the rGO is obtained, with a diffractive maximum of $2\theta = 26.2^\circ$. Its value changes when using other reductants (2θ between 20.0 and 26.6°).

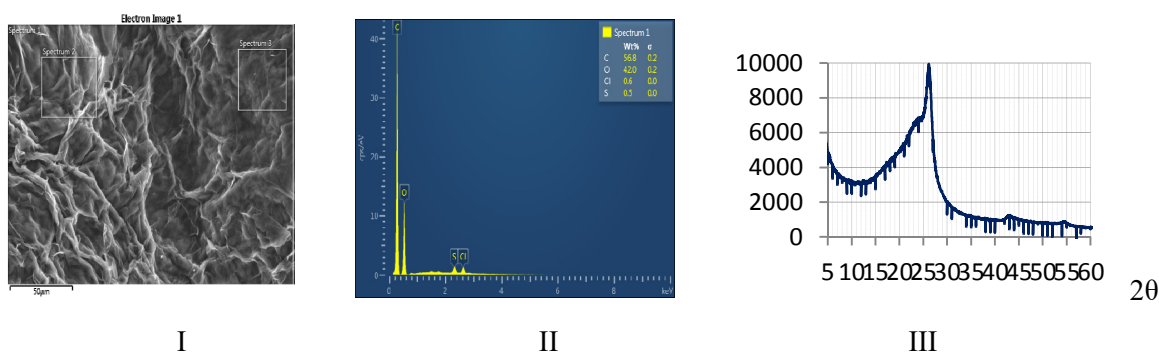


Figure 1. SEM image (I), EDX spectrum of rGO sheets and XRD patterns of rGO(III)

The reduction GO from decanted solutions was carried out with ascorbic acid at 100°C . rGO precipitation occurred when the reaction mixture was cooled. The precipitate was filtered, washed with sodium bicarbonate solution, then with water ($\text{pH} = 6$), acetone (x3) and redispersed in water or organic solvents. The membranes were obtained by the methods of vacuum-filtration and evaporation of solvents of homogeneous suspensions. 3-15 cm diameter membranes were obtained. Methods of deposition the GO and rGO on organic and inorganic supports have been developed; membranes reinforced with cellulose fibers are also obtained.



Figure 2. Image of obtained membrane samples.

Abstract

SYNTHESIS OF AMINO ACID BASED UNSATURATED BIODEGRADABLE POLY(ESTER AMIDE)S WITH DOUBLE BOND MOETIES IN THE BACKBONES AND FUNCTIONAL POLYMERS BASED ON THEM

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α -Amino acid based (AAB) poly(ester amide)s (PEAs) are a relatively new class of resorbable polymers [1-6]. Besides the diversity in material properties [1,7], they have shown good biocompatibility [8-10] and low inflammatory response [10], which makes PEAs highly attractive for biomedical applications. The lateral functional groups (e.g., -COOH) along the PEA chain makes it suitable for a wide range of chemical modifications [6]. One of the most convenient ways to render biodegradable polymer functional is the incorporation of unsaturated double bonds in the polymer backbone [11].

The synthesis of α -amino acid L-leucine (Leu) based high-molecular-weight soluble biodegradable unsaturated poly(ester-amide)s (PEAs) was elaborated. Amino acid L-phenylalanine (Phe) was used as well for a comparative study and to synthesize some copolymers.

The syntheses of three types of new unsaturated PEA polymers were explored - (i) Leu- and Phe-based unsaturated PEA homopolymers (UPEAs) composed of 100% of fumaric acid, (ii) Leu-based unsaturated-saturated copolymers (USPEAs) composed of fumaric acid and saturated fatty diacids, and (iii) Leu- and Phe-based UPEA copolymers composed of 100% fumaric acid (co-UPEAs).

Many of the targeted unsaturated polymers were soluble in common organic solvents and showed good film-forming property. The UPEAs were further chemically modified into functional derivatives as well as subjected to thermal and photochemical transformations (curing) that substantially expand material properties and, hence, the scopes of potential applications of α -amino acid based biodegradable poly(ester amide)s as absorbable surgical devices and drug carriers.

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**TRANSFORMATION OF PETROLEUM AND PETROLEUM
PRODUCTS IN THE ENVIROMENT**

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The degree of use of crude Petroleum is determined by the content of non-hydrocarbon high-molecular compounds, a significant part of which are tar-asphaltene substances. To study the tar-asphaltene substances the photochemical method which differs from chemical methods by softness of the conditions - the method of thermal destruction was used. The photochemical properties of tar-asphaltene substances from various types of Georgian oils – paraffinic (Samgori oil), aromatic (Norio oil) and tarry (Supsa oil) were studied. All of them belong to low-sulfur types of oils. It was established that asphaltenes from Samgori and Norio oils were similar to each other and had a net-like structure consisting of three layers: the top one – a two-dimensional flat net-like structure, easily separated from the total mass and distinguished by its elasticity and strength; the bottom layer – a three-dimensional net-like skeleton forming a spatial lattice; the intermediate layer – a flat net-like structure attached to the lower layer. In the process of irradiation, the products of photochemical transformation (PPCT) were investigated every 20 hours. Methods of analysis were elemental analysis, gas-liquid chromatography and spectrometry (IR and PMR). The results of the analyses showed that during irradiation of tar-asphaltene substances in air, there can be seen photochemical destruction of molecules with emission of gaseous products, on the one hand, and intensive photo-oxidative processes with formation of liquid and high melting compounds, on the other hand.

When irradiation of tar - asphaltene substances in the air the photochemical destruction of molecules with release of gaseous products on one hand, and an intensive photo-oxidative processes with formation of compounds melting on higher temperatures on the other hand occurs. The destructive-condensation transformations in tar - asphaltene substances occurring under the influence of light and oxygen of air and formation of water-soluble forms explain destruction and erosion of high-mountain asphalt coating.

In the process of photochemical oxidation of tar - asphaltene substances, the water soluble biologically active substances are formed, and this explains the stimulation of plant growth by high-boiling oil residues, which is observed in practice and used in agriculture. Destructive transformation of TASs during photochemical oxidation and formation of water-soluble forms explains, the destruction and erosion of high-altitude asphalted roads, on the one hand, and formation of biologically active substances that stimulate plant growth on the other hand, as well as self-purification of water basins polluted with Petroleum and Petroleum products.

Formation of biologically active substances soluble in water in the process of photochemical oxidation of tar-asphaltene substances, that explains stimulation of plant growth by high-boiling oil residues happening in practice and used in agriculture. This suggests the prospect of researches in the field of obtaining of new biologically active compounds from readily available cheap raw materials like tar-asphaltene oil substances. It is established that destruction occurs mainly with detaching of saturated substituents from the tar asphaltene molecules, and photo-oxidation occurs with formation of hydroxyl groups of the phenol type and regulating growth of plants.

Abstract

DETERMINATION CHEMICAL METHODS' APPLICATION FOR INORGANIC POLYMERS

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Numerous methods for the determination of various metals and metalloids, containing in different inorganic compounds, are well known [1-5].

The aim of presented work was to apply various and diverse methods for the determination of metals and non-metallic composants in inorganic polymeric compounds, to compare the results obtained by us with the available literature data and to study the influence of various factors. These factors may be the following: interfering elements, permissible metals, pH of precipitation process, precipitated and weight forms, the temperature during experiments [5-8].

Along with unconditional advantages and benefits, each of the known methods has some of its drawbacks and which, in our opinion, needed certain improvements, or rather, clarifications.

Experiments were carried out on crystalline substances obtained by Avaliani et al [2, 8] who provided us with the opportunity to study the composition of these compounds using chemical analysis, (concretely – the gravimetric method) although using already approved methods, but which we tried to adapt on condensed compounds, namely for condensed phosphates and improve accordingly. The elemental composition of inorganic polymers obtained by authors [2, 7-8] during investigation of multi-component systems $M^I_2O-M^{III}_2O_3-P_2O_5-H_2O$ at the temperature range of 100-: 600 ° C was determined. Our experimental data were compared with the available scientific publications [1-3, 6].

Methodical recommendations for the deposition of monovalent and polyvalent metals from condensed poly- and cyclophosphate samples using various methods of chemical analysis are proposed.

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Abstract

Ag(I) MODIFIED POLY (1-VINYLMIDAZOLE/DIVINYLBENZENE) MAGNETIC NANO-COMPOSITE AS AN EFFICIENT ANION EXCHANGE MATERIAL FOR ORANGE II ADSORPTION

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The recent decade has shown an explosion in the development of new nano-materials. Some of the advances have been made in the preparation of magnetic nano-adsorbents. The new materials have made many applications in adsorption, removal and solid phase extraction of target chemicals. One of the most developed nano-adsorbents is magnetic polymer nanoparticles. However, the potential use of the adsorption properties of the new materials remains largely unexplored. Future needs for a clean environment will lead to increasingly higher standards for water pollutants. These challenges require better sorbents that are not commercially available [1].

In this work, a core-shell magnetic poly (1-vinylimidazole/divinylbenzene) was prepared. At first, 3-(trimethoxysilyl)propyl methacrylate was grafted to magnetite nanoparticles. Then, the final product was prepared when 1-vinylimidazole and divinylbenzene were polymerized on the surfaces of the silylated magnetite nanoparticles. X-ray diffraction spectroscopy (XRD), scanning electron microscopy (SEM), transmission electron microscopy (TEM), FT-IR spectroscopy, vibrating sample magnetometry (VSM), thermogravimetric analysis (TGA) and energy dispersive analysis X-ray spectroscopy (EDX) were used to characterize the nano-adsorbent. The prepared magnetic nanoparticles were then used as an efficient adsorbent for removal of orange II as the anionic dye. The results showed that imidazole groups of the magnetic nano-material can act as the electron pair donating sites for adsorption of Ag(I). Therefore, an anion exchange magnetic polymer can be formed. The affecting parameters were investigated and the silver modified magnetic nano-material was applied for adsorption of orange II. The experiments showed that orange II was removed by 95% at pH equal to 8.6 during 5 min adsorption at 20, 30 and 50 °C. Adsorption behavior of orange II on the adsorbent was correlated with Langmuir, Fraundlich and Temkin isotherm models. The studies revealed that Langmuir model is obeyed more than the other models when orange II is adsorbed.

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Abstract

ADSORPTION STUDY OF FOLIC ACID ON CATIONIC MAGNETIC POLY(4-VINYLPYRIDINE/DIVINYLBENZENE) NANOCOMPOSITE

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Many methods have been used for removing the chemicals. They are coagulation and flocculation, membrane separation, oxidation or ozonation, electro-coagulation and adsorption. Adsorption is now an effective and economical method for the removal of the chemicals from water and waste waters [1]. Adsorption processes are being employed widely for large-scale biochemical, chemical, environmental recovery and purification applications [2].

Folic acid is one of the B vitamins which is produced by many companies. More than 80 countries use folic acid as additive in foods as a micro-nutrient. Long-term supplementation is also associated with small reductions in the risk of stroke and cardiovascular disease. Folic acid may pollute water sources when is leaked from factory or home, or during transportation.

A magnetic poly (4-vinylpyridine/divinylbenzene) nanocomposite was prepared by using 3-(trimethoxysilyl) propyl methacrylate as a linker to magnetite nanoparticles. Then, the magnetic polymer was reacted with bromoethane to prepare the final magnetic anion exchanger nanocomposite (MAEN). Fourier transform infrared spectroscopy, scanning electron microscopy, atomic force microscopy, dynamic light scattering, thermogravimetric analysis and X-ray diffraction were applied to characterize MAEN. Then, the adsorption thermodynamics of folic acid with MAEN was investigated. Affecting parameters such MAEN dose and pH was studied to achieve the highest possible folic acid adsorption efficiency. At optimum condition after 5 min extraction, yield was greater than 94%. Various adsorption isotherms such as Langmuir, Freundlich, Temkin and Langmuir-Freundlich isotherms were evaluated at different temperatures. The Langmuir isotherm was found to be the best fitted isotherm for adsorption of folic acid on MAEN. Maximum adsorption capacity for folic acid on MAEN was found about 350 mg g⁻¹ at 50 °C. For the adsorption ΔH and ΔS were found as -26.86 KJ mol⁻¹ and 17.94 J mol⁻¹ K⁻¹, respectively. Folic acid was added to lake and river water matrices and then, adsorption efficiency of folic acid was evaluated. Adsorption of folic acid was obtained 71.5 and 85.3% in lake and river water matrices, respectively. A slight decrease in adsorption efficiency of folic acid was observed after 5 times successive uses of MAEN.

Acknowledgment. The authors wish to thank the Research Council of the University of Mohaghegh Ardabili for the financial support of this work.

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Abstract

STUDY OF ANTIMUTAGENIC AND ANTITOXIC EFFECTS OF PLAIFERON IN CASE OF MUTATIONS INDUCED BY ARNOLD'S BASE

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People are continuously exposed exogenously to varying amounts of chemicals that have been shown to have carcinogenic or mutagenic properties in experimental systems. Exposure can occur exogenously when these agents are present in food, air or water, and also endogenously when they are products of metabolism or pathophysiologic states such as inflammation. It has been estimated that exposure to environmental chemical carcinogens may contribute significantly to the causation of a sizable fraction, perhaps a majority, of human cancers, when exposures are related to "life-style" factors such as diet, tobacco use, etc. [1].

The antimutagenic and antitoxic effects of plaferon was studied on the laboratory mice in case of mutations induced by Arnold's base-4,4'-methylenedianiline (MDA), a known hepatic carcinogen [2,3].

The cytogenetic and toxicological methods of investigation were used in our research. Arnold's base is characterized by mutagenic, cytotoxic and consequently general toxic action. Introduction of Arnold's base (dose 1/5 LD50) per oral to animals induced strong increasing ($P < 0,001$) of chromosomal aberrations (multiple fragmentation, lyses), a genomic mutations (triploidy, tetraploidy), Pathological mitosis (K-mitosis, hollow metaphase, adhesion of chromosomes) and destruction of interphase nucleuses (hollow nucleus). plaferon is characterized with greatly expressed antimutagenic and anticytotoxic effect and statistically reliable reduces mutagenic and cytotoxic effect of Arnold's base. At separate effect of Arnold's base (dose 1/5 LD50) the frequency of chromosomal anomalies was 12,0 %, pathologic mitosis – 24,2 %, interphase nucleus destruction – 4,5%. After addition of plaferon in diet, these indexes decrease accordingly to 3, 0 %; 8, 6 % und 1, 5 % ($p < 0,001$).

On the base of conducted experiments application of plaferon for medical purpose is prospective, especially for people who are in contact with harmful mutagenic substances, also for the individuals poisoned with cancerogen.

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Abstract

THE MODIFIED NATURAL ZEOLITES IN IONEXCHANGE ADSORPTION OF SOME HEAVY METALS

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One of ways for creation adsorbents with advanced adsorption and ion-exchange allowed to open and use the renewed methodic of processing the natural zeolites clinoptilolite (CL) and mordenite (MOR) from deposits of Georgia and studied their adsorption capacity in regards to heavy metals Pb, Cu, Mn, Cd, and Zn.

The study was carried out using batch techniques, X-ray, AAS, ESR to outline the crystalline and morphology modifications. Model solutions of heavy metal ions with different concentrations, pH and at a zeolite : solution ratio of 5:50 (mg/mL) were used. Tests to determine both the rate of adsorption and the uptake at equilibrium were performed under batch conditions from single and multi-component solutions.

Fast adsorption of cations reaches in general for the first 45 - 60 mins, with ~ 75% total removal. Then the rate of adsorption decreases. For obtaining a maximum efficiency during the adsorption process the conditions of adsorption (contact time, concentration, and optimum amount of substrate) were optimized. Was found the following sequence of adsorption $Pb > Cu > Mn > Cd > Zn$ for MOR, and $Cu > Pb > Mn > Zn > Cd$ for CL. Below 10^{-4} M both MOR and CL remove Pb and Cu from the solutions almost completely. However, CL and MOR in natural and modified forms were not effective in adsorption Cd.

The adsorption capacities and removal efficiencies of the zeolites for the two highly toxic heavy metals, Cd and Pb, were also determined at a low-to-medium concentration range (10^{-6} to 10^{-3} M), and at a zeolite:solution ratio of 5:50 (mg:mL), in competition with 10^{-3} M of Ca. Below 10^{-4} M, both MOR and CL removed Pb from the solution almost completely. As Pbconcentration increased, removal efficiency decreased. However, the zeolite samples (particularly MOR) were not effective in reducing Cd concentrations to the legal $\mu\text{g/L}$ level.

XPS showed that Na +K ions were the principal cations involved in the exchange adsorption of Pb and Cd. As such, CLwith 482mmol/kg of exchangeable Na+K adsorbed more Pb and Cd than mordenite with only 265mmol/kg of Na+K. Showed that Pb was evenly distributed within zeolite particles but Cd accumulated on particle surfaces. This may be because the hydration energy of Cd ion is larger than that of Pb or Cu ions ion. For obtaining a maximum efficiency during the adsorption process the adsorption conditions (contact time, ratio of adsorbent/adsorbate) were optimized. These parameters were further used in kinetic modeling of the adsorption processes. The uptake of Cd^{2+} , Cu^{2+} and Pb^{2+} was followed by a Langmuir adsorption isotherm and the maximum uptake capacity was estimated to be 88.12 mg/g Cd^{2+} , 113.43 mg/g Cu^{2+} from aqueous solution with two cations. Correlated with the surface structure, composition and morphology the adsorption kinetic mechanisms and the substrate capacities are further discussed.

Abstract

ARSENIC IN POLY(VINYL CHLORIDE)

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One does not need to argue the importance of providing antibacterial activity to materials. The way it was done earlier was simply using materials which can destroy bacteria. There are immediate problems since some such materials including arsenic are highly toxic; they do destroy bacteria but not only... One option which has been used before our project began was using low molecular weight antibacterial agents. This represents progress as compared to 'nude' arsenic or arsenic oxide; however, toxicity is mitigated. [1-6]

We put arsenic (III) into poly(vinyl chloride) (PVC). Sufficient antibacterial activity is achieved. The antibacterial material so obtained is non-irritant and non-toxic. At the same time, the PVC-based composite has high thermal stability as demonstrated by thermogravimetric analysis (TGA, PerkinElmer). Thermal transitions have been located by differential scanning calorimetry (DSC, PerkinElmer). Still further, we have determined scratch resistance in a Microscratch Tester from CSM, Peseux, Switzerland. Higher scratch resistance than in neat PVC has been demonstrated, including stronger viscoelastic scratch recovery.

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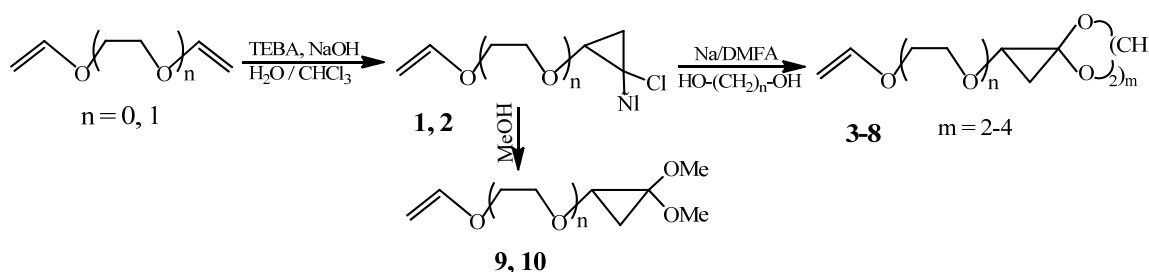
SEPARATE AND JOINT RADICAL POLYMERIZATION OF VINYLOXY- AND (2-VINYLOXY-)ETHOXY- SUBSTITUTED CYCLOPROPYLACETALS

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It was known that an introduction of heteroatom into monomer molecule leads to the increase of polar influence and reactivity of the monomers in their radical polymerization. This work has been devoted to the separate and joint radical polymerization of new monomers – vinyloxy- and (2-vinyloxy-)ethoxy- substituted cyclic and acyclic cyclopropylacetals synthesized on scheme presented below:



Dichlorocarbene has been generated in the reaction conditions of alkaline hydrolysis of chloroform in the presence of interphase catalyst TEBA. The corresponding acetals have been prepared from dichlorocyclopropyl compounds **1** and **2** in the presence of strong base of NaH in DMFA.

The composition and structure of the synthesized acetals **3-10** have been established on the basis of chemical and spectral analyses.

The radical polymerization of the monomers **3-10** was carried out in polar solvents such as DMSO, DMAA and DMFA in the presence of AIBN.

For elucidation of the nature of separate and joint polymerization of the monomers **3-10** their homopolymerization was carried out in benzene solution at 60°C in the presence of AIBN. The homopolymers obtained in this case are soluble in acetone, DMFA and other polar solvents.

An increase of the polymerization rate of monomers is accompanied by increase of maximum conversion. However, at more high conversions of monomers some decrease of maximum conversion is observed.

The reaction of joint polymerization of monomers **3-10** with MA both in solution and in mass in the presence of radical initiators of AIBN and benzoyl peroxide has been studied. It has shown that the joint polymerization processes proceed with formation of complexes between comonomers. K_r constants of the forming complexes have been determined and the thermodynamic parameters of the complex-formation process have been calculated.

The independence of the copolymer composition on composition of the initial mixture has been established. The copolymerizations constants values r_1 and r_2 , and also as Q and e parameters characterizing the activity of monomers and the polarity of the radicals formed from them have been calculated. The obtained copolymers are soluble in a number of polar solvents and insoluble in benzene, alcohols and alkanes. The composition of the obtained copolymers has been determined by elemental analysis (finding the acid number).

Abstract

INVESTIGATION OF SORPTION PROPERTIES OF CARBONACEOUS MATERIALS OBTAINED FROM CELLULOSE CONTAINED WASTE

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The purpose of this work is to study the sorption properties of carbonaceous materials obtained from cellulose contained waste using the technology developed by the authors [1] of the work and to establish the possibility of their use for purifying water polluted with heavy metals.

The analysis of the literary data have shown, that adsorbents used today for purification of drinking and waste water, oil products and organic solvents are characterized by high cost and complex technologies of obtaining-regeneration. Therefore, creation of cheap and effective adsorbents, especially on the basis of waste is an actual problem.

Suggested by us technology provides high porosity of sorbent, its purity, because of the absence of chemical processing and cheapness -the source of the sorbents is renewable, because of the growth of plants.

Adsorption capacities of walnutshell and hazel nutshell, sawdust, nectarine kernel and activated carbon are studied with the aim of purification of drinking and waste waters from copper, cadmium, cobalt and lead ions. Dependence of adsorption values $A(\text{mg/g})$ on delay time of adsorbent in solution, on fraction sizes of adsorbent (40, 315, 700, 1200 microns) and on the Me^{++} ions concentration in solution is also studied.

It is established, that among considered materials the best adsorptive properties have material obtained from walnut shell. The properties of material obtained from hazel nutshell, are not so good, particularly:

ions	Adsorption on walnutshell, mg/g:	Adsorption on hazel nutshell, A mg/g:
Pb (II)	138.0	77.0
Cd(II)	27.0	19.5
Cu (II)	13.0	19.0
Co (II)	9.5	6.5

Thus, the sorbent obtained by us may be recommended for purification of drinking and waste waters.

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1. USA Patent 9663662

MOLIBDENUM POLYMERIC CHELATES

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Providing the population with cheap, qualitative, and ecologically safe agrarian products is one of the most actual problems recently. One of the main reasons determining low quantitative and qualitative indicators of these products is a deficit of microelements. Therefore, for solving this problem we decide to provide them with fertilizers containing chelate elements [1,2]. Among these microelecters, molybdenum was selected as the object of our research. Molybdenum is characterized by a low toxicity than the other microelements. It is in the composition of a number of ferments and, demonstrates a clearly expressed antioxidating property, provides to disassemble and remove the toxic substances in the plants, actively participates in the synthesis of amino acids and vitamins (especially vitamin C), facilitates absorption of iron by the plant. Although known the advantage of chelate form of microelements over the non-chelate ones, in fertilizers it is used as simple inorganic compounds. This fact can be explained as the microelements in the anion composition are characterized by less striving of formation the chelate compounds.

In our researches we established conditions for the synthesis and we obtained molybdenum in chelate form by chemical methods - Polymeric molybdenum anionic chelates by the general formula $(H_2MoO_4)_x \cdot L \cdot nH_2O$, where L=glutamic acid, methionine or ethanolamine; x=1-3; n=1;2. Composition and individuality of synthesized compounds was established through element analysis and melting temperature. Qualitative solubility of polymeric chelate was determined in different solvents (water, alcohol, acetone and dimethyl sulfoxide), according to which they are characterized by low solubility in the organic solvents both at room temperature and when heated. The compounds are high soluble in water.

Based on polymeric chelate molybdenum were made fertilizer concentrate and 5% working solution, which were tested on corn culture. Based on the experiment analysis can be concluded that using of polymeric molybdenum fertilizers:

- ✓ Increase of the quantitative and qualitative data of maize yield
- ✓ Increase of assimilation of macro elements (N,P,K)
- ✓ Improve physiological status of plants and metabolic processes
- ✓ Prolong activity of fertilizers
- ✓ Enrich soil and improve its structure, which will affect positively the productivity, better retention of water and elevation of resistance to external factors (draught and low temperature), increase of resistance to pests and various diseases;

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Abstract

COMPARATIVE STUDY ON IMPACT OF THE NEW COMPOSITIONS ON THE HISTOARCHITECTONICS OF THE WHITE MICE ORGANS

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Earlier, we illustrated that wood composites in which organic and silicone-organic polymers are used as a binding-adhesive substances do not change the total number of leukocytes in the peripheral blood of white adult mice during one month, unlike particleboard (Low-density Fiberboard LDF). (1) Taking into account the data found in literature (2) and the outcomes obtained by us, we decided to conduct a comparative study of the above mention compositions on the tissues and on impact at cellular level.

Purpose of the study. Comparative study of the impact of a new compositions and particleboard on the histoarchitectonics of the white mice organs.

Objective of the study. Adult (8g) white non-linear mice (50 pcs.).

Research Methods. Preparation of the white mice liver and the hippocampal paraffin slides; and evaluation of the changes to the organ histoarchitectonics by the light microscope.

Results: Researches found that wood composites in which organic and silicone-organic polymers are used as a binding-adhesive substance do not cause visible changes in the histoarchitectonics of the liver and brain tissue of the adult mice.

In contrast to the compositions described above, the lumen of the central blood vessels and the circulating cells in a large number of cells in the neighboring tissue are affected by the effect of particleboard on the liver parenchyma of animals, which indicates inflammatory and / or other pathological processes.

It was also found that, in contrast to the control, the orientation of cells was disturbed in the dentate gyrus and some changes were observed in the sub granular layer of hippocampus of animals from experimental group. In particular, polymorphic cells of this layer are not identified.

Conclusion: Wood composites, in which organic and silicon-organic polymers are used as a binding-adhesive substances contrast to the particleboard, do not have a negative impact on histoarchitectonic of growing white mice liver and brain tissue during one-month.

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Abstract

TEST METHOD OF DETERMINATION OF PORE SIZE AND POROSITY OF POLYMERIC MEMBRANES

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Membrane technologies allow to effect separation, concentration of liquid mixtures and their purification on the molecular level as well as separation of the valuable components and secondary utilization of wastes. Membrane separation technology is used in production of food and pharmaceuticals, waste water treatment.

Membrane films were produced from polymers homogeneous solutions by so called phase inversion method, with use of Automatic Coating Machine (Memcast TM, Porometer NV).

Microfiltration, ultrafiltration and reverse osmosis membranes were produced using polysulfone, polyoxadiazole and fluoroplastic polymeric materials.

Membrane pores sizes were determined with use of the POROLUX™ 500 (Porometer NV), an instrument based on capillary flow porometry measuring pore size distribution and gas permeability.

For the samples where the POROLUX™ showed very small flow at the end pressure of 35 bar we used also the alternative method of Liquid Liquid Porometry (LDP) .

Production of the membranes and determination of their properties were done in the Membrane Technologies Research Laboratory of the Agrarian and Membrane Technologies Institute of Batumi State University.

The obtained data is important for matching of the appropriate membrane for the filtration process, as well as for further research and modification of membranes.

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Abstract

GLASS-FORMING MOLECULAR MATERIALS CONTAINING DONOR AND ACCEPOR MOIETIES FOR ORGANIC LIGHT EMITTING DIODES

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Glass-forming molecular materials containing donor and acceptor moieties recently synthesized at the laboratories of the presenting author will be reported.

Derivative of 3-(trifluoromethyl)benzonitrile and 3,3'-bicarbazole was found to exhibit both TADF and exciplex-forming properties [1]. Warm-white OLED based on this material showed external quantum efficiency (EQE) of ca. 20 %.

The derivative of acridan and dicyanobenzene was found to be efficient TADF-emitter exhibiting both thermally activated delayed fluorescence and aggregation induced emission enhancement. Green OLED fabricated using this emitter exhibited maximum current, power efficiency and EQE of 68 cd/m², 62 lm/W and 22.5 %, respectively [2].

A series of carbazole-quinoxaline-carbazole derivatives exhibiting TADF and mechanochromic luminescence properties were synthesized and studied. Green-blue to green-yellow TADF OLEDs fabricated by solution processing demonstrated EQE up to 10.9% and luminance of 16760 cd m⁻² [3].

By utilization of the derivatives cyanophenyl and ditertbutylcarbazolyl-substituted triphenylbenzene with the different substitution pattern as host and guest of the emissive layer, deep-blue OLED based on triplet-triplet annihilation with EQE of 14.1% were fabricated [4].

Compounds containing accepting pyridine-3,5-dicarbonitrile and donating carbazole units were found to exhibit bipolar charge transport in their solid layers and photoluminescence quantum yields up to 98% for the solutions in oxygen-free toluene [5]. Using the newly synthesized emitters OLED exhibiting maximum current and external quantum efficiencies exceeding 15cd/A, and 7%, respectively, were obtained and characterized.

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A CONTEMPORARY VIEW AND THE FUTURE VIABILITY OF BIODEGRADABLE POLYMERS

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The development of the world economy is closely linked to polymer production technology. The current dynamics of polymer waste generation, taking into consideration various measures, is illustrated in the graph (Fig. 1) [1].

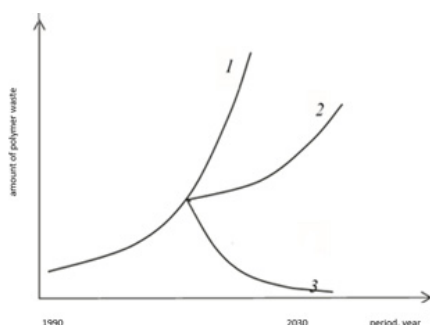


Fig.1. 1- uncontrolled waste;
2- use of government and legislative measures;
3- use of biodegradable polymeric materials

Judging by this relationship, the more effective method of reducing polymer waste is the development of biodegradable polymers, that is, the polymers, which preserve the performance characteristics only during use, and then they experience physical, mechanical, and biological transformations by external factors (light, temperature, moisture, water), and are easily integrated into metabolic processes of natural biosystems. At this time, high-molecular substances break down into low-molecular (water and carbon dioxide) humic substances and biomass. There occurs natural circular flow of substances, by maintaining the ecological balance in nature

[2, 4]. There are two major classes of biodegradable polymers: natural (starch, cellulose, chitin, chitosan); synthetic, which can be of two types – produced by polymerization (polyethylene, polypropylene, polystyrene, polyvinylchloride) and by polycondensation (polylactides, polyesters, etc.), the process of their disintegration is possible by action of light rays (photo-degradable), microorganisms (biodegradable) and chemical substances [3, 5]. There are three main areas, where the use of biodegradable polymers is required: Environmental Protection, Medicine and Food Industry [6].

Biodegradability of polymeric materials is conditioned by their chemical properties, macromolecule structure, equal distribution of supplements in polymeric mass, and by technological parameters [5]. Finally, it should be noted that in the field of the creation of biodegradable polymers, the intensification of research is important not only for further development of the biodegradable materials market, but also for solving one of the global environmental problems related to environmental pollution by polymer waste.

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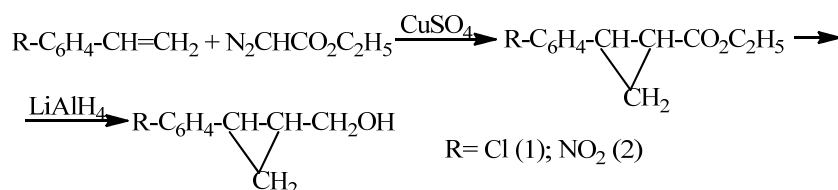
SYNTHESIS, COPOLYMERIZATION OF PHENYLCYCLOPROPYLMETHACRYLATES WITH GLYCIDYLMETHACRYLATE AND THEIR PROPERTIES

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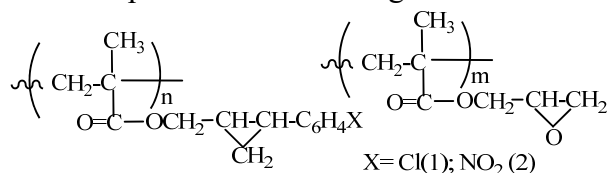
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Now, the researchers are faced with the task not only to improve the technological characteristics of photoresists used in photolithography, but also to obtain new polymeric photosensitive materials and revealing the optimal conditions of their use. This explains the relentless interest of researchers to preparation of new types of the negative photoresists meeting the definite purposes. This work has been devoted to the synthesis of the polymer photosensitive materials in order to create new negative photoresists on their basis. The photosensitivity of the obtained polymers is $55 \text{ cm}^2 \cdot \text{J}^{-1}$. It has been firstly studied the addition of carboethoxycarbene forming in interaction to para, nitro and chlorostyrene in the conditions of thermocatalytic decomposition of ethyl diazoacetate in the presence of anhydrous CuSO_4 on the following reactions and then by establishment the compounds 1 and 2 have been obtained:



The synthesis of phenylcyclopropylmethacrylate (PhCMA) has been realized by interaction of (1) and (2) with chloranhydride of methacrylic acid in the presence of pyridine, and then their radical copolymerization with glycidylmethacrylate (GMA) has been carried out. According to the spectral data the obtained copolymers correspond to the following structure:



The radical copolymerization of PhCMA (M_1) with GMA (M_2) was carried out in a mass and in a benzene solution under action of dinitrile azoisobutyric acid at 70°C for 4 h. In all studied compositions of the initial monomer mixtures, the reaction proceeds without an induction period with constant initial rate.

The copolymer was precipitated by sulphuric ether and dried in vacuum. As a result, the polymer in the form of a white powder was obtained with high yield (88%); the copolymer characteristic viscosity was determined in benzene at 20°C and it was 0.57 dl/g . The data of IR- and PMR-spectroscopy data indicate the behavior of the polymerization of copolymers of vinyl bonds and are evidence of behavior of the selective vinyl polymerization on the radical mechanism of PhCMA. As a result of the copolymerization of PhCMA with GMA, the reactive fragments remain unaffected in the side chains. The copolymerization constants of PhCMA with GMA have been calculated on data of the copolymer composition determined on an epoxide number by Fineman- Ross equations, which are $r_1=0.57$, $r_2=0.65$.

SYNTHESIS OF OPTICAL TRANSPARENT POLYMER ON THE BASIS OF p-CHLOROPHENOXYCARBONYLCYCLOPROPYL STYRENE

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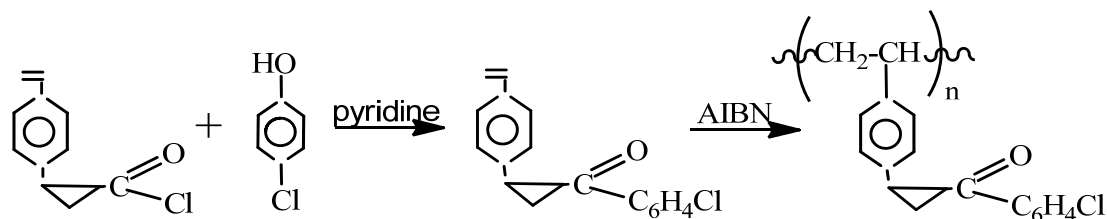
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The polymers and copolymers on the basis of cyclopropane monomers have a unique complex of valuable exploitation properties and can be successfully used in various fields of science and technology as photosensitive and optical transparent materials. This work has been devoted to the investigation of synthesis of the polymerization and study of the optical transparent properties of the obtained polymer.

The radical polymerization of CPhCPS was carried out in a mass and in a benzene solution under action of dinitrile azoisobutyric acid. This polymerization proceeds in the studied conditions without induction period with constant initial rate considerably exceeding the styrene polymerization rate. It has been revealed that an introduction of the chlorine atom into phenyl ring has an essential influence on polymerization rate. As a result, the polymer in the form of a white powder was obtained with high (85%) yield. It has been shown that at 70°C the polymerization of CPhCPS in benzene is characterized by usual kinetic regularities, i.e. the polymerization rate is proportional to monomer concentration in the first degree and initiator concentration in the degree of 0.5.

The data of IR- and PMR-spectroscopy indicate the behavior of the polymerization on vinyl bonds and are evidence of behavior of the selective vinyl polymerization of CPhCPS on the radical mechanism. The synthesis of CPhCPS and its polymerization proceeds on the following scheme:



The obtained polymer was dissolved in benzene and precipitated by methanol: dried in vacuum to constant mass at room temperature. The polymer solution viscosity was determined in benzene at 20°C in Ubbelohde viscometer $\eta=1.0$ dl/g. It has been revealed that this polymer has a high optical transparency – $n_D^{20}=1.607$ and its light transmission is 88%. It has been shown that this cyclopropane-containing polymer exceeds some plastics with exceptional transparency, differing in light transmission in a wide range including the UV- spectrum. It has been revealed that a good complex of physical-mechanical properties of this polymer is kept in the temperature range from - 50°C to 80°C, and also the products prepared from this polymer retain transparency up to 200°C in their aging for 3 hours. In addition, this polymer has good impact resistance, processability and other properties.

SYNTHESIS OF AMIDE TYPE HOMO – AND COPOLYMERS

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Linear structure homo- and copolymers based on carbamide and thio-carbamide were synthesized in water solution. Methanal was used as aldehyde component. Synthesis was carried out at 95°C.

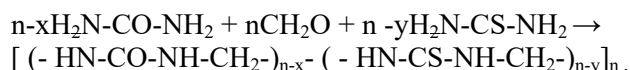
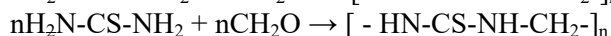
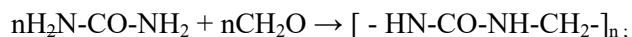
It was shown that equivalent ratio of amide and aldehyde components should be considered optimal.

Succession of introduction of components into reaction medium makes impact on polymer structure. When aldehyde components are introduced into reaction by stages, excess of amide components is preserved and polymer structuring doesn't occur.

In the process of reaction methylol groups are formed and their content decreases at the increase of temperature and decrease of pH.

Infra-red spectroscopic study showed that -NH- groups are preserved in the oligomer, referring to the fact that at such conditions spatial structure is not formed.

Simplified scheme of reactions of creation of homo- and copolymers is as follows.



$$n = x + y$$

Properties of polymers were studied. The obtained polymers can be used as biodegradable nitrogenous fertilizers acting by prolongation mechanisms, which will enable us to avoid global pollution by nitrogenous fertilizers.

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Abstract

DEVELOPMENT OF TECHNOLOGY FOR PRODUCING HIGH-TEMPERATURE INSULATING MATERIAL OF SANDWICH TYPE BASED ON PERLITE AND PHOSPHORIC ACID

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The work relates to the actual topic - the creation of high-temperature composite insulation material of sandwich type, on the basis of which it is possible to manufacture high-efficiency thermal installations. A technology has been developed for the production of sandwich-type thermal insulation materials, for which the local raw materials perlite and refractory clay were used. Orthophosphoric acid was used as a binder. In addition, for the manufacture of sandwich panels of various types, high-temperature zirconium oxide and talk made from durable fibrous fabric materials were used. Samples of a sandwich type developed by us showed high strength up to 2.5 MPa, which is 4-5 times higher than the strength of a non-sandwich material of the same type.

A model was made of a composite sandwich material, on the basis of which three types of sandwich panels were created and their thermal insulation properties were studied on the example of a specially created high-temperature (1100⁰C) furnace. It was found that at a temperature of the inner wall of the furnace 1000⁰C, the temperature of the "outer" wall of the furnace did not exceed 65 - 90⁰C.

Abstract

CROSSLINKING DEGREE EFFECT ON SHAPE MEMORY PROPERTIES OF IRRADIATED POLYETHYLENE

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Crosslinking is the dominant process when polyethylene is irradiated under inert atmosphere. Its degree depends not only on the dose and rate of gamma irradiation, but in case of technical applications, additionally on the presence and content of additives used to give the product all necessary properties. Heat-shrink polyethylene is a special type of crosslinked polyethylene which shape memory properties are especially influenced by the content and topology of crosslinked structures. Understanding the shape memory properties of heat-shrink polyethylene as derived from the network topology at the molecular level make possible to develop new products with improved properties.

In this work the shrink ratio was evaluated in connection with the gel content and compositions of polyethylene compounds irradiated at different irradiation conditions.

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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Abstract

ALGINATES FILMS FOR WOUND HEALING APPLICATIONS

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Alginates are naturally available anionic polysaccharides derived from marine algae. It is a promising biomaterial particularly in the field of wound care management, due to its availability and least toxicity. Nano particle-based drug delivery systems are revolutionizing the field of medicine by significantly improving the therapeutic efficacy and reducing the side effect of clinically established drugs. They have caused significant impacts on the biomedical applications. The major limits of some important drugs with hydrophobic agent such as Curcumin have the poor solubility and wettability it will leads to poor bioavailability and reduction in therapeutic efficiency. These challenges are addressed in this work presented here. This work is particularly focused on the preparation and the characterizations of cross-linked alginate films loaded with curcumin nano particles. These Nano Curcumin loaded alginate films can perform as potential wound dressing material, and also it provide a greater water-absorption welling stability, bioavailability minimal solubility and are capable to maintain their integrity up to a week due to the presence of curcumin nano particles more over the Nano curcumin loaded films exhibit a significant antimicrobial activities against S.aureus and E. coli. In summary, alginate-Nano curcumin loaded films suitable to formulate as an antimicrobial wound healing films.

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Abstract

EVALUATION OF THE CATION-EXCHANGE SORPTION MECHANISM OF THE COMPOSITE PEAT-CHITOSAN SORBENT

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pH-meter estimated the cation-exchange sorption mechanism of the composite sorbent based on peat and chitosan. Processes were carried out in a static mode. The studies were carried out on the basis of a model solution of 0.1 N NaCl. As a standard for comparison, similar experiments were also carried out on a cation exchanger (KU-2-8). Such a comparison indicates the ion-exchange mechanism of the adsorption of cations on the surface of peat and peat-containing materials.

Organic components of peat, in particular humic substances, are primarily responsible for providing negatively charged adsorption sites on which metals are bound by several mechanisms. The main mechanism of peat sorption can be considered an ion-exchange mechanism, however, due to the fact that there are many other functional groups on the peat surface, such as alcohols, aldehydes, carboxylic acids, ketones and phenolic hydroxides, peat has a high capacity of complex formation. Thus, there may be other mechanisms for the binding of metal ions on the peat surface (for example, complexation) [1].

It is important to evaluate the ion-exchange mechanism of peat-containing sorbents. In particular, composite peat-chitosan sorbent. Peat modification was carried out according to the procedure given in [2].

Sorption on chitosan is not ion exchange in nature, as compared with samples of peat and activated peat, the pH decrease in this case is the lowest.

The mechanism of adsorption of peat and peat-containing materials (sorbents) is (besides other types of adsorption) cation-exchange character. The identity of the pH change profiles of these materials with the pH change profile of the cation exchanger indicates that the ion-exchange adsorption mechanism is taking place.

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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 monodisperse latexes. The report demonstrates electron photographs of particles of the latexes synthesized based on chloroprene, styrene and vinyl acetate.

Abstract

STRUCTURE AND PROPERTIES OF MICROFIBERS OF L-POLYLACTIDE

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Poly lactide materials (PLA) are currently widely used in medicine as resorbable sutures. As many researchers has shown in recent years, PLA is a promising material for the production of polymer matrices for tissue engineering. An interest to PLA fibers, films and composite materials based on it has evidently increased in connection with the development of transplantology and reconstructive medicine.

It is known that the properties of polymers, in particular the kinetics of their destruction in active media under the action of mechanical loads, depends on the morphology of fibers or films, the parameters of the crystal structure. In particular, it is shown that PLA crystallizes well. It is characterized by two crystalline modifications, α and β . Polymorphic transformations of PLA crystallites are possible under the action of temperature and tensile stresses. The transition of the crystal structure from α - to β -modification is possible only under thermal stretching under the action of tensile stresses. Meanwhile, the relationship between the α and β structure and the strength of the fibers has not been proven. X-ray and colorimetric measurements performed on the fibers demonstrated the contribution of both structures to the strength of the fibers.

The study of the crystal structure of PLA fibers and films was carried out over a number of years; however, insufficient attention was paid to the study of the structure of microfibers obtained from a solution by electrospinning. Therefore, the aim of the work was to study the structure of microfibers from L-PLA, as well as the effects of heat treatment on the strength and deformation properties. Microfibers from L-PLA were obtained by electrospinning on a "Nanon-01A" installation (MECC Co., Japan). The deposition of microfibers was carried out on a rotating receiving electrode in the form of a metal tube 1.0 mm in diameter. The rotational speed of the tube was 500÷2500 rpm. The obtained PLA tubes were subjected to heat treatment at temperatures from the interval $T=40-160^{\circ}\text{C}$ in isothermal mode, the exposure time was 60 min. The structure of microfibre tubes was studied using a Supra 55VP scanning electron microscope (Carl Zeiss, Germany). The crystal structure was studied by X-ray diffraction on Bruker D2 PHASER (Germany) using $\text{CuK}\alpha$ radiation. The crystallite sizes were calculated by the Scherrer formula. Thermal properties were determined by DSC. The mechanical properties of the materials were investigated using an Instron 5943 tensile testing machine (England).

The orientation of microfibers in a tubular sample was found to depend on the speed of rotation of the receiving electrode. There were no diffraction maxima on the X-ray diffractogram of the fibers obtained by the electrospinning, that indicates an amorphous structure of microfibers. The treatment at $T=70^{\circ}\text{C}$ significantly changes the diffraction pattern: narrow diffraction maxima of different intensity appear, that testifies to the presence of crystalline regions in the heat-treated PLA fibers. A further increase in temperature up to 160°C has little effect on the diffraction pattern. The crystallization of the PLA microfibers during the heat treatment process is confirmed as well by the results of the DSC study.

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Abstract

POLYLACTIDE AND ITS MODIFICATION - BIODEGRADATION, COMPOSTING, APPLICATION

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Currently, the most common biodegradable polymer at industrial scale is polylactide (PLA). Next to PLA, poly(hydroxybutyrate) (PHB), poly(glycolic acid) (PGA) and natural-based polymers like starch and cellulose are of scientific and industrial interest as well. Each of above mentioned polymers has many different advantages and disadvantages. PLA is a thermoplastic aliphatic polyester of bio-origin as it can be derived from renewable biomass like fermented corn starch, cassava, sugar cane and other plants. There are many types of PLA or its modification differing in ability to crystallization, thermal properties, processing parameters and thus application. From chemical point of view one has to take into account that in case of using racemic mixture of L- and D- lactide for PLA polymerization we obtain poly- DL- lactide (PLLA), which is amorphous. In the presence of stereospecific catalyst PLA crystalline can be obtained. From physical point of view PLA can be modified by different small molecular weight nucleants, high molecular compounds or compatibilizers when blends are created. It has been certified as compostable polymer within 6 months in industrial condition (58 °C degree, humid environment). It degrades very slowly at ambient temperature or marine environment. For the time being it can be applied in medicine, 3D printing technology, tobacco industry, packaging industry or industry of single use products. The last application could be questionable for Europe after publication of The Single Use Plastic Directives by the Council of the European Union on 15 April 2019 which entered into force on June 7, 2019. This fact opens the discussion about organization of organic composting of polymers, separation of compostable polymers from the main stream of plastic wastes and in the end about life cycle analysis/assessment (LCA). It is underlined that LCA, although has many scientific overworkings and tools is not enough taken into account in practice, especially when the influence on environment of the materials coming from various sectors are compared.

Acknowledgment. This work was supported by the Gdansk University of Technology and National Center for Research and Development.

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Abstract

3D PRINTED FLEXIBLE STRUCTURES FOR TISSUE ENGINEERING: DESIGN AND DEGRADATION STUDIES

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In the branch of regenerative medicine many different scaffolding techniques for tissue porous constructions have been developed so far. These methods include electrospinning, solvent casting combined with particle leaching, gas forming or thermally induced phase separation [1]. However, the limitations of most of these methods are inadequate control of the distribution of pores and porosity as well as the repeatability of scaffolds quality [2]. The possibility to design and optimize the final porous structure before fabrication can overcome these drawbacks. Nowadays, additive manufacturing (AM) technologies (3D printing-3DP) combined with computer modeling (computer-aided drafting CAD) are the most attractive methods of tissue engineering scaffolds production. But not only through a controllable 3D architecture but also through the availability of a variety of biomaterials and methods for their formation. Fused Deposition Modeling (FDM) is one of the 3D printing technology used in medicine. FDM involves deposition of melted material on a movable platform. Among the many available 3DP techniques, FDM stands out above all with the most favorable "quality / price" ratio. It also allows the use of both CAD models and images obtained from radiographic studies (computed tomography CT, magnetic resonance MRI). Therefore, it is also readily used in the production of customized details in medicine area [3]. The proper selection of biomaterial (biocompatibility, biostability or biodegradability and bioactivity) for tissue scaffold is a key aspect, however design, appropriate porous architecture and mechanical properties are equally important factors. Here we present research on new designs of porous 3D constructions which are adapted to 3D printing in FDM technology by using highly flexible polymer materials. The prototypes thus obtained were examined for use in tissue engineering as porous tissue scaffolds. Porosity and compressive strength were determined as well a short-term degradation studies were conducted. It was noticed that printed scaffolds matched the computerized model quite well with well-defined porous, but for further minimization of structures it is necessary to reduce the diameter of the printing nozzle (which allows to increase Z and XY resolution). The porosity of printed structures was between 63-72% and the compressive strength was within the range of 0.53-1.26 MPa, depending on the type of designed structure. The susceptibility to degradation in controlled conditions (28 days, 37°C) of printed porous structures allowed observation of processes and evaluation of used materials. It turned out that commercial filament (Bioflex, Filoalfa, Italy) is highly resistant to concentrated media (5M NaOH and 2MHCl), thus its use on degradable scaffolds is highly limited. However, it can be successfully used for 3D printing of highly stable and durable solid implants. Contrary to those materials filaments fabricated in our lab (Polyesterurethane, KTP) are eager to degrade in 5M NaOH.

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WATER SORPTION IN POLYESTER / DOLOMITE DUST / GLASS POLYESTER RECYCLATE COMPOSITES WITH NANOFILLERS

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These days composites are applied more extensively, especially for transporting structures, construction industry, electronics, sport and leisure. Fibre reinforced plastics are very strong and durable. They have been used as boat materials. In the world there are more than 23 million pleasure boats. Glass fibre reinforced plastics dominate the composites market accounting for approx. 95 % of its total volume. In Poland there are three producers of unsaturated polyester resins and gel-coats, one producer of glass fibre and reinforcements, and several hundred composites manufacturers with an overall production estimated at 80 000 tonnes/year. Production is mainly focused on marine applications, ranging from sporting boats and yachts to parts for big ships. A growing number of composite boats worldwide will create the problem of how to dispose of after-production waste and utilized boats in a sustainable way in the future. The best way of solving the problem with composite after-production waste is mechanical recycling via collection, shredding and milling down into fractions. The recyclate can then be reused as a filler in new formulations and has other industrial uses. Several studies have been reported on mechanical recycling of glass reinforced polyester waste in recent years [1-3].

This case study was carried out on the mechanical recycling of glass reinforced polyester waste shredded into smaller fragments. The recyclate can be added into polyester composites with dolomite dust. Nanofillers (modified montmorillonite) have been applied into composites with glass reinforced polyester waste. The purpose of the presented work has been observed the change of water uptake in the composites.

Water uptake can lead to a change in the physical, chemical, mechanical and dimensional properties of the matrix (hydrolysis, swelling as a function of its affinity with water). It has been found that there is a correlation between water absorption and discontinuities structure of composites [4]. The higher absorption indicates a greater number of defects in composites. It is therefore of big importance to characterize water absorption in the complicated polyester/dolomite dust composites with glass polyester recyclate and nanofillers. Sorption curves were obtained for composites to determine characteristic parameters, including the diffusion coefficient and the maximum water uptake.

The obtained results have showed that water uptake and the diffusion coefficient were clearly reduced in a result of the addition of nanofillers.

The recyclate can be applied only as a filler in building materials which do not require high strength. The composites with glass reinforced polyester recyclate can be used as countertops, parking curbs, construction barricades, insulation material and garden ornaments.

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Abstract

IMPACT OF INITIAL STATE OF POLYMER STRUCTURES OF KU-2-8 AND POLY-4-VINYLPYRIDINE ON IONIZATION IN INTERGEL SYSTEM

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As an alternative to the existing technologies of extraction of metal ions in hydrometallurgy is application of intergel systems. Remote interaction of the polymers in intergel system provides possibility to obtain highly-ionized polymer structures. The most important for the process of remote interaction is dissociation of ionized groups. As known polyelectrolyte undergoes ionization stage during dissociation when it interacts with solvent ions. Ionization of polymer structures in intergel systems is a relevant problem which is complicated by various factors. One of the major factors, which impact on ionization of the macromolecules is their initial state. The goal of this work is to study influence of the initial state (swollen/dry) of the polymers of ion-exchanger KU-2-8 and poly-4-vinylpyridine hydrogel (hP4VP) on the ionization process in intergel system.

The polymers in dry initial state in intergel system KU-2-8-hP4VP (dry-dry state) provides gradual increase of the specific electric conductivity with time. During mutual activation of the macromolecules areas of maximum ionization are observed: maximum ionization ratios are KU-2-8:hP4VP=3:3 and 2:4. At these ratio there is decrease of protons in the initial solution, what indicates to the high ionization of the macromolecules.

Dry state of KU-2-8 provides shift of maximum ionization to the ratio KU-2-8:hP4VP=5:1 in the intergel system when KU-2-8 is dry and hP4VP is swollen. Such shift occurs due to the fact that KU-2-8 is dry and unionized, while hP4VP is swollen. Ionization mainly occurs during association of hydrogen ions by the ion-exchanger's functional groups.

Swollen initial state of the ion-exchange resin KU-2-8 shows that maximum ionization of the initial macromolecules occurs at ratio 4:2 when hP4VP is in dried initial state. Almost the same values of the conductivity are observed at ratio KU-2-8:hP4VP=5:1. In other words it can be said that maximum areas of ionization are these ratios. There is formation of optimal conformation during intermolecular changes of each polymer.

In case when the intergel system KU-2-8-hP4VP consists from the swollen hydrogels the values of the specific electric conductivity are not very high. This phenomenon points to the fact that hydrogels are almost in equilibrium state. Nevertheless the exact maximum is observed at ratio KU-2-8:hP4VP=2:4.

The final conclusion about maximum ionization cannot be made only due to the data on specific electric conductivity. High values of this parameter may also indicate to the prevalence of dissociation process over proton association process. Highly ionized structures with optimal conformation are observed in intergel system KU-2-8 : hP4VP (swollen-swollen state) at polymers ratio 2:4. Completeness of the process of remote interaction can be shown by the measured concentration of H⁺ ions after equilibrium. With the decrease of [H⁺] concentration sorption ability of the intergel system in relation to low-molecular ions increases.

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Abstract

SEPARATION OF ENANTIOMERS OF ANTIMICOTICS USING POLYSACCHARIDE BASED CHIRAL STATIONARY PHASES

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Separation of enantiomers is an actual problem of modern chemistry, which has both theoretical and practical significance.

Polysaccharide derivatives, in particular phenylcarbamates and cellulose and amylose esters, are widely used in high performance liquid chromatography to separate enantiomers.

We have investigated the separation of some chiral antimicrobial drugs using polysaccharide-based chiral selectors with polar-organic and reversed mobile phases. The influence of the structure of polysaccharidal chiral selector and the composition of the mobile phase on separation of enantiomers was studied. The structure of chiral selector, in particular, as the structure of the main chain, the nature and position of the substituents in aromatic ring, has significant impact on separation of enantiomers. The enantiomers of ornidazole were resolved baseline on amylose-based columns, but were not separated on cellulose tris(3,4-dichlorophenylcarbamate) and cellulose tris(3,4-dimethylphenylcarbamate)-based columns and were partially separated on Lux Cellulose-2 and Lux Cellulose-4 columns. The separation of thioconazole enantiomers on Cellulose-2, Cellulose-4 and cellulose tris(3,4-dichlorophenylcarbamate) is baseline, while they are not separated on cellulose tris(3,4-dimethylphenylcarbamate)-, cellulose tris(2,4-dichlorophenylcarbamate)- and cellulose tris(2,5-dichlorophenylcarbamate)-based chiral columns. Similar results were obtained for enantiomers of several other drugs. Full enantioseparation of itraconazole enantiomers was obtained using Cellulose-4 column with 3% water content in the mobile phase, but were not separated using Cellulose-2 column, in spite of the fact that both columns have similar chiral selectors with just difference in positions of substitution in phenyl moiety. Addition of ammonium acetate to mobile phase improves the separation. Addition of water affects both, separation of enantiomers and their retention. Addition of water in case of methanol as a mobile phase increased retention times, but with acetonitrile the trend was different, small concentrations of water decreased retention times firstly but after increasing the percentage of water in mobile phase, values of retention times were increased.

The order of elution changes under the influence of the composition of the eluent and the nature of the stationary phase.

Abstract

CHEMISTRY OF PSEUDO-PROTEINS AND RELATED SYNTHETIC AMINO ACID BASED POLYMERS

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Proteins are one of the most appropriate biomaterials for a variety of biomedical applications including resorbable surgical and pharmaceutical devices owing to their innate affinity to tissues, enzymatic biodegradability with releasing “the bricks of life” - α -amino acids (α -AAs) which could be assimilated by the organism promoting in that way tissue regeneration. However, the proteins have some serious shortcomings among which the most important is *immunogenicity* that is attributed to their molecular architecture.

More promising are α -AA based synthetic biodegradable (AABB) polymers having a new macromolecular architecture less recognizable by the immune system of the living organism. The presentation deals with an overview of the main families of the α -AA based synthetic polymers such as poly(amino acid)s, pseudo-poly(amino acid)s, polydepsipeptides, and provides somewhat more expanded information about the fourth class - so-called pseudo-proteins [1,2] which represent relatively new and broad family of the biodegradable polymers qualified for numerous biomedical applications [3-8]. A new class of pseudo-proteins – the polymers composed of non-proteinogenic amino acids were obtained as well [9]. These new polymers are expected to have as wide range of biological activities.

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IMPROVEMENT OF BIODIESEL QUALITY WITH NANO-COMPOSITIONS

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Biodiesel is the common name that has been given to mono-alkyl esters of long chain fatty acids derived from vegetable oils or animal fats through the process of etherification. Biodiesel is a clean, renewable, alternative to common petroleum fuel, made from natural vegetable oils, and/or animal fats, i.e. from bio resources. Biodiesel is a high quality fuel, which can be used in any segment of industry where petro-diesel is used, including the internal combustion engines.

The presented work is aimed at creating a complete model for production cycle of biodiesel from various bioresarches, including rapeseed oil, as the main raw material for production of biodiesel fuel, as well as waste edible oil from catering facilities. For the first time in the history of Georgia, a full technological cycle has been developed for production of biodiesel fuel on an industrial scale using innovative methods that will benefit the economy of Georgia, the environment, create new jobs, improve the ratio of exports and imports and ensure the development of energy-saving technologies.

B100 biodiesel fuel was produced by the company “Biodiesel Georgia”. The by-product of the production, glycerin, is used for production of technical detergents, and pure glycerin can be used in medicine and the perfume industry. Composites of biodiesel and mineral diesel B10 and B20 were made.

Biodiesel, as one of the most effective, affordable, and carbon-neutral renewable fuel, can reduce the exploitation of fossil fuels, thus contributing to curbing greenhouse gases (GHG) emissions and reduction of anthropogenic global warming factors. Biodiesel can be especially useful in urban areas, where concentration of vehicles is high and the air is polluted with the harmful emissions from the internal combustion engines of vehicles.

The oil and acid composition of biodiesel fuel has been studied and identified through liquid chromatography and the functional groups of the fuel were analyzed using a Fourier IR spectrometer. Based on the 0results of the research, an improved nano-composition of biodiesel has been offered, which, while maintaining the highest quality and meeting the demands of EN 14105, ASTM D 6751 and EN 590 standards, can significantly reduce harmful emissions. The improved physical and chemical parameters of biodiesel will allow using of this eco-friendly, renewable bio fuel and its blends in almost all kind of internal combustion diesel type engines serving as a reliable, alternative fuel for sustainable city transport and reduction of GHG emissions.

The quality of the fuel is extremely important for consumers, especially those from transport sector, where diesel type internal combustion engines are used. The high quality of the fuel ensures high output of the engine as well as economy and long life cycle of the mechanisms. The fuels, including biodiesel, are required to maintain quality parameters for months. We have designed a new nano-composition for biodiesel fuel which extends the life cycle of biodiesel at the same time maintaining all parameters at the highest level.

It is established that the nano-composition of biodiesel allows you to use fuel in its pure form, that is, B100, and/or mixed with petroleum diesel fuel. The storage time of biodiesel with nano-composition has significantly increased and the fuel maintained its top quality for more than one year.

Abstract

SYNTHESIS OF NEW PSEUDO-PROTEINS BY INTERACTING BIS-AZLACTONES WITH DIAMINE-DIESTERS COMPOSED OF NON-PROTEINOGENIC AMINO ACIDS

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A new family of pseudo-protein (PP) biomaterials composed of non-proteinogenic amino acids are of special interest of modern biomedicine and nanobioengineering since they can influence biological processes and be cleared from the body after the fulfillment of their function. The most unique biological property of these materials is their support of cell adhesion and proliferation; besides, they have been evaluated for some unique biomedical applications ranging from stent and suture coating, vascular patches, biodegradable nanoparticles for drug delivery, 3D tissue printing, 3D microporous hydrogel scaffolds for stem cells tissue engineering, burn wound treatment, non-viral gene vectors to synthetic vaccines.

One of the most important classes of PPs are amino acid-based poly(ester amide)s (PEAs). These polymers combine all advantages of “parent polymers” - aliphatic polyesters and polyamides: ability of biodegradation, a high affinity to tissues and, hence, good compatibility with them. The scopes of applications of PEAs can substantially be expanded by their functionalization through the incorporation of chemically active and/or hydrophobic groups into the backbones or lateral chains. Functional PEAs can bind covalently or non-covalently various bioactive compounds.

One of the cheapest and effective ways to render polymers functional is incorporation of hydrophobic fragments into the macromolecules. For hydrophobic modification of polymers we have selected so called “Oxazolinone Method” because the basic monomers – *p*-phenylene-bis-oxazolinones (“bis-azlactones”) are high active bis-electrophilic compounds [1]. Another way for functionalizing the PPs is the application of bis-nucleophilic monomer composed of based on non-proteinogenic α -amino acids containing unsaturated lateral substituents.

The present work deals with the successful synthesis of new PEAs by solution polycondensation of bis-azlactones and diamine-diester made of non-proteinogenic amino acid as stable di-*p*-toluenesulfonic acid salts. The synthesized polymers were characterized in terms of yield, elemental analysis, and GPC.

The obtained new PPs showed relatively low-molecular-weights (M_w within 2,800-6,600 Da, GPC in DMF). They are of interest for synthesizing functional polymers by means of polymeranalogous transformations using unsaturated lateral groups of non-proteinogenic α -amino acids.

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Abstract

WOOD FLOUR AS A FILLER OF ELASTOMER BLENDS CONTAINING CHLOROSULFONATED POLYETHYLENE AND STYRENE-BUTADIENE RUBBER

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Fillers are inherent elements of elastomer blends. At present, rubber products are practically only produced with fillers. Depending on their activity, they can perform various functions. Passive fillers are used to reduce the cost of the composition. Active fillers, in addition to the economic aspect, are used to improve the performance properties of rubber products. In the elastomer technology, among various types of fillers, including fiber fillers and synthetic resins, mainly carbon black and mineral fillers are used. Nowadays, scientific trends in the field of nanotechnology have also resulted in the distinction of nanofillers as a separate group.

However, novel trends in science are also focused on the environmental aspects. The production of biodegradable materials, as least burden on the environment, is strongly promoted by society. In elastomer technology wood flour (WF) can be used as a greening filler. Wood flour, which is well pulverized wood, is classified as organic powder filler. The usage of WF as a filler of elastomer blends is limited – it has been used mainly to fill vulcanizates of natural rubber (NR) or epoxidized natural rubber (ENR) [1, 2]. Moreover, WF has little compatibility with the polymer matrix. Therefore, modified wood flour is used in the processing of polymers. Several modification methods are described in the literature, including acetylation or alkaline modification [3, 4]. Modified WF is mainly used to prepare composites containing polypropylene (PP).

The purpose of this work was to modify wood flour and afterward to determine the effect of modified wood flour on the crosslinking degree of elastomer blends and properties of their vulcanizates. Wood flour from softwood (WFS; wood flour from coniferous trees) was used for the study. The modification was performed by the WFS heating or by the WFS extraction in the vapors of boiling acetone or toluene. The elastomer blends were made of chlorosulfonated polyethylene and styrene-butadiene rubber (CSM/SBR). Copper(I) oxide (Cu_2O) or Copper (II) oxide (CuO) were used as crosslinking agents. The results indicate that the use of modified WF affects the increase of crosslinking degree. The mechanical properties of vulcanizates containing unmodified and modified WF are comparable.

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Abstract

MATERIALS BASED ON GUAR GUM WITH THE ADDITION OF POLYMER MICROSPHERES FOR MEDICAL AND COSMETIC APPLICATIONS

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Guar gum is a natural polymer belonging to the polysaccharide group, used in various industries, including the cosmetics industry. This polymer is a reserve material for some faba bean plants (*Leguminosae*) and it is stored in the sapwood of their seeds. A particular advantage of guar gum is its biodegradability.

The aim of my work was to optimize the recipe of hydrogel materials based on derivative of guar gum, to investigate the physicochemical properties and influence of the obtained materials on skin parameters using a probe of corneometer, tewameter and colorimeter.

Aqueous colloidal solutions of guar gum were obtained and cross-linked with sodium tetraborate. Polymeric matrices were prepared, which differed in the amount of added plasticizer – glycerin. In order to determine the effect of glycerin on the functional properties of the materials obtained, the material without plasticizer was prepared. On the basis of organoleptic evaluation, the most optimal formula was selected and then enriched with gelatin microspheres with absorbed water-glycol extract of pot marigold flowers. This extract has moisturizing, anti-inflammatory, bacteriostatic, astringent and astringent properties and accelerates epidermal regeneration processes.

With the increase in plasticizer concentration, the stiffness of the matrices decreased and their plasticity increased. Increasing the glycerin content increased the ability of the obtained materials to swell, but at the same time decreased their stability in the environment by pH=5.5. TEWL value increased the least after application of hydrogel with addition of microparticles. The obtained matrices did not show any irritating or coloring effect on the skin. Based on the obtained results it was concluded that each of the prepared materials showed a strong moisturizing effect and these matrices could be used as cosmetic masks moisturizing the skin or as carriers of active substances in biomedical applications.

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Abstract

PREPARATION OF NEW MATERIALS BASED ON THE INCORPORATION OF MICROPARTICLES INTO COLLAGEN MATRICES

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Collagen is the most abundant biopolymer in animals and it possesses many interesting properties, e.g. biocompatibility, non-antigenicity, non-toxicity. For this reason, collagen is regarded as one of the most useful natural biomaterials. This protein is also a common constituent of many cosmetic products. At present, the main sources of type I collagen are bovine or porcine dermis. However, due to outbreak of Bovine Spongiform Encephalopathy (BSE) and Transmissible Spongiform Encephalopathy (TSE) in pigs, cattle, use of collagen and collagen derived products from these sources have been limited. Type I collagen has also been extracted from skin, bone, fins, and scales of fresh water and marine fishes. In the present study, collagen was isolated from scales of *Esox lucius*.

Present study focuses on preparation and characterization of new collagen-based materials through incorporation of microparticles into the collagen matrices without modifying significantly their microstructure. Microparticles are small beads (1-500 μm) with the potentially very broad application in medicine, pharmacy and cosmetology. Microparticles can be the base for working out a system for active substance controlled release.

In this work microparticles made of gelatin and poly(vinyl alcohol) were prepared. The obtained microparticles were loaded with the *Calendula Officinalis* flower extract or retinol and they were incorporated into the collagen matrices. The prepared materials were characterized using scanning electron microscopy, ATR-IR and UV-Vis spectroscopy. The properties of matrices, such as porosity, mechanical and swelling properties were studied.

The results obtained suggest that incorporation of microparticles into collagen matrices can be used as modifying agent for preparation of new collagen-based materials for cosmetic and dermatological applications.

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Abstract

RHEOLOGICAL PROPERTIES OF PITCH-THERMOPLASTIC AS A PRECURSOR IN THE PRODUCTION OF CARBON MATERIALS

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Coal tar pitch is a heavy thermoplastic residue formed during the distillation of coal tar. It is a heterogeneous system of highly condensed carbo- and heterocyclic compounds and is capable of exhibiting polymeric properties.

Coal tar pitch due to its unique properties is a promising and inexpensive raw material for the production of various carbon materials: carbon composites, solid foams, carbon fibers, adsorbents, etc. The main problem is that its rheological properties do not meet the requirements for the production of carbon materials. Coal tar pitch refers to non-Newtonian fluids, the degree of anomaly of which increases with decreasing temperature and with a small shear stress.

It has been established that when the temperature of the coal tar pitch changes in the range from softening point to 125 °C, a transition from elastic-brittle bodies to solid-like plastic and further to structured and Newtonian liquids is observed. At a temperature of more than 125 °C, coal tar pitch exhibits a Newtonian flow, due to the destruction of its coagulation structure, that is, it has a very low viscosity. This does not allow its use in the processes of obtaining carbon materials, which are carried out at higher temperatures.

The paper shows that pretreatment of coal tar pitch with polyvinylchloride (PVC) and polymethylmethacrylate (PMMA) allows to change and to control the viscosity of the pitch precursor.

By varying the time of modification and the amount of PVC and PMMA, it is possible to change the flow index of the resulting pitch-thermoplastic from 0.5 to 100 g/10 min (at 150 °C).

Modification of the coal tar pitch with polar polymers at the processing temperature of the pitch to 170 °C provides the obtaining of plastic material – pitch-thermoplastic with the specified rheological properties, which allows it to be used as a precursor in the production of carbon foam, carbon composites, and others.

The advantages of modifying coal tar pitch with polar polymers are the use of fairly low temperatures and the absence of any waste that allows solving ecological and energy-saving issues of obtaining a pitch precursor.

INVESTIGATION OF PROPERTIES OF NANOCOMPOSITES ON THE BASIS OF HIGH PRESSURE POLYETHYLENE WITH METAL-CONTAINING NANOFILLERS

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The development of a science of nanosized and cluster metal-containing particles in polymer matrices is stimulated by continuously growing interest for this problem in many fields of chemistry, physics and materials science. The development of such investigations has largely favored the creation of the metal-polymer composition materials with specific physical-mechanical and exploitation properties: increased heat- and electrical conductivity, high magnetic susceptibility, ability to screen ionizing radiation.

It was known that for improvement of exploitation characteristics of plastics there are used the fillers in a quantity of 30-50 mass %. The plastics are mainly used as construction material. In the modern world, the various types of the polymer composition materials on the basis of nanofillers actively displace traditional materials.

In this work it has been investigated the influence of additives of nanofillers (NF) containing nanoparticles (NP) of the copper oxide, stabilized by polymer matrix of maleinized polyethylene (MPE), obtained by mechano-chemical method on peculiarities of properties of composites on the basis of high pressure polyethylene (PE) by methods of X-ray phase (RPhA) and thermographic (TGA) analyses.

It has been shown that the introduction of 0.3 – 0.5 mass % of NF into structure of the composition leads to an increase of strength index from 11.39 to 14.06 MPa and deformation value at the break of the composite in 1.65÷1.95 times. This has been apparently connected with synergetic effect connected with availability of the copper-containing nanoparticles on matrix of MPE containing maleic groups, a mutual influence of which favors increase both deformation value and strength index. The investigation on Vicat heat stability of the obtained compositions showed that an introduction of filler into the composition of PE leads to an increase of heat stability index from 130 to 143 °C.

The derivatographic investigations showed that an introduction of NF containing NP of the copper oxide into structure of the composition favors the increase of half-decay temperature of the samples: T_{50} from 400 to 450°C; half-decay time $\tau_{1/2}$, is increased from 72 to 79 min., activation energy (E_a) of decay of thermal-oxidative destruction of the obtained nanocomposites is increased from 120.4 to 131.9 kJ/mol.

The obtained results indicate that small quantities of nanofiller (0.3 – 0.5 mass %), introduced into the polymer, obviously, play a role of the structure-forming agents – artificial nuclei of crystallization, which favors the appearance of a fine-spherulite structure in the polymer characterized by improved physical-mechanical, rheological and thermal properties of the obtained nanocomposite.

Abstract

THE INFLUENCE OF METAL-CONTAINING NANOFILLER ON THE RHEOLOGICAL PROPERTIES OF THERMOPLASTIC ELASTOMERS BASED ON ISOTACTIC POLYPROPYLENE AND ETHYLENE-PROPYLENE-DIENE ELASTOMER

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In recent years, polymer nanocomposites have attracted great attention of researchers due to the enhancement of their performance properties. The presence of nanofillers in the polymer matrix leads to the improvement of mechanical, thermal, electrical and rheological properties of polymers. Among the polymer compositions, mixtures based on polyolefins and rubbers occupy an important place. With a rubber content of up to 50-90%, fundamentally new materials are formed - thermoplastic elastomers (TPE), which combine the mechanical properties of rubbers at normal temperatures with the processing ability characteristic of linear thermoplastic polymers above their melting point.

The purpose of this work is to study the structure and features of the rheological properties of nanocomposite polymeric materials based on isotactic polypropylene (PP) and ethylene propylene diene (EPDM) using metal-containing nanoparticles (NPs) stabilized on a polymer matrix as nanofillers (NF).

The effect of nanofiller (NF) additives containing nanoparticles (NPs) of copper oxide stabilized by a high-density polyethylene polymer matrix, obtained by a mechanochemical method, on the rheological properties of mixed thermoplastic elastomers based on isotactic polypropylene (PP) and ethylene propylene-diene elastomer (EPDE) was studied. The viscosity, shear rate, shear stress, and the activation energy of viscous flow of the compositions are determined.

It is shown that when a PP/EPDE polymer mixture is filled with copper oxide nanoparticles (1.0 wt.pt.) at low temperatures, a regime close to Newton's regularity of the melt flow is observed, which is broken with increasing temperature, and a slight increase in the melt shear rate of the composite is observed.

The appearance of the rheological curves indicates the pseudoplastic nature of their flow with the demonstration of viscosity anomaly — a decrease in viscosity with an increase in shear rate characteristic of most polymers.

Based on the results of the study, it was found that the activation energy of a viscous flow of a composite filled with copper oxide nanoparticles is 1.5–2.0 times lower than that of the initial PP/EPDE mixture.

The data obtained indicates the possibility of processing nanocomposites by high-speed injection molding, which is necessary to obtain large parts in the automotive and aviation industries.

METAL-CONTAINING NANOCOMPOSITE EPOXY DIANE RESINS

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The epoxide resins by a number of their properties are distinguished among other polymeric materials. They are widely used as electro-isolation materials, binders for composition materials, are used for making the products of various functional purpose. With development of nanotechnology, it has been confirmed that the nanosized fillers have a greater effect on exploitation characteristics.

An addition of nanoparticles of filler to epoxide resin allows modifying and expanding the areas of their practical application. The carbon nanostructures, nanosized metal particles are widely used in the practice of modification of the epoxide resins.

The purpose of work – preparation and investigation of structure and properties of the nanocomposite polymer materials on the basis of epoxy diane resin (ED-20) with use of metal-containing nanoparticles (NP) stabilized on polymer matrix as nanofillers (NF).

In the work there have been used: epoxide resin ED-20 with epoxide number 22, polyethylene polyamine (PEPA), methylenedic anhydride (MEA), accelerator of hot curing UP606/2.

As NF it was used NP of the copper oxide I (Cu_2O) and zinc oxide (ZnO), stabilized on polymer matrix of the industrial high pressure polyethylene and obtained by mechano-chemical method in polymer melt. Content of nanoparticles – 5 mass.%, size – $11 \div 17$ nm, degree of crystallinity – $35 \div 45\%$. Ratio of components of composition (mass %): ED-20/PEPA/NF = 100/12/(0.25; 0.5; 1.0) and ED-20/MEA/NF = 100/100/(0.25; 0.5; 1.0)

For investigation of influence of nanoparticles on thermal resistance of epoxide materials, the compositions of "cold" and "hot" curing at ratios mentioned above have been prepared.

The curing was studied by a method of differential-thermal analysis (DTA) on derivatography of mark Q-1500D of firm MOM (Hungary). The tests have been carried out in the air atmosphere in the dynamic regime in heating of the sample $5^\circ\cdot\text{min}^{-1}$ from 20 to 500°C , sample 1– 00 mg, sensitivity of channels DTA –250mkW, TG-100, DTG-1 mV. The curing was carried out in platinum crucibles.

The influence of nanofillers containing nanoparticles of the copper and zinc oxides on peculiarities of properties of epoxy diane resin cured by PEPA and MEA+ accelerator of hot curing UP606/2 has been investigated.

It has been shown that the copper oxide nanoparticles increase the thermal properties of ED-20 and are the catalysts of the curing reaction, which is seen from height of the peak on curing curve. In this case, the zinc oxide nanoparticles practically do not influence on thermal properties of nanocomposites on the basis of ED-20.

TECHNOLOGY FOR PRODUCING HARD-COMBUSTIBLE EPOXY-AMINE COMPOSITES MODIFIED WITH COPPER(II) HEXAFLUOROSILICATE

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Composite materials based on epoxy resins are a unique type of polymer materials with an extremely wide range of applications in various industries and construction. Therefore, the requirements for combustibility, flammability of epoxy resins and their smoke-forming ability under burning, as well as toxicity of combustion products of epoxy polymer materials constantly increase. In this regard, it is extremely important to find new ways to reduce the combustibility of epoxy-amine polymers and use them to develop a new type of fire-resistant materials. The most promising way to solve this problem is the chemical modification of epoxy polymers, involving the use of reactive fire retardants. Here, special attention is paid to the application of transition metal complexes [1–4]. In particular, we have developed a unique fire retardant-hardener for epoxy resins to be as a chelate complex, composed of polyethylenepolyamine and copper (II) hexafluorosilicate. The curing process of epoxy-amine composites in the presence of a developed flame retardant-hardener has one distinguishing feature, which consists in the exceptional ability of the chelate complex to incorporate into the polymer framework of the composite producing chemical bonds with nitrogen-containing components, forming a polymer monolith thereby.

By incorporating a flame-retardant hardener into the epoxy polymer, the heat resistance of samples of the epoxy-amine composites is enhanced, and the amount of a coke residue increases. The application of the given fire retardant-hardener results in an increase in the ignition point and self-ignition point for the polymer composites obtained, a decrease in the maximum temperature of gaseous products of combustion and mass loss in burning of these epoxy-amine composites. The epoxy-amine composites modified with copper (II) hexafluorosilicate are the hard-combustible materials with moderate smoke-forming ability; these do not spread the flame which itself is able to go out [5, 6].

The optimization of the formulation and technology for producing epoxy-amine composite materials with lowered fire risk has been carried out. It is provided that such composites in practice can be used as glues for the manufacture of chipboards, as flame-retardant coats for wood, and as pouring polymer floors for industrial and administrative buildings. That approach allows reducing the fire load of various objects and the probability of the fires origination there.

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Abstract

COATING OF CORDIERITE MONOLITH SUBSTRATE BY WASHCOAT

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The main goal is the development and laboratory testing of ceramic filters modified by nanomaterials (nanocomposite) obtained via innovative technology. Ceramic filters containing nanosilver, nanomanganese dioxide and nanoiron oxide will be used in the model water purification process.

As nanofilter substrate we use the cellular-structure cordierite with a washcoat, on which a nanocomposite material will be layered. Cellular-structure cordierite substrate due to its small specific surface has to be layered by a porous aluminum oxide ($\gamma\text{Al}_2\text{O}_3$) with a large specific surface or by bohemite (AlOOH), in order to load sufficient amount of hybrid nanocomposite into cordierite.

Attempts to optimize primary layer of $\gamma\text{-Al}_2\text{O}_3$ (washcoat) coating of monolith honeycomb substrate as well as service characteristics of the washcoat are described. The optimum technology for filtering material has been developed. Cordierite substrate covered with wash coat is analyzed with SEM and EDS (Fig.1, Fig.2) The Coating is stability and homogeneity.

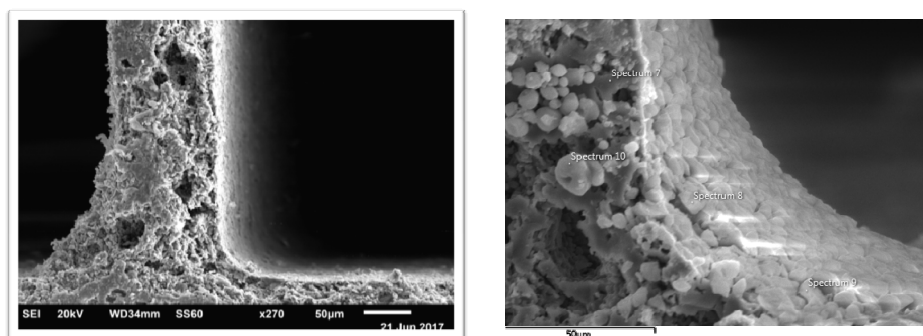


Fig.1 SEM images: a) Cordierite substrate b) cordierite substrate with washcoat

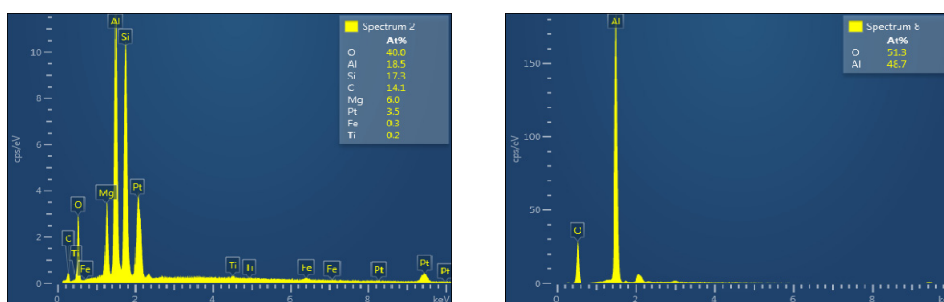


Fig.2 EDS Images a) Cordierite substrate b) cordierite substrate with washcoat

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Abstract

INVESTIGATION OF COMPLEX FORMATION PROCESS OF ZINC WITH FULVIC ACIDS, ISOLATED FROM NATURAL WATERS AT PH=9

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Natural macromolecular organic substances -fulvic acids (FA) take an active part in complex formation processes and stipulate migration forms of heavy metals in natural waters. In spite of researches, experimental data on stability constants of complex compounds of FA with heavy metals (among them zinc) are heterogenous and they differ in several lines from each other. 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 zinc (II) and FA was studied by the solubility method at pH=9,0. The suspension of ZnO was used as a solid phase. FA were isolated from Paravani Lake by the adsorption –chromatographic method.

In balanced solutions correlation $[Zn(II)_{total}]:[FA_{total}]$ on average equals to 1:0.22. 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 1/5 part of this associate inculcates into zinc'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 1675,5. 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 zinc (II) fulvate complex and stability constant.

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 $\log([Zn(II)_{total}] - [Zn(II)_{free}]) - m \log [FA_{total}]$

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 1,11. So in ZnO(solid) — Zn (II)(solution) — FA—H₂O system at pH=9,0, dominates zinc fulvate complex with the structure 1:1

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

$$F(L) = \frac{[Zn(II)_{total}] - [Zn(II)_{free}]}{[FA_{free}][Zn(II)_{free}]} = \beta_1 + \beta_2 [FA_{free}] \quad (1), \text{ where } [FA_{free}] = [FA_{total}] - [ZnFA] = [FA_{total}] - ([Zn(II)_{total}] - [Zn(II)_{free}]) \quad (2).$$

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: $\beta = 1.6 \times 10^4$

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

A NEW Pd(II)-SUPPORTED CATALYST ON MAGNETIC SBA-15 FOR THE SUZUKI REACTION

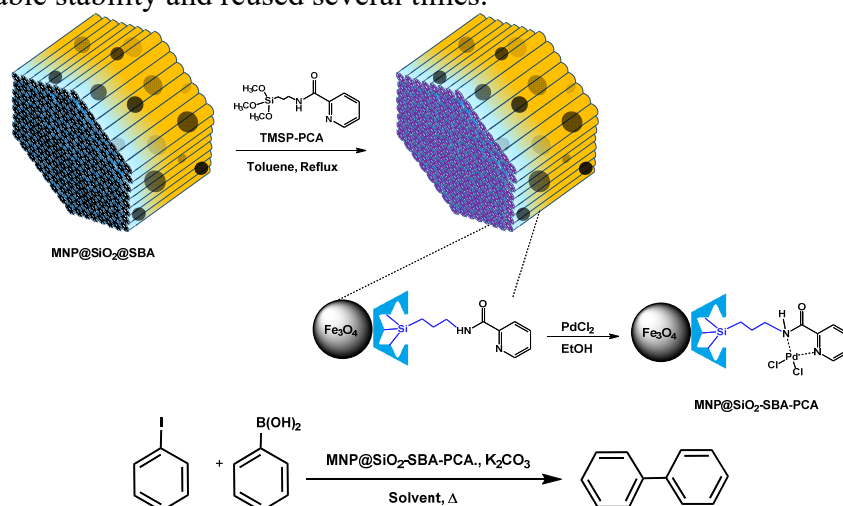
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In recent years, anchoring catalysts on magnetite nanoparticles (MNPs) has been extensively studied. MNPs are nontoxic, highly dispersible, biocompatible, and they have a high surface-to-volume ratio. Furthermore, MNP-supported catalysts enjoy the benefit of easy and rapid separation from different reaction mixtures magnetically [1]. It is highly recommended to coat MNPs prior any treatment, because they agglomerate intrinsically due to strong magnetic dipole-dipole interactions and high specific surface area [2]. The most popular way to overcome this problem is the using MNPs in the form of a composite with other metal oxides. Combination of MNPs with different forms of mesoporous silica such as MCMs and SBAs has been widely investigated in recent years [3-5].

In this work, magnetic mesoporous silica composite (MNP@SiO₂-SBA) was obtained via embedding magnetite nano-particles (MNPs) between SBA-15 channels, silylated with N-(3-(trimethoxysilyl)propyl)picolinamide (TMSPCA) and then complexed with Pd(II). The obtained supported Pd (II) catalyst (MNP@SiO₂-SBA-PCA) was characterized with conventional methods. Based on thermo gravimetric analysis (TGA) studies, the loaded amount of the complex was obtained 248.2 mg g⁻¹. The prepared magnetic catalyst showed high activity in the Suzuki reaction under optimal reaction conditions, including solvent, amount of catalyst, base and temperature. Wide range of aryl chlorides, aryl bromides and aryl iodides have been tested and the catalyst exhibited noticeable stability and reused several times.



Acknowledgment. This work was supported by the graduate council of University of Mohaghegh Ardabili.

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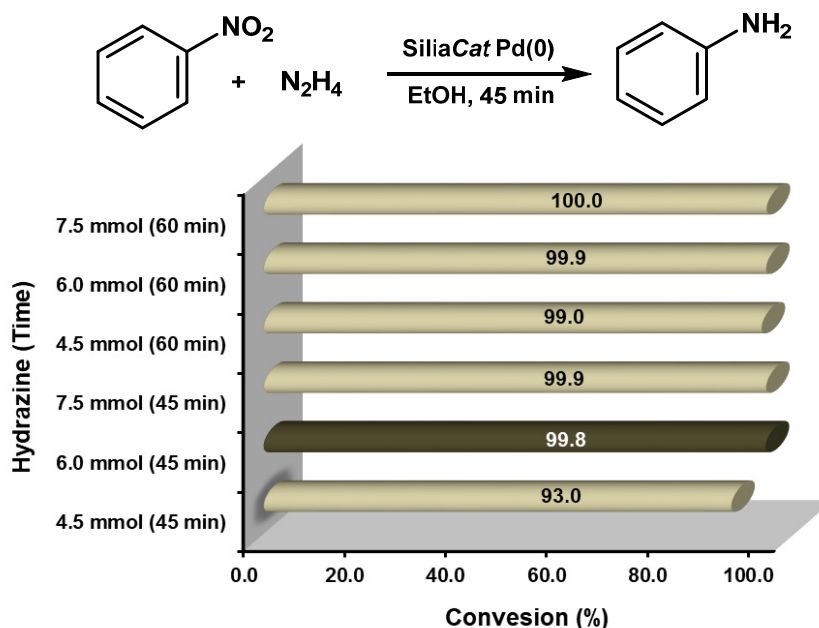
PD(0) ON THE SILICAT: AN EFFICIENT HETEROGENOUS CATALYST FOR REDUCTION OF NITBENZENE

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In recent years, the preparation of wide spectrum of supported Pd(II) catalysts for organic transformations has been reported [1]. Improving the reaction yields and decreasing reactions time, processes costs, and byproducts are some the results of these investigations [2]. The catalytic process for hydrogenation of nitrobenzene is an industrially principal reaction for the synthesis of aniline. About 85% of all over aniline in the world is produced by catalytic routes [3]. SiliaCat Pd(0) is a new series of patent-protected sol-gel-entrapped Pd nanocatalysts. It is made from highly dispersed Pd nanoparticles (*uniformly in the range 4.0-6.0 nm*) encapsulated within an organosilica matrix (made in Canada). The nanocatalyst was tested in hydrogenation of nitrobenzene. The SiliaCat Pd(0) (0.5 mol%) was dispersed in EtOH at room temperature, then a 2 eq NH₂NH₂ and nitrobenzene (1 mmol) were added into the reaction then stirred for 45 min. The reaction conversion was reach to 100%, as measured by GC analysis, by optimizing of the model reaction conditions. The catalyst exhibited noticeable stability and reused several times without significant loss of reactivity.



Optimizing of the reaction conditions of Ph-NO₂ reduction by SiliaCat Pd(0). Reaction conditions: Ph-NO₂ (3.0 mmol, Solvent 1.0 ml, Catalyst 6.3 mg)

Acknowledgment. This work was supported by the graduate council of University of Mohaghegh Ardabili.

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ATOMIC PROCESSES IN QUASIMOLECULE

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The quasi-molecule is formed by two colliding atoms in keV energy range when their nuclei are close enough for the atoms to interact. This is a short-living (femtoseconds) system by two atoms which form the quasimolecule as they come close (nanometers) together and decay in flight. Investigation of elementary processes in quasimolecule allows research of the fundamentals of atomic collisions and may lead us to understand the properties of the super-heavy atoms in advance [1]. During collision of two atomic particles, when atoms approach to distances, the smaller sizes of inner shell vacancies can be produced. The occurrence of large energy losses, production of inner shell vacancies, can be explained as a result of promotion of inner-shell electrons predicted by quasi-molecular-orbital (MO) theory, which is based on hydrogen-molecular-ion orbital wave functions approach. Investigation of Auger-electrons and x-rays by using coincidence methods of electrons or x-rays with scattering ions allows to determine a behavior of (MO), consequently to perform spectroscopy of quasimolecule [1].

The processes of bombardment by fast atomic particles in keV energy range with solid surfaces and emission of secondary atomic particles in different quantum states can be considered in framework of quasimolecular approach as well [2]. As quasimolecules we usually consider pair of systems: a) the bombarding atomic particle and a surface with their electronic states and b) an emitted atomic particle and surface with electronic states as well. Production of quantum states takes place at exchange interaction of electronic systems of approaching and escaping atomic particles from one side and electronic states of solid surface. Analyzing emitted particles using experimental methods allows to get important information about electronic and atomic states of surfaces [2].

Investigation of atomic processes of excitonic quasimolecule (biexciton), which is formed by spatially separated electrons and holes in surfaces, is significant and continues to grow for their wide application. Excitonic quasimolecule localized on the surfaces of the quantum dots in a nanoelements and formation of biexciton has a threshold behavior from distance between electrons and holes. The binding energy of the singlet ground state of excitonic quasimolecule has significantly large value, almost by two orders of magnitude, larger than the binding energy of the single crystal [3]. The binding energy of the excitonic quasimolecule comes from the electron–hole exchange interaction energy, which is greater than the contribution from the electron–hole Coulomb interaction. This effect allows to use the biexciton as an active medium of nanolasers, radiating in the infrared range and working on the excitonic transitions at room temperature, as well as a nanostructures based in a quantum computer. Consequently they demonstrate the possibility of creating new quasiatomic nanosystems – excitonic quasimolecules, with unique physical properties.

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Abstract

EFFECTS OF DYSPROSIUM ADDITION ON THE SUPERCONDUCTING PROPERTIES OF Hg-1223 HTS

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Preparation of Hg-based cuprate superconductors is labor-consuming. Particularly, these samples are prepared in closed quartz ampoules or by high-pressure methods. Such as the other high-temperature superconductors the Hg-based superconductors also have the problems of the weak links. Additionally, worsening of the weak links is related to the excitation of O₂ gas and Hg steam. Particularly, the HgO dismisses on O₂ gas and Hg steam in the process of syntheses and sintering. The second problem is that the synthesis of the Hg-1223 phase in a pure state is possible at high pressures, but at low pressures is difficult and it is feasible only in case when mercury oxide will be substituted by high valency atoms partly. In this case, the technique of the sealed quartz tube is useful for receiving of high purity high-temperature phase. Additives or substituent of the Hg-based superconductors by the appropriate metals or oxides can improve the nature of the grain boundaries, as well as promote the formation of the superconducting phase or introduce the effective pinning centers.

Therefore, the goal of this work was to investigate the effects of doping of Dysprosium (III) oxides on the physical and chemical properties of Hg-1223 material. Samples with composition HgBa₂Ca₂Cu₃Dy_xO_{8+δ} (x=0.0-1.2 wt.%) were prepared by the sealed quartz tube technique. The prepared samples were characterized by X-ray diffraction and FTIR spectrometer; physical properties were investigated by ac susceptibility and high harmonic. As a result, we could conclude that the presence of dysprosium oxide made the system more reactive and enhanced the kinetics of reaction, as well as the promotion of the high-T_c phase and enhances the transport critical current densities J_c.

Acknowledgment: This work was supported by Shota Rustaveli National Science Foundation (SRNSF), grant number: 217524, Project title: Influence of the polymerization and various dopants on the Hg-1223 superconductive properties.

Abstract

ADSORPTION OF MYCOTOXINS ON THE NATURAL RAW MATERIALS

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Mycotoxins are secondary metabolites of mold fungus, which have unwanted influence on human and animal organism, as well as on agricultural crops. Mycotoxin contamination of the food is the serious problem all over the world.

The mycotoxins, that represents special threat, are aflatoxins. Substrate and atmosphere relative humidity promote the production of aflatoxin. Aflatoxin is carcinogenic, teratogenic and mutagenic to humans, it represents toxic metabolite group produced by *Aspergillus flavus* and *Aspergillus parasiticus*. AFB1 is the most common and toxic among the secondary metabolites [1].

Among the preparations are used for the detoxication of aflatoxin, we have selected an adsorbent on the basis of tree sawdust:

The technical lignin which is distinguished with its low self-cost and high efficiency.

The sulfate lignin in a dry condition is a brown powder. Sulfate lignin is considered as nontoxic compound, which is applied as a wet paste, doesn't produce dust and isn't flammable. Sawdust samples are selected – coniferous, deciduous tree sawdust and their mixture.

We have used known natural adsorbent - clinoptilolite, which is processed with sodium thiosulfate, to study and compare the quantity quality of aflatoxin adsorption [2].

Experiments preliminary results have shown, that the technical Lignin has quantitative more adsorption ability. Experiments are still being continued to determine the adsorption ability of other mycotoxins' various natural adsorbents Table 1.

Table 1
Quantitative analysis of aflatoxin adsorption on lignin and clinoptilolite
specimens (duration of experiment 30 days)

#	Adsorbent	A, mg		R, %	
		Humidity	Aflatoxine	Humidity	Aflatoxine
1	Sulfate Lignin	0,0012	0,0023	22	46
2	Clinoptilolite	-	0,0003	-	6

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Abstract

APPLICATION OF THE POSSIBILITIES OF FRONTAL POLYMERIZATION FOR THE SYNTHESIS OF POLYACRYLAMIDE HYDROGELS WITH IMPROVED PROPERTIES

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Polyacrylamide hydrogels are one of the most sought-after research topics in various scientific disciplines: chemistry, physics, biology, medicine, etc. Polyacrylamide hydrogel is a cross-linked polymeric structure capable of absorbing and releasing large amounts of water multiple times without destroying its original form. Thanks to these properties polyacrylamide hydrogels has entered many fields of national economy: agriculture, bio-engineering pharmacology, medicine, cosmetology, plastic surgery, production of general hygiene items, oil industry [1, 2].

The report presents studies in the field of adiabatic and frontal polymerization with the aim to determine necessary kinetic and macrokinetic parameters of the process of hydrogel synthesis to produce hydrogels according to the requirements of consumers.

Due to the specificity of frontal polymerization [3], and the detailed analysis of the models and possibilities of the implementation of frontal polymerization in continuous tubular reactors in flow [4], we succeeded in providing controllability for the synthesis process of polyacrylamide hydrogels, and accordingly, obtained hydrogels with prescribed absorption and release of water (from 0.2 g to 5000 g of water per 1 g of dry hydrogel), as well as with required physical and mechanical properties — elasticity, mechanical elasticity, ability to withstand high mechanical loads.

It should be specifically noted that, in contrast to the traditional methods for the synthesis of polyacrylamide hydrogels, the method proposed by us provides absolute environmental safety for the product completely free of even traces of residual toxic monomer-acrylamide.

Acknowledgment. This work was supported by Science Committee of the Ministry of Education and Science of Armenia

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Abstract

INFLUENCE OF NANOPARTICLE ADDITIONS ON THE STATIONARITY OF FRONTAL POLYMERIZATION

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This report is devoted to clarifying some of the nuances of stability (stationarity) violation of heat wave propagation in the process of frontal polymerization. Frontal polymerization has great contribution in the synthesis of polymeric nanocomposites. It was established [1, 2, 3] that the synthesis of nanocomposites by traditional methods requires that nanoparticle agglomeration be excluded. In frontal polymerization, however, these problems are absent, and polymer nanocomposites are produced with a uniform distribution of nanoparticles in polymer matrix. Frontal polymerization of metal-complexes of acrylamide was carried out with and without additions of nanoparticles. The effect of nano-additions on the heat wave stability loss of frontal polymerization was investigated.

The monomers (metal-acrylamide complexes) were chosen with the aim to study the kinetics of frontal polymerization, and meanwhile, maintain the stability of the heat wave propagation. Moreover, monomers of this group are of great interest for the synthesis of multifunctional polymeric gradient materials with controllable properties, and by precise determination of the kinetic and macrokinetic characteristics of the process of frontal polymerization one can use these monomers in combination with others to obtain materials with graded properties.

Acknowledgment. This work was supported by Science Committee of the Ministry of Education and Science of Armenia

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Abstract

FLUORINE CONTAINING SOLVENT-FREE POLYMER ELECTROLYTE MEMBRANES

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Polysiloxanes are promising components for comb polyelectrolytes because they possess a flexible backbone that enhances the transports of ions. Their amorphous and highly flexible $[\text{Si-O}]_n$ backbone results in glass transition temperatures as low as -100°C ; there is little or no crystallinity at room temperature. In addition, each monomer unit has two sites for cross-links or functional side chains through bond formation with silicon. Simulations indicate that comb polyelectrolytes should display higher conductivity values than their analogs to local motion of the bound anions in comb systems.

Presented paper is dedicated to synthesis of comb-type methylsiloxane polymers with donor allyl trifluoroacetate host groups, containing reactionable functional groups, which was obtained via hydrosilylation reaction of 2.4.6.8-tetrahydro-2.4.6.8-tetramethylcyclotetrasiloxane (D_4^{H}) with allyl trifluoroacetate and vinyltriethoxysilane at 1:3:1 ratio of initial compounds in the presence of platinum catalysts corresponding $\text{D}_4^{\text{RR}'}$ type adduct have been obtained.

Via ring opening copolymerization reaction of $\text{D}_4^{\text{R,R}'}$ with terminated agent- hexamethyldisiloxane in solution, in the presence of tetramethylammonium fluoride, at various temperatures, new comb-type siloxane polymers with pendant propyl trifluoroacetate side groups and ethyltriethoxysilane groups, as cross-linking moieties have been obtained. Synthesized $\text{D}_4^{\text{R,R}'}$ compound and comb-type polymers were analyzed by FTIR, ^1H , ^{13}C , and ^{29}Si NMR spectroscopy, DSC and GPC methods.

Sol-gel reactions of compound $\text{D}_4^{\text{R,R}'}$ and polymers doped with lithium trifluoromethylsulfonate (triflat) and lithium bis(trifluoromethanesulfonyl)imide have been studied and solid polymer electrolyte membranes have been obtained. The ion-conductivity of the membranes was determined via electrical impedance spectroscopy. The electric volumetric specific conductivity at 25°C , of obtained solid polymer electrolyte membranes changes in the range 7×10^{-8} - 4×10^{-5} Siemens/cm and depends on the structures of grafted anion receptors and the polymer backbones.

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Abstract

REGULATION OF THE MECHANICAL PROPERTIES OF POLYMER COMPOSITES WITH SAWDUST BY CHANGE OF THERMODYNAMIC PARAMETERS

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The development of the industry more and more expands the demands on the wood materials. However, an increased deficit of the natural wood stipulates the scientific-technical researches on the theme of analogical materials. At this time a great attention attracts the materials obtained in result of combination of sawdust with use of different binders. This process takes place often as polymerization of polymer substances on the surface of dispersed wood product. Besides of there are wide spread the methods of extrusion and hot pressing in the press mould of the high dispersive thermo-plastic polymers and sawdust.

In the presented work the investigation of the effect of such thermodynamic parameters as temperature and pressure on the mechanical properties of composites based on PhES and sawdust is presented. The composites on the base of blends of ingredients were obtained under different pressures and temperatures at simultaneously acting of them on the composites. The temperature was changed in the interval 80-220⁰C and pressure in the interval 10-20 MPa during 10-15 min.

Using the method of mathematical planning of the experiment, the optimal values of pressure and temperature were established, under conditions of which the composites with best mechanical properties are obtained. In accordance with the experimental data, composites containing 10Wt% the binder PhES (at 90Wt% of sawdust) are characterized by the best mechanical properties, when the materials are obtained at temperature 210⁰C and pressure 15 MPa acting during 15 min.

The obtained results are explained in terms of structural changes in the composites at given thermodynamic conditions.

Acknowledgment. The financial support of the Georgian National Science Foundation, Science and Technology Centre in Ukraine #5892 is gratefully acknowledged.

Abstract

SILOXANE BASED SOLID POLYMER ELECTROLYTE MEMBRANES FOR ENERGY STORAGE DEVICES

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The wide application of organosilicon polymers in many fields of techniques pushed the development of organosilicon chemistry and increased application-oriented researches in above mentioned field. Nowadays, development of new and more efficient methods of energy storage and conversion is one of the major problems facing scientists. This includes the efficient storage of electricity. Therefore, development of batteries and other energy storage devices with high energy density, low energy losses during operation, low cost and long lifetime is one of the most important challenges.

The aim of our work is synthesis of siloxane based polymer electrolytes with pendant octafluoropentyl propionate side groups. Investigation of sol-gel reaction of this polymers for obtaining of new solid polymer electrolyte membranes on the base of Lithium trifluoromethylsulfonate (triflat) and lithium bis(trifluoromethanesulfonyl)imide and study their electro physical properties.

The hydrosilylation reaction of 2.4.6.8-tetrahydro-2.4.6.8-tetramethylcyclotetrasiloxane (D_4^H) with 2.2.4.4.5.5.6.6-octafluoropentyl acrylate and vinyltriethoxysilane at 1:3:1 ratio of initial compounds in the presence of platinum catalysts corresponding $D_4^{RR'}$ type adduct have been obtained.

Synthesized $D_4^{R,R'}$ compound was analyzed by FTIR, 1H , ^{13}C , and ^{29}Si NMR spectroscopy, DSC and GPC methods.

Sol-gel reactions of compound $D_4^{R,R'}$ doped with lithium trifluoromethylsulfonate (triflat) and lithium bis(trifluoromethanesulfonyl)imide have been studied and solid polymer electrolyte membranes have been obtained. The ion-conductivity of the membranes was determined via electrical impedance spectroscopy. The electric volumetric specific conductivity at 25⁰C, of obtained solid polymer electrolyte membranes changes in the range 1.9×10^{-6} - 2.2×10^{-8} Siemens/cm. The experiment shows that practically for membranes containing about 10 wt % of the salts we have noted above maximums on the curves of concentration dependences of the membranes.

Acknowledgment. The financial support of the Georgian National Science Foundation, Science and Technology Centre in Ukraine STCU-2016-16 (6301), is gratefully acknowledged.

Abstract

SYNTHESIS OF LOW MOLECULAR POLYMER ADDITIVE CONTAINING DISULFIDE GROUPS

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One of the applications of polymers is using them as raw materials in the synthesis of polymer additives, containing various functional groups.

Research established that oil containing additives- polybutylenes, its copolymers, vinipoles and others provides less wear on machine parts and mechanisms. The lower the molecular weight of the polymer, the higher its adsorbability and better are the anti-wear properties. Restoration of a destroyed boundary adsorption layer on a metal surface can occur faster and more efficiently, the lower molecular polymers are contained in the oil.

We have developed low molecular polymer additive containing disulfide groups that improve lubricating properties of oils.

The additive was derived on the basis of low molecular isobutylene copolymer with styrene in ratio 9:1 with molecular mass 400-700 chlorosulfur with sulfur chloride at low temperature 3-5°C for 2-3 hours with the subsequent interaction with sodium disulfide at a temperature 60-65°C for 4-5 hours. Derived low molecular polymer additive is a light-brown viscous compound that is well soluble in organic solvents and oils with 23% sulfur content.

Lubricating properties of this additive were studied in MC-20 and AK-15 oils in 3 and 5% concentrations and showed effective results. Besides low molecular polymer additive containing disulfide groups proved to be resistant to mechanical destruction.

PREDICTION OF THE EFFECT OF INJECTED MASS IN SIZE EXCLUSION CHROMATOGRAPHY

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A procedure of modeling chromatography separation, based on the plate model, has been developed [1]. An equilibrium between the analyte (polymer) in the mobile and stationary phases is described by the concentration-dependent partition coefficient. Changing the injected mass results in a series of elution curves with positions dependent on injected mass. The procedure has been tested on modeling concentration effects on the basis of dependences of the partition coefficient on local concentrations on each plate. By a comparison with experiment, the slope of the concentration dependence of the partition coefficient of polystyrene in benzene was estimated (Fig. 1). It is in qualitative agreement with the literature data obtained by a computer simulation of chromatography separation of polymers in good solvents [2].

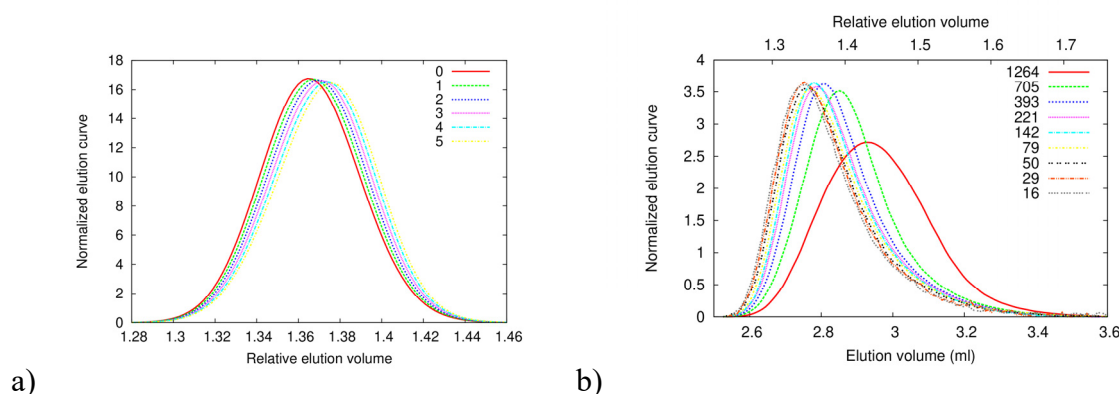


Fig. 1. Comparison of the (a) theoretical and (b) experimental elution curves for polystyrene in benzene. The injected mass in (a) μg and (b) products injected mass and the slope of the concentration dependence are denoted with the curves.

Acknowledgment. The financial support of the Grant Agency of the Czech Republic (project 17-04258J) is gratefully acknowledged.

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Abstract

EFFECT OF ACRYLONITRILE CONTENT ON LASER TEXTURING EFFICIENCY OF THE NBR VULCANIZATES

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The most popular way of surface modification of materials still remains their chemical treatment. This is because of the advantage of well-known mechanisms and processes involved, low cost and applicability to broad variety of materials. As an example, one can give hardening and/or hydrophilisation of plastics by bath chlorination [1]. The main drawback of chemical treatments is generation a considerable amount of wastes, which have to be utilised or subjected to usually expensive recycling/recovery. For this reason many studies on surface modifications using “clean” physical techniques have been conducted recently. The most popular examples are plasma treatment or chemical and physical vapours deposition coatings [2]. Another method of physical surface modification of materials, gaining in popularity nowadays, is high energy ion beam treatment [3]. Laser texturing of the surface of materials is a method of their modification based on selective heating of surface areas with very high precision. This technique allows to modify morphology of the surface layer without any changes to the bulk of materials. Its application is simple, cheap and “clean”, and obtained effects are visible to the naked eye. As an example, one can refer to works presented silicon wafers of superhydrophobic surface having a structural colour [4, 5].

In this study the effect of acrylonitrile content on the efficiency of laser surface texturing of elastomeric composites based on acrylonitrile-butadiene rubber (NBR) matrix, containing black iron Fe₃O₄ used as a substance allowing the process to be carried out and determining the degree of resulting changes, has been investigated. The elastomers studied were of the similar crosslinks density but varied according to acrylonitrile (AN) comonomer content: 19%, 28%, 33% and 39%. The treatment parameters varied according to: laser beam power, scanning speed and modulation of the beam. Results obtained demonstrate influence of the texturing parameters on surface geometry characteristics of the NBR vulcanizates and associated surface free energy and friction.

Acknowledgment. This work was supported by the Lodz University of Technology internal grant number: W-3D/FMN/28G/2018

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NEW FIRE-RESISTANT ELASTOMER BLENDS CONTAINING CHLOROPRENE AND BUTADIENE RUBBERS

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Elastomer blends have been widely used in the rubber industry. Rubber blends composed of different elastomers find many important applications owing to their superior properties which may not be otherwise achieved by individual components. Thus, rubber blending enables producing new materials, obtaining the best processability and reducing the cost of rubber product manufacturing process [1-3].

The aim of our study was to development the technology and analysis of new rubber materials, characterized by very good mechanical properties and high resistance to fire. For this purpose, elastomer blends containing chloroprene rubber (CR) and butadiene rubber (BR) were prepared. Chloroprene rubber was combined with the butadiene rubber to achieve special properties of both elastomers. The disadvantage of chloroprene rubber is difficult processing due to its susceptibility to crystallization. Therefore, the incorporation of butadiene rubber into chloroprene rubber lead to decreases to create crystalline regions, which results in better dispersion of fillers and other components in the elastomeric matrix. The proposed CR/BR blends were crosslinked with iron(III) oxide (Fe_2O_3). Additionally, the effect of fillers (silica, china clay, chalk) on the crosslinking of CR/BR/ Fe_2O_3 blends and properties of vulcanizates was studied [1].

It was found that the cross-linking degree of the CR/BR compounds depended on the molar ratio of both elastomers and amount of cross-linking agent. The curing degree increased with chloroprene rubber content in the CR/BR blends. The incorporation of filler (silica, china clay, chalk) led to an insignificant improvement in the mechanical properties. The obtained vulcanizates were also characterized by very high resistance to flame. All unfilled and filled composites belong to non-flammable materials as evidenced by the value of oxygen index ($\text{OI} = 37\%$). Additionally, the advantages of our rubber materials is the simple technology and low production costs. The CR/BR/ Fe_2O_3 vulcanizates can be used everywhere where it is necessary to use products with increased resistance to fire. They may be conveyor belts, wire and cable jacketing, coated fabrics, extrusions and many other articles.

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Abstract

THERMO-CHEMICAL CONVERSION OF HIGH MOLECULAR CHEMICAL WASTES AND FABRICATION OF TiC-SiC BASED HARD ALLOY COMPOSITES BY SHS TECHNOLOGY

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Tire and plastics are among most problematic sources of waste. Progress in recycling has resulted in a major reduction in dumping.

Because tires and plastics are highly durable and non-biodegradable, they can consume valued space in landfills and oceans. In 1990, it was estimated that over 1 billion scrap tires were in stockpiles in the United States. As for 2015, only 67 million tires remain in stockpiles. As for plastics the Marine Conservancy has published that the estimated decomposition rates of most plastic debris found on coasts are between 100-500 years. Commercially available plastics (polyolefins like polyethylene, polypropylene, etc.) have been further made resistant to decomposition by means of additional stabilizers like antioxidants.

The main idea of offered new approach consists in 2 stage recycling of tire and plastic waste into the carbon black (CB) and fabrication novel ceramic TiC-SiC based composites using Self-propagating high temperature syntheses (SHS) technology. The application of CB as a main component in Ti-C powder blends and SHS processes allows not only synthesize TiC & SiC carbides precursors but at the same time provides full burning of sulphur from reminder ash and as a result to fabricate TiC-SiC based composites near to theoretical densities for machinery and armor reasons.

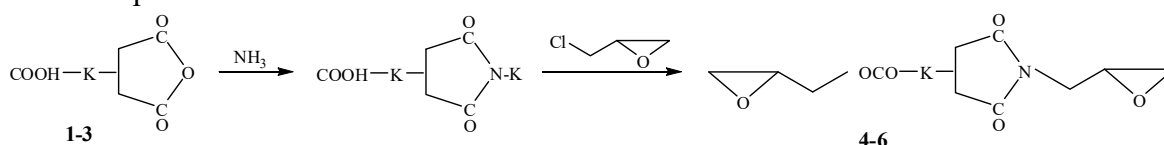
The above mentioned and other reasons of structure/property relationship depending on SHS conditions will be presented and discussed.

HARDENED EPOXY-IMIDE ROSIN DERIVATIVES FOR PREPARATION OF HEAT-RESISTANT COMPOSITION MATERIALS

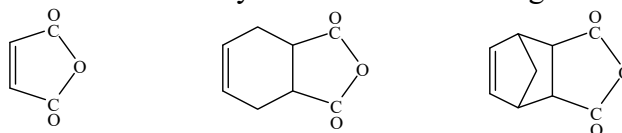
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The composition materials on the basis of epoxy-imides, where glycidyl groups are located near the nitrogen atom of imide cycle, have high heat-physical properties, including high heat- resistance [1]. It could be assumed that the epoxy-imide compounds obtained from anhydride-containing derivatives of levopimaric acid, which is part of the rosin, by their imidizing with subsequent conversion to epoxide derivatives, will also have high strength and heat-physical properties after their hardening. With this purpose, the epoxy-imide rosin derivatives have been obtained according to the scheme presented below:



For synthesis of the compounds 1-3 the anhydrides of the following structure have been used:



The preparation reaction of epoxy-imides proceeds at 90-100°C for 1,5–2,0 h at ratio imide:epichlorohydrin = 1:15÷20. At the end of the reaction, the excess of ECH was distilled away, and the resulting reaction product – epoxy-imides were isolated as resinous substances easily soluble in polar solvents (DMFA, DMSO, acetone, etc.). An availability of epoxide groups in the molecules of the obtained substances, and also their quantity have been determined by analytical methods and IR-spectroscopy data.

It has been established that the obtained epoxy-imide compounds both in individual form and in the form of a mixture with epoxy diene oligomeric resin, are easily hardened with amine and anhydride hardeners, forming a compound with high strength and heat- physical parameters. It has been shown that an availability of tertiary amine groups in the composition of epoxy-imide compounds favors the acceleration of the hardening process, which allows to carry out the hardening at relatively low temperatures (at 100-150°C) in comparison with used standard hardening conditions.

The composition materials made in this way possess improved physical-mechanical and heat-physical properties and can be used in various fields as a heat-resistant and high-strength material for technical purposes.

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Abstract

SYNTHESIS OF POROUS COMPOSITES CONTAINING CARBON NANO-ONIONS

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The study focused on a facile low-cost synthesis of polyaniline nanotube (PANI_{NT}) –carbon nano-onion (CNO) composites for solid-state supercapacitors. Scanning electron microscopic (SEM) analyses indicate a uniform and ordered composition for the conducting polymer nanotubes immobilized on a thin gold film.

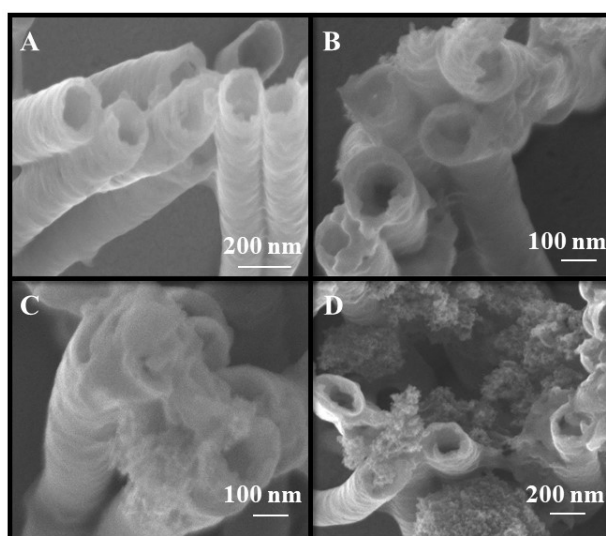


Fig.1. SEM images of vertically oriented PANI_{NT} on a Au surface, (A) pristine PANI_{NT} and PANI_{NT} functionalized with CNO_{ox} 0.5 mg mL⁻¹ (B), 1 mg mL⁻¹ (C), and 4 mg mL⁻¹ (D).

The combination of these two types of materials improved the capacitive properties. Notably, the nanostructural properties of both components and the unique perpendicular organization of the conducting nanotubes relative to the surface electrode affected the unusual electrochemical properties of these materials. The electrochemical performance of the composites is affected by the mass of the carbon nanostructures. The PANI_{NT}/CNO_{ox} composites exhibited a high specific capacitance ca. 950 F g⁻¹, which is one of the highest values published to date for analogous materials. In addition, the nanocomposites offer high conductivity and a porous and well-developed surface area. The PANI_{NT}-CNO nanocomposites were tested as electrodes with high potential and long-term stability for use in easy-to-miniaturize high-performance supercapacitor devices.

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Abstract

POLYMERS DESTRUCTION KINETIC'S RESEARCH DURING MECHANICAL TENSION SIMULTANEOUS INFLUENCE

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To study polymers chemical destruction process was used spectrophotometer method, because during the experiment the used aggressive, areas don't merge spectra's visible or ultraviolet ($>210 - \text{nm}$) area.

The practical measurements were done in the thermostatical reactor for the mechanical experiments with magnetic weed, the alkali solution's volume was 50 ml. Before the experiment, we were doing thermostatic on the given temperature with $\pm 0,2^\circ\text{C}$ accuracy. The polymer pattern was covered with solution.

During the experiment we took from the reactor alloys periodically and did analysis on the spectrophotometer.

The produced spectra during reaction products destruction is given on the Figure 1.

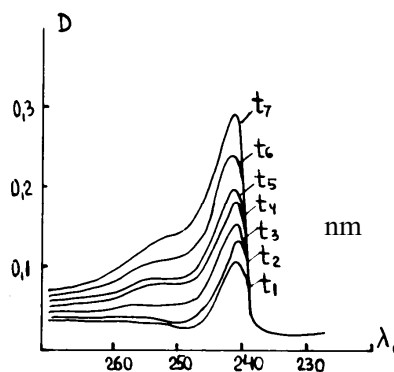


Figure 1. The changes of the polymer's destruction products spectra in 2 % KOH,
 $T=22^\circ\text{C}$ $S=1,76 \text{ cm}^2$

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Abstract

ASYMMETRIC TRANSFER HYDROGENATION OF VARIOUS KETONES BY COMPLEX OF IMIDAZOLIUM WITH $[\text{Rh}(\mu\text{-Cl})(\text{COD})]_2$

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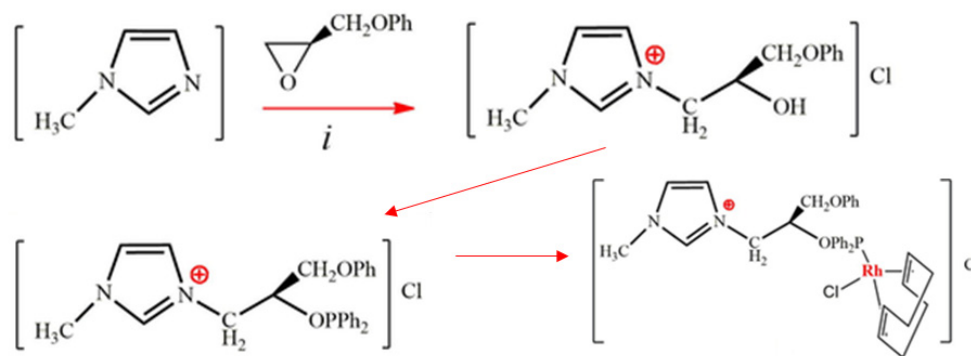
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The combination of [3-[(2*S*)-2-[(diphenylphosphanyl)oxy]-3-phenoxypropyl]-1-methyl-1*H*-imidazol-3-ium chloride] with $[\text{Rh}(\mu\text{-Cl})(\text{cod})]_2$, in the presence of KOH/*iso*PrOH, has been found to generate catalysts that are capable of enantioselectively reducing alkyl, aryl ketones to the corresponding (*R*)-alcohols. We obtained the secondary alcohol products in high conversions and enantioselectivities using only 0.5mol% catalyst loading.



Scheme 1. Synthesis of the [3-[(2*S*)-2-[(chloro(η 4-1,5-cyclooctadiene)rhodio) diphenyl phosphanyl]oxy}-3-phenoxypropyl]-1-methyl-1*H*-imidazol-3-ium chloride], (a) 1 equiv. (*S*)-2-Oxiranylanisole, 1 equiv. HCl, $\text{C}_2\text{H}_5\text{OH}$; (b) 1 equiv. Ph_2PCl , 1 equiv. Et_3N , CH_2Cl_2 ; (c) 1/2 equiv. $[\text{Rh}(\mu\text{-Cl})(\text{cod})]_2$, CH_2Cl_2 .

Synthesis of [3-[(2*S*)-2-[(chloro(η 4-1,5-cyclooctadiene)rhodium)diphenyl phosphanyl]oxy}-3-phenoxypropyl]-1-methyl-1*H*-imidazol-3-ium chloride]

$[\text{Rh}(\mu\text{-Cl})(\text{cod})]_2$ (0.054g, 0.110mmol) and $[(\text{Ph}_2\text{P})\text{-C}_{13}\text{H}_{16}\text{N}_2\text{O}_2]\text{Cl}$ (0.100g, 0.221mmol) were dissolved in dry CH_2Cl_2 (25mL) under argon atmosphere and stirred for 1h at room temperature. The volume was concentrated to ca. 1–2mL under reduced pressure and addition of petroleum ether (20mL) gave the corresponding Rhodium (I) complex as a yellow microcrystalline solid. The product was collected by filtration and dried in vacuo. Yield: 130 mg, 84.2%; m.p.:124–125°C; $[\alpha]_{\text{D}20} = +33.2^\circ$ (c 1, CHCl_3); IR: ν 3146, 3053 (aromatic C H), 2937, 2874 (aliphatic C H) 1435 (P-Ph), 1044 (O P) cm^{-1} ; Anal. for $\text{C}_{33}\text{H}_{38}\text{N}_2\text{O}_2\text{PRhCl}_2$ (699.46g/mol): calcd. C 56.67, H 5.48, N 4.05; found C 56.56, H 5.44, N 4.01%.

Acknowledgements. Partial supports of this work by Project numbers: FEN.17.019 and FEN.17.023 and IRN: AP05132833, BR05236800 is gratefully acknowledged.

Abstract

DESULFURIZATION OF FUELS BY METAL-CONTAINING IONIC LIQUIDS

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Desulfurization of fuels attract considerable attention because of atmospheric pollution caused by NO_x and SO_x oxides [1].

Toughening the requirements for sulfur content in motor fuels stimulates the search for new ways to purify hydrocarbon raw materials from sulfur compounds and improving all existing technologies of desulfurization processes. In this work, we considered a method for purifying liquid motor fuels from organosulfur compounds, into an ionic liquid, partial oxidation of extracted sulfur-containing compounds under the action of a catalyst in an alcohol-based solution or in an acidic aqueous solution.

The scientific novelty of our method is that we create extractive systems based on metal-containing ionic liquids, capable of simultaneous extraction of both sulphur compounds and nitrogen compounds from motor fuels as can be seen in figure 1:

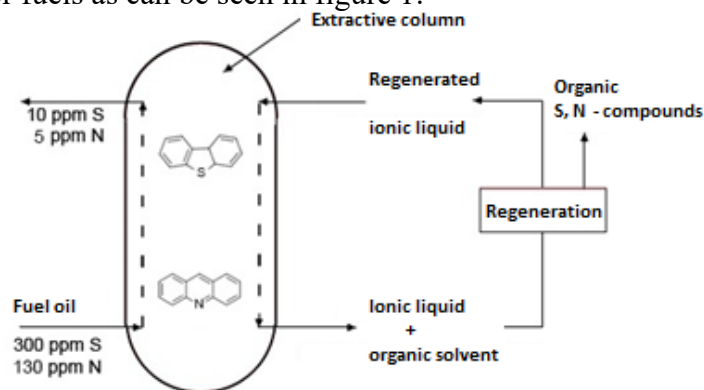


Figure 1. Extractive systems based on metal-containing ionic liquids

The study of the extraction ability of N-methyl-N-methylimidazolium dimethyl phosphate [MMIM] [DMP] and N-butyl-N-methyl imidazolium dibutyl phosphate [BMIM] [DBP] showed that the solubility of dibenzothiophene and benzothiophene in aqueous solutions of ionic liquids with a 25 °C is changing:



In this case, dibenzothiophene dissolves better than benzothiophene. The most effective for desulfurization was [EMIM] [DEP].

Acknowledgements. Partial supports of this work by Project number: IRN: AP05132833, is gratefully acknowledged.

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Abstract

POLYMERIC COMPOUNDS IN CREATING LUBRICATING COMPOSITIONS FOR VARIOUS PURPOSE MOTOR ENGINES

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Polymers are widely used as additives to change the realogic properties of lubricating oils, in particular, to increase the viscosity and viscosity index, lowering the pour point. A dramatic increase in the viscosity of petroleum oils with a decrease in temperature and its decrease in elevated temperatures make it difficult for machines and mechanisms to work stably. However, to prevent a sharp change in viscosity with temperature (to ensure a high viscosity index) and to increase the pumpability of oils at low temperatures, viscosity additives are introduced into them, high-molecular-weight organic polymers — polyisobutylenes, polymethacrylates, vinyl polyols, and some copolymers, for example (ethylene-propylene copolymer).

The use of polymethacrylates, polyisobutylene, vinipole and other additives to obtain high-index oils caused many questions of a theoretical and applied nature. Researches of scientists revealed that polymethacrylate viscosity additives are most preferable.

In this work, the viscosity-temperature properties of foreign additives of polymethacrylate type – Viscoplex -3-950; 1-810; 8-450; 4-550; 2-670; ПМА «Д», Shellvis-50; Eridan B-1751 in base oil M-8. These additives differ in molecular weight, chemical structure, some additional properties and increase the viscosity and viscosity index of lubricating oils. Their viscosity at 100°C is within the limits of 700–2000 mm²/s., the density at 20°C is 900–940 kg/m³, and the flash point is 100–190°C.

The additives studied have a different degree of influence on the increase in kinematic viscosity and oil viscosity index and are distributed in the following order:

to increase the kinematic viscosity:

Viscoplex-2-670 > Viscoplex -3-950 > Viscoplex-1-810 > ПМА «Д» >

Viscoplex-8-450 > Viscoplex-4-550 > Shellvis-50 > EridanB-1751;

to increase the index viscosity:

Viscoplex-2-670 > Viscoplex -3-950 > Viscoplex-1-810 > Viscoplex-8-450 >

EridanB-1751 > ПМА «Д»; > Viscoplex-4-550 > Shellvis-50;

According to the results of studies conducted in the creation of new lubricant compositions M-10Г₂ (API CC SAE 30), M-14Г₂ (API CC SAE 40), M-10B₂ (API CB SAE 30), M-14B₂ (API CB SAE 40) along with other additives for various purposes, Viscoplex.-2-670 were used as viscous additives; 2-670; 1-810; 8-450; 4-550 and so on.

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COMPARISON OF MODIFIED POLYETHYLENE INCUBATION EFFECTS IN SEA WATER AND COMPOSTING NATURAL ENVIRONMENT

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Polyethylene (LDPE) is relatively inert towards micro-organisms, but has demonstrated a certain, though limited, long-term biodegradability [1]. It has been known that starch, used as biodegradation additive, is readily degraded by a wide variety of yeast, fungi and bacteria [1,2]. The initial step for biodegradation of polyethylene is photooxidation. To improve the overall degradability the starch could be accompanied by prooxidants which promote abiotic oxidation due to hydroperoxide - catalyzed autooxidation of the prooxidant in synergistic combination with biodegradation of the starch particles [3]. The biodegradation process could be sped up through microbiological consumption of starch particles producing a greater surface/volume ratio of polyethylene matrix to provide oxygen permeability. When biodegradation process is performed in an aqueous environment the release of degradation products from the samples should be facilitated. In this study LDPE MB, containing pro-degradant additive in the form of a master batch (MB) in amount of 20%, was used. The MB consisted mainly of corn starch, linear low density polyethylene as the carrier resin, styrene-butadiene copolymer and manganese stearate (the last two are referred to as the prooxidant system) [3]. In addition, LDPE samples with only corn starch (8%) were studied. The incubation of polymer samples took place in The Baltic Sea water and in the living composting environment with plant treatment active sludge. The comparison of sample changes in the weight and tensile strength after incubation in sea water [3] and composting natural environment is presented. The very little microbial degradation was observed for modified LDPE in sea water and compost. This could be explained by low sea water temperature (3.2-21.6°C), moderate biological activity of micro-organisms and low amounts of solar radiation reaching the films. There was also no defined trigger for the autooxidation process under ambient conditions in the dark as is in compost. Also the starch removal was limited because of low contain of moisture in compost (dry mass 59.25-65.32%) and this did not lead to disintegration of LDPE matrix. There was no correlation between small weights losses and tensile strength. The changes of tensile strength were more visible. They were continuously decreasing for all samples incubated in the natural marine environment and natural compost. It was mostly because of mechanical damage cause by shear stresses (the fluctuation off water) or by the swelling and bursting of growing cells of the invading micro-organisms or by macro-organisms. FTIR analysis of biotically aged modified LDPE confirmed the observed degradation process [4].

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Abstract

THE STUDY OF CARBON MATERIAL SUSPENSION IN DISPESIVE MEDIA

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Currently, the use of carbon material is increasing at a rapid pace. Due to its properties, carbon material (CM) finds its application in various industries, including for obtaining wear-resistant composite electrochemical coatings (CEC). The process of formation of the CEC is primarily associated with the preparation and state of the suspensions, in particular with their stability.

The process of dispersion of carbon material obtained from the shell of hazelnuts is studied in water, in an aqueous solution of a surfactant (sodium dodecyl sulfate) and in nickel plating electrolyte. An original method for obtaining carbon material from recycled materials was developed at our institute [1].

The optical density of the suspensions obtained indicates the quality of dispersion. The stability of the suspensions obtained was evaluated by comparing the results every hour and twenty-four hours after the ultrasonic treatment. The dispersion was carried out in a bathtub for 10 minutes at a frequency of 40 kHz and power of 60 W, the volume of the solution was 10 ml.

Table 1 shows the results of measurements of the stability of aqueous suspensions of carbon material of various concentrations, in water, in an aqueous surfactant solution and nickel plating electrolyte (Watts electrolyte).

#	Solution	After disper sion	After 1 hour	After 2 hours	After 3 hours	After 4 hours	After 24 hours
1	Water + 0,08 g/L CM	0,574	0,546	0,527	0,513	0,501	0,359
2	Water + 0,04 g/L CM	0,288	0,276	0,273	0,271	0,250	0,187
3	Water + 0,01 g g/L CM	0,078	0,072	0,065	0,065	0,064	0,05
4	Water + 0,08 g/L CM + 10^{-2} SDS	0,562	0,530	0,502	0,478	0,466	0,357
5	Water + 0,04 g/L CM + 10^{-2} SDS	0,310	0,278	0,244	0,221	0,105	0,097
6	Water + 0,01 g/L CM + 10^{-2} SDS	0,068	0,068	0,063	0,058	0,058	0,044
7	electrolyte + 0,08 g/L CM + 10^{-2} SDS	1,694	1,106	0,786	0,625	0,487	0,180
8	electrolyte + 0,04 g/L CM + 10^{-2} SDS	1,44	0,988	0,757	0,595	0,492	0,138
9	electrolyte + 0,01 g/L CM + 10^{-2} SDS	0,840	0,615	0,526	0,451	0,383	0,117

As can be seen from the table, dispersion has a positive effect on the stability of aqueous suspensions. Adding sodium dodecyl sulfate does not affect the stability of this solution. Even diluted electrolyte solutions sharply reduce the stability of the suspensions.

A study is needed to identify stabilizing additives for this system.

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1. USA Patent 9663662

Abstract

POLYMERIC SOL-GEL NETWORK AS PRE-TREATMENT FOR APPLICATION OF ELECTROLESS NI-P COATING ON MAGNESIUM ALLOY

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The sol-gel process is conversion of metal alkoxides into a colloidal solution (sol) that acts as the precursor for an integrated network (or gel) of either discrete particles or inorganic polymeric network. This method is widely used for application of primer films before the final corrosion protective coatings on the metals. On the other hand, the magnesium alloys are recently attracted much popularity for application in the aerospace and automotive industries due to their high strength to weight ratio. However, the magnesium alloys are susceptible to the corrosion which limits their outdoor applications. Application of the electroless Ni-P coatings is considered as suitable method in order to enhance the corrosion resistance of the magnesium alloys. Unfortunately, direct application of the electroless Ni-P coating on the magnesium alloys is faced with many challenges such as high electrochemical reactivity and electrochemical heterogeneity of the surface and so, an especial pre-treatment is necessary to solve this problem before the final plating process. In this work, sol-gel polymeric coating was applied on AM60B magnesium alloy as pre-treatment for the final Ni-P electroless plating. The sol-gel pre-treatment layer and final Ni-P coating were characterized with different surface analysis methods such as SEM, EDS, XRD, and AFM. The results showed that the sol-gel layer acts as suitable pre-treatment for application of uniform, defect-free, cauliflower-like, and mixed amorphous-crystalline Ni-P coating on the magnesium alloy. The corrosion resistance of the bare magnesium alloy, sol-gel pre-treatment, and final electroless coatings were fully investigated in 3.5 wt. % solution by using PDP and EIS methods. The results showed that the sol-gel pre-treatment causes to the significant improvement in the corrosion resistance of the final Ni-P coating on the magnesium alloy.

Acknowledgment. The authors wish to thank the Research Council of the University of Mohaghegh Ardabili for the financial support of this work.

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Abstract

HIGH-STRENGTH AND HEAT-RESISTANT RUBBERS BASED ON CHLOROCYCLOPROPANE BSR

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Butadiene-styrene rubber, containing unsaturated bonds, is easily destroyed during aging. An aging of such rubbers is accompanied by cross-linking, therefore the rubber compounds made from them harden, and the rubbers obtained on their basis lose flexibility and elasticity. This process (oxidation) is often activated by availability of metals, traces of which are contained in antioxidants or oxidation inhibitors added to rubber compounds [1]. BSR is usually vulcanized by sulphur with use of usual accelerators. The rubbers made in this case have high elasticity, higher strength characteristics in a wide temperature range, chemical resistance and other useful properties.

In this work the results of sulphuric vulcanization of BSR modified by addition reaction to rubber macromolecules of dichlorocarbene generated in the conditions of alkaline hydrolysis of chloroform are presented [2]. The carried-out experiments showed that in the vulcanization process the strength of vulcanizate depending on conditions of its making is firstly increased, then is decreased, i.e. passes through a maximum. This is stipulated by the fact that the processes of cross-linking and destruction occur simultaneously in the vulcanizate. It has been detected in this case that the most important technological parameters of vulcanization are temperature, process duration, type of elastomer and vulcanizing group. These parameters influence on vulcanization rate and the properties of the resulting rubbers.

With the aim of improvement of the physical-mechanical and technological properties of rubber as a filler it was used carbon black (DG-100). It has been detected that due to increase in rigidity owing to the formation of cross-links the strength of the vulcanizate is increased.

Based on required complex of properties of the rubbers, the formulation of making of the rubber mixtures has been developed and the conditions of vulcanization of BSR chlorocyclopropanated in various degrees have been chosen. The rubbers obtained as a result of vulcanization of the rubber mixture on the basis of chlorocyclopropanated BSR show higher stability to heat aging: resistance coefficient to heat aging at 373 K for 72 h on tensile strength and relative elongation comes to 0,77 and 0,81, while the rubbers made from unmodified BSR have the coefficients values 0,61 and 0,73 respectively. The tendency to premature vulcanization of the rubber mixtures is also decreased: the beginning time of the prevulcanization at 403 K is 25-40 min.

Acknowledgment. This work was supported by the Science Development Foundation under the President of Azerbaijan Republic [joint grant № SDF-BGM-3-BRFTF-2+/2017-15/09/4-M-07] and the Belarusian Republican Foundation of fundamental investigations [joint grant №. T18A3-001].

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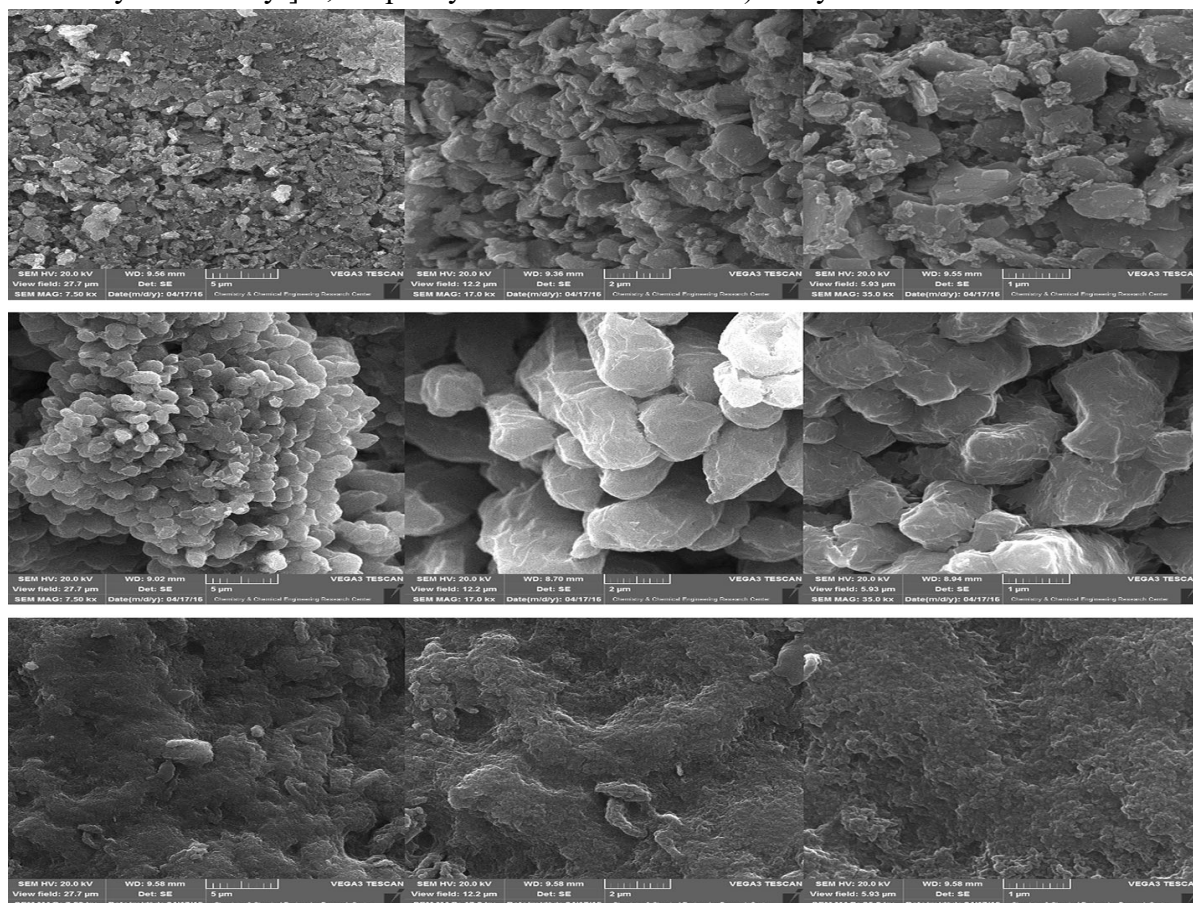
Abstract

NANOCARRIERS AND NEW INORGANIC-BASED NANO MATERIALS: SYNTHESIS, CHARACTERIZATION, BIOLOGICAL ACTIVITIES

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Inorganic nanoparticles have different applications in drug delivery mechanisms and have drawn a lot of attention owing to their various features such as wide accessibility, proper biocompatibility, and excellent surface functionality. Employing nanomaterials as carriers is a heated debate in drug molecule release and delivery. Moreover, the gradual release of drugs as nanoparticle carriers can correspond to the drug delivery systems, having advantages like extended release time and accurate drug delivery to locations. For a practical usage of LDH (layered double hydroxide) as a drug delivery carrier, it is very important to control the release rate of drug molecules, and thereby characterize the maintenance time of drug molecules in vivo [1-3]. In this research, some of the new nano compounds were synthesized. These new compounds were characterized by spectroscopic methods such as FT-IR and UV spectra, X-ray diffraction, SEM techniques and some physical properties. The biological activities such as antitumor activities of these nano compounds against a different kinds of tumor cells such as panel of human tumor cell lines (HT29: Human colon adenocarcinoma cell line T47D:human breast adenocarcinoma cell line) was determined by MTT(3-[4,5-dimethylthiazol-2-yl]-2,5-diphenyl-tetrazolium bromide) assay.



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GEOPOLYMERS - THE FUTURE ALTERNATIVE TO PORTLAND CEMENT

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Due to high energy-intensity of cement production and therefore CO₂ emissions into the atmosphere, the issue of using geopolymeric binders as one of the substitutes of Portland cement has been actively considered in recent years.

Geopolymeric binders are been obtained from industrial waste that have undergone heat treatment or from natural minerals activated at 750-850 °C temperature [1]. As a raw material, it is used aluminosilicate of the feldspathic group, as well as ashes and slags. Accordance to the data from J. Davidovits, the temperature activation of the starting materials helps to accelerate the formation of strong polymer structures similar to natural zeolites [2]. According to some authors, geopolymers are – nanomaterials [2, 3].

The main factors determining the firmness of the materials obtained include, in particular, the strength of the crystalline frame of the silica component, cemented with silica gel. The strength properties new formations of insoluble hydrosilicate affect the hardness of the frame.

Previously, we carried out works on obtaining geopolymer binders on the basis of dump furnace slag and volcanic rock, trachyte, for which mechanical and thermal activation of the used raw materials had been carried out. Research has been carried out on thermal transformations of waste slag and trachyte, as well as on processes of mineral formation during heating. Under laboratory conditions, geopolymer binders have been obtained for various modes of hardening [4].

One of the main components for the production of geopolymers is metakaolin, which is obtained by calcination of minerals of the kaolinite group or kaolin clays at 500-800°C temperature. World reserves of these materials are limited and of particular interest is the production of metakaolin from shale.

The mode of calcination of shales has been elaborated for the purpose of synthesis of the maximum quantity of a metakaolin. The geopolymeric binders based on the calcined shales have been received [5].

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

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HIGH-STRENGTH MATERIALS ON THE BASIS OF POLYMERS OF GLYCIDYL ETHERS OF METHYLSUBSTITUTED *p*-VINYLPHENOLS

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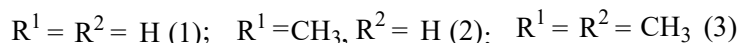
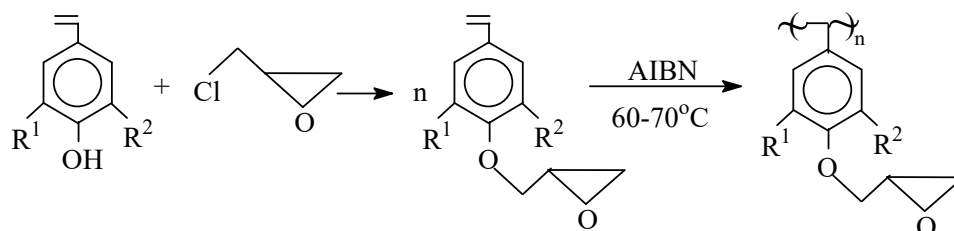
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It is known that the polymers containing chemical active functional groups capable of reacting on effect of various chemical reagents and irradiation sources in macromolecules (both in the main and in the side chain) are widely used in various fields of technology, including instrument-making, microelectronics, medicine, etc.

Taking into account the above-mentioned, in this work the synthesis of glycidyl ethers of methylsubstituted *p*-vinylphenols has been realized and their radical polymerization both in solution and in mass in the presence of AIBN at tempertaure 60-70°C has been carried out.

It has been shown that the polymerization under the selected conditions proceeds in the absence of an induction period and is completed with formation of the high-molecular polymers of linear structure and with side glycidoxyphenyl groups. It has been established by data of the chemical and spectral analyses that the polymerization of synthesized derivatives of glycidyl ethers of *p*-vinylphenol proceeds only with opening of C=C-bond of the vinyl group.

The epoxide groups do not participate in the polymerization process, remain unaffected as side appendages:



The reactivity in the polymerization reactions of the compounds **1-3** has been determined using the method of GLC-analysis. With this aim, the dependence of a degree of the conversion of the monomers **1-3** on polymerization time has been studied under identical conditions.

It has been established that an introduction of a methyl group in *meta*- position in relation to the vinyl group of the aromatic nucleus increases the reactivity of the monomer **2** in comparison with the compound **1**.

An introduction of the second methyl group into benzene ring (monomer **3**) slightly increases the reactivity of this compound. According to the activity in radical polymerization, these compounds change in the next series: **3** ≥ **2** > **1**. It has been shown that the appearance of the methyl groups in the aromatic nucleus increases a degree of conjugation of the compound **2,3** in comparison with the compound **1**.

It has been established that the obtained epoxy-containing polymers after structurization with corresponding amine hardeners possess high strength indices and thermal stability.

REACTION HYDROSILYLATION OF ALLYL-2,3,4-TRI-O-ACETYL- β -D-RAMNOPYRANOSE WITH METHYL- AND PHENYLCYCLODISILAZANES

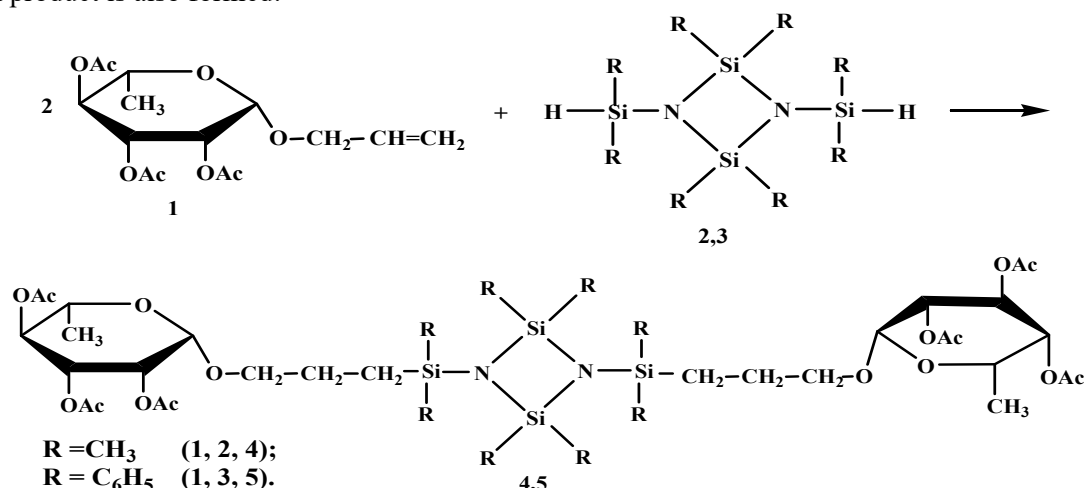
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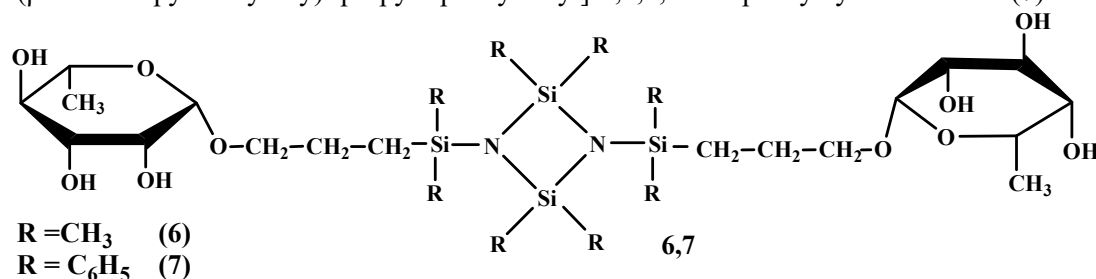
In order to obtain biologically active compounds, we have devised a new method for synthesizing glycosides containing silicon and sulfur. Insertion of silicon and sulfur atoms in known medicinal preparations can result in essential change of character of action of a preparation, and sometimes can give them a number of new properties.

By hydrosilylation 1-0-allyl-2,3,4-tri-O-acetyl- β -L-ramnopyranose (1) with 1,3-bis(dimethylsilyl)-2,2,4,4-tetramethylcyclodisilazane (2) and 1,3-bis(diphenylsilyl)-2,2,4,4-tetraphenylcyclodisilazane (3) in the presence of catalyst – $\text{Co}_2(\text{CO})_8$, we obtained 1,3-di[3-(2,3,4-tri-O-acetyl- β -L-ramnopyranosyloxy)propyldimethylsilyl]-2,2,4,4-tetramethylcyclodisilazane (4) and 1,3-di[3-(2,3,4-tri-O-acetyl- β -L-ramnopyranosyloxy)propyldiphenylsilyl]-2,2,4,4-tetraphenylcyclodisilazane (5).

The reaction mainly proceeds according to anti-Markovnikov rule, although a small amount of Markovnikov addition product is also formed:



By deacetylation of compounds 4 and 5 in absolute methanol in the presence of sodium methoxide, we obtained 1,3-di[3-(β -L-ramnopyranosyloxy)propyldimethylsilyl]-2,2,4,4-tetramethylcyclodisilazane (6) and 1,3-di[3-(β -L-ramnopyranosyloxy)-propyldiphenylsilyl]-2,2,4,4-tetraphenylcyclodisilazane (7).



The structures of obtained oligomers were established by physical-chemical methods of analysis, FTIR, ^1H , ^{13}C NMR spectra data.

A NEW SOLUTION OF THE ROTARY BARREL SEGMENT OF A SINGLE-SCREW EXTRUDER

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Until now, the general construction of the plasticizing system has assumed placing the screw in a fixed barrel. However, at the end of the 20th century, a completely new concept of the design of an extruder was put forward, which had never been used before in the industry or in experimental machines. This new solution consisted in kinematic activation of the barrel itself, which meant it could rotate in the direction identical or opposite to the direction of screw rotation. So far, several design solutions concerning kinematic activation of the barrel of the plasticizing system have been proposed. The idea of this solution is presented in the picture.

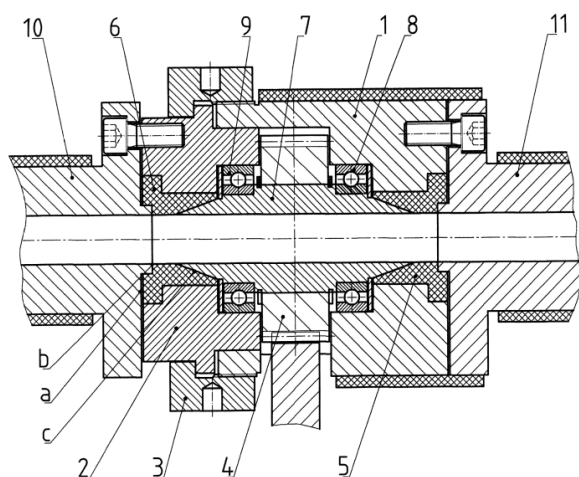


Fig. Schematic of a plasticizing system equipped with an active rotary segment: 1,2 - parts of the housing, 3 - special nut, 4 - gear drive, 5,6 - sealing bushes, 7 - rotary sleeve, 8,9 - bearings, 10,11 - stationary components of the barrel; a, b, c - areas of contact of the housing and sealing bushes with the fixed part of the barrel

As a result of the implementation of the international NEWEX project within H2020-MSCA-RISE several new construction concepts were developed for which CAD models were created using the SolidWorks programme. All CAD models were made in such a way that they could constitute the modification of W-25 single-screw extruder, and all of them present a classic or modified screw placed in the barrel plasticizing system, therefore screw diameter D equals 25 mm. The joint length of rotational barrel elements equals $4D$. The main reason for using such constructional solutions is the intensification of the mixing process and the increase of homogenization of the processed polymer, filled polymer or a composite. The strength and thermal calculations of selected models were carried out and computer simulations were performed concerning the optimization of the adopted solutions.

The most important aim is to maximize the mixing, quantified here by WATS, with little changes in the remaining criteria, *i.e.*, output, melt temperature at die exit (T_{melt}), mechanical power consumption ($Power$), length of the screw required for melting ($L_{melting}$) and viscous dissipation.

Acknowledgment. The project leading to this application has received funding from the European Union's Horizon 2020 research and innovation programme under the Marie Skłodowska-Curie grant agreement No 734205”.

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CONDUCTING POLYMERS: POLYANILINE AND POLYPYRROLE

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Polyaniline and polypyrrole are the most common conducting polymers (Fig. 1). They are easily prepared by the chemical oxidation of respective monomers [1,2]. Depending on the preparation design, they can be prepared as powders, thin film, coatings of various organic or inorganic objects, nanotubes, colloidal dispersions and hydrogels/cryogels [3,4].

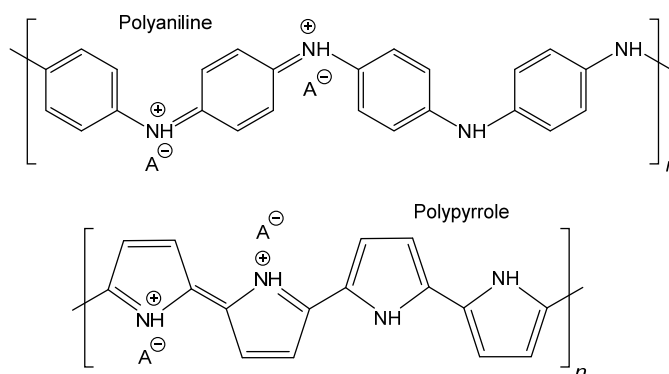


Figure 1. Polyaniline (emeraldine) and polypyrrole are prepared as salts with various acids, HA

The conductivity of materials based on conducting polymers depends on the way of preparation. The typical conductivity of polyaniline and polypyrrole is of the units S cm^{-1} but can be increased for nanotubular form of polypyrrole over 100 S cm^{-1} [5]. In the contrast to electrochemistry, the chemical oxidation of respective monomers allows to deposit thin conducting film both on conducting and non-conducting substrates.

In addition to the conductivity, conducting polymers also electroactive, i.e. they can be oxidized or reduced. This is exploited in the corrosion protection of metals. In dependence on pH, they exist as salts or bases. All these forms differ in conductivity, colour, hydrophilicity, and other properties, and responsive features have been used in the design of sensors. Conducting polymers reduce noble-metal ions to metals and generate composite materials that are useful in electrocatalysis. Soft macroporous cryogels may find uses in biomedicine for the monitoring or electro-stimulation of biological objects. Conducting polymers are also efficient adsorbents or organic dyes and they are thus applicable in environmental issues.

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USING OF POLYMERS TECHNOLOGIES IN THE INDUSTRY

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We have developed a constructive ozone generator device. Resulting from ozone with its high antibacterial properties, is widely used in the industry.

The most critical nodes, where as a result of an electronic discharge, ozone with oxygen is produced, Polymer compounds are used: fluoroplastic and vinyl plastic. It is the most unusual and exhibits the best performance in terms of temperature and chemical resistance, and non-stick properties. Its major disadvantage is that it does not actually melt when heated and, therefore, is difficult to process and very unconventional techniques are needed to mould, extrude, and weld this fluoroplastic.

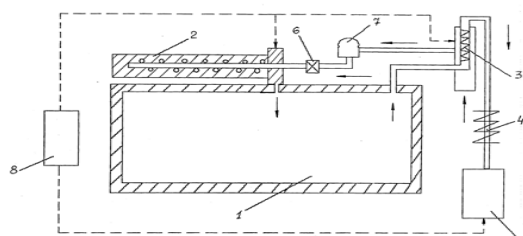


Figure 1. Sterilization unit

At present the preparatory research works are conducted in the central library of the TSU for conducting ozonotherapy of books. Ozone allocated for disinfecting books is a mixture with the rest of the components of the air (water vapor, hydrogen peroxide, nitrogen, carbon dioxide, etc.). This ozone mixture is included in the upper part of the chamber, evenly distributed on the bottom of the disinfecting chamber on books, and then with gloves it is necessary to flip through the books.



Figure 2. Disinfecting chamber

Our studies show the ozone's apparent advantage over other disinfectants. The potential user of the use of ozone generators is the Institute of Manuscripts of Georgia and the national Museum.

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Abstract

SYNTHESIS AND INVESTIGATION OF PROPERTIES OF COMB-TYPE METHYL SILOXANE COPOLYMERS WITH DIPHENYL SILOXANE GROUPS IN SIDE CHAIN

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The possibility of realizing novel technical solutions in many branches of industry is always defined by thermal and frost resistance of modern elastic materials. That is why development of methods for obtaining new polymers for composites with improved resistance to destabilizing influence of high and low temperatures is always relevant. One of the most interesting ways in this direction is synthesis of block-copolymers (BCP), which macromolecules represent a “hybrid” of two or more blocks different by chemical structure or composition. In the majority of cases, thermodynamic incompatibility of the blocks induces stable microphase splitting, which, finally, allows an original combination of properties of heterogeneous fragments of BCP.

The main aim of this investigation is the synthesis of regular comb-type copolymers combining soft poly(dimethylsiloxane) blocks and rigid blocks with diphenylsiloxane fragments in the side chain and investigation of their properties. The poly(dimethylsiloxane) blocks possessing glass transition temperature of -123°C and dielectric constant of 28 impart high elasticity at low temperatures, good dielectric properties, high resistance to ozone-induced aging, durability and good gas permeability. One other hand the more rigid high-melting diphenylsiloxane blocks imparts high strength and other valuable properties to the Block-Copolymers (BCP). These newly synthesized BCP materials can be applied as stationary phases for gas-liquid chromatography or thermoplastic elastomers.

For synthesis of comb-type copolymers and BCP we obtained the initial compounds. Via heterofunctional condensation reaction of dihydroxydiphenylsilane and diphenyldichlorosilane in 20% solution of dry toluene in the presence of dry pyridine at 1:2 ratio of initial compounds at -5–0°C. By dehydrocondensation reactions of PMHS and polymethylhydrosiloxane-dimethylsiloxane copolymers with hydroxydiphenylsiloxanes in the presence of dry potassium hydroxide comb-type copolymers were obtained.

FTIR and NMR spectroscopy was used to study the synthesized materials at different stages of the synthesis and confirm their chemical structures and compositions. Therefore, for synthesized copolymers and BCP have been carried out GPC (Gel- Permeation Chromatography), Differential scanning calorimetry (DSC) and Thermogravimetric (TGA) investigations.

Acknowledgment. This work was supported by the German Academics Exchange service (DAAD).

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THE THEORETICAL DESCRIPTION FOR VO(OH)-ASSISTED ELECTROPOLYCONDENSATION OF 2,5-DIBROMODERIVATIVES OF FURAN, PYRROLE AND THIOPHENE

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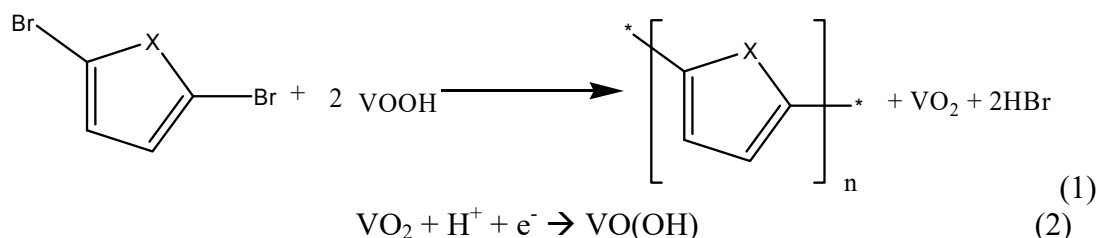
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Conducting polymers may be synthesized by chemical and electrochemical means [1]. In the first case, the strong oxidants are used to transform the monomer into cation-radical. In the second case, the electric current is used to oxidize monomer (directly or indirectly)

An interesting method for indirect synthesis of conducting polymers has been described by Zotti and co-workers [2]. The polyfuran has been obtained by electro reductive polycondensation of 2,5-dibromofuran in the presence of zinc compounds. Another way to realize this process may be the electrode modification by vanadium (III) oxyhydroxide. Nevertheless, vanadium oxyhydroxide use as electrode modifier hasn't been studied completely. Moreover, the electrochemical instabilities, typical for the electrosynthesis of conducting polymers [3] may also accompany this process. Thus, the practical realization of the electrosynthesis won't be efficient enough without the theoretical behaviouristic investigation including the development and analysis of a mathematical model, capable to describe adequately the processes in the system.

In this work, the VO(OH) – polymer composite synthesis by electrochemically assisted polycondensation in potentiostatic mode will be described. In this case, the polymer formation will be realized by the reactions (1) and (2):



In potentiostatic mode, the electro polycondensation is described by a classical bivariant differential equation set (3). Its analysis confirms the stable steady-state formation and maintenance. On the other hand, the oscillatory behavior in this system will be more probable than in the analogous systems with the indirect electro polymerization, due to the presence of two processes influencing the DEL.

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Abstract

PREPARATION OF THE PROTON CONDUCTING PHASE-SEPARATED MULTIBLOCK COPOLYMERS WITH SULFONATED POLY(PHENYLENE SULFONE) BLOCKS

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Increasing demand for environmentally benign energy sources encourages development of various technologies. Among them, polymer electrolyte membrane fuel cells (PEMFCs) are considered as one of the most promising alternative energy conversion devices due to the high energy density and environmental friendliness [1]. PEM is the key component of the system, which strongly influences as FC performance, as well as production cost. The present state-of-the-art PEMs are perfluoro-sulfonic acids (PFSAs) such as Nafion[®]. However, PFSA membranes have several disadvantages such as low operation temperature (<90°C), which does not meet request of industry (higher operation temperatures >100°C are desirable for several reasons, including faster electrode kinetics and higher tolerance to CO poisoning of catalyst), environmental incompatibility, high gas permeability and a very high electro-osmotic drag of water [2,3]. Hence, there is interest in the development of novel polymer electrolyte membrane materials. Among them one of the most promising PEM materials are multiblock copolymers consisting of alternating hydrophilic sulfonated poly(phenylene sulfone) (sPSO₂) and hydrophobic poly(phenylene ether sulfone) segments [4]. sPSO₂ blocks are advantageous over frequently reported sulfonated poly(arylene ether sulfone)s due to their higher stability against desulfonation. The stabilization effect is caused by the presence of electron-withdrawing groups (-SO₂-) in the ortho position to the sulfonic acid groups [5]. Previously we have reported on the synthesis of multiblock copolymers with hydrophilic sulfonated poly(phenylene sulfone) block, where each phenyl ring is monosulfonated (sPSO₂-220) [4]. These phase-separated copolymers with ion-exchange capacity (IEC) of 1.6 showed slightly higher proton conductivity compared to Nafion and reasonable viscoelastic properties, but insufficient for commercial application. Here we report on the synthesis of multiblock copolymers, where hydrophilic block presents sulfonated poly (phenylene sulfone), where only half of phenyl rings are sulfonated (sPSO₂-360). The multiblock copolymers were obtained by multiple sequential coupling of the pre-synthesized hydrophilic with the hydrophobic blocks. The coupling reaction is based on a nucleophilic aromatic substitution reaction between the phenoxide end-groups of the hydrophobic blocks and BPAF10 end-groups of the hydrophilic blocks. By variation of the block lengths (degree of polymerization) IEC value was kept equal to 1.6 meq./g allowing fair comparison with most well-studied sPSO₂-220 based multiblock copolymer (SU₁₄-FS₁₅) [4].

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Abstract

PHENOL-FORMALDEHYDE POLYMERIC NETWORK TO GENERATE ORGANIC AEROGELS: SYNTHESIS, PHYSICOCHEMICAL CHARACTERISTICS AND POTENTIAL APPLICATIONS

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In this study, phenol-formaldehyde (PhF) resins with different molar ratios of both components and bisphenol A diglycidyl ether with the different concentrations were used for the copolymerization of the monomers [1]. Two organic aerogels (AGs) were derived from these polymerization reactions. The data showed that organic AGs exhibited porous and functionalized structures resulting in efficient Cu(II), Mn(II) and Fe(III) ions removal from water sources. AGs showed also fairly good sorption properties towards organic solvents and dyes. Combined complex permittivity and ac electrical conductivity measurements sense structural changes, indicating that AGs can be also promising sensors for the interaction of fluids interpenetrating their porous system. We have presented the first example of phenol-formaldehyde-based aerogels used to oils, organics and heavy metal ions removal from wastewater. The nanoporous structures of AGs can be tuned by concentration of used monomers and experimental conditions for their formation. Despite the fact that PhF organic AGs, show lower sorption capacity compared to some other aero-like sorbents, our samples are still promising to be used for removing of some organic pollutants and heavy metal ions from wastewater, considering the multifunctionality, low-cost, fast sorption rate and excellent recyclability. BDS results indicate that the huge internal grains; surface area of AGs exhibit increased efficiency of collecting undesirable atoms or molecules by transferring them through the porous system by fluids or air. Aerogels may also be used as sensors of such entities by simply recording changes, of some orders of magnitude, in both the capacitance and electric conductivity.

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Abstract

ASSESSMENT OF PHARMACEUTICAL PROPERTIES AND PHARMACOLOGICAL ACTIVITY OF ALGINATE HYDROGELS WITH CYNAROSIDE, A FLAVONE DERIVATIVE OF LUTEOLIN

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In our study, alginate (ALG), an anionic polymer with bioadhesive properties, was selected as a cynaroside (CYN) carrier and used to create multiple hydrogel formulations. All developed formulations possessed a homogenous consistency, and CYN particles were uniformly suspended in the vehicle, colouring the hydrogel base yellow. The particle size of the suspended CYN ranged from approximately 22 to 26 μm . Comparing the CYN formulations showed that the viscosity of the hydrogel increases with increasing CYN concentration. The *in vitro* CYN release from all formulations was examined through a natural cellulose membrane using an enhancer cell with a surface area of 3.80 cm². The samples were analysed by HPLC. Hairless mouse skin samples were used to imitate *in vivo* conditions, and the data obtained suggest that the bioadhesive properties of the prepared formulations were correlated with the ALG concentration in the hydrogel base and its consequent viscosity. In addition, the anti-inflammatory and anti-allergic activities of all hydrogel formulations were evaluated *in vivo*. The results showed that 10% CYN could inhibit the release of anti-inflammatory mediators, and both tested concentrations, 5% and 10% (2 mg and 20 mg CYN per site, respectively), reduced oxazolone-induced ear swelling. Histopathological examination of samples revealed a marked reduction in paw skin and ear tissue inflammation and inflammatory infiltrates. The influence of CYN on cell proliferation was examined by the PCNA staining method, and the staining and distribution of PCNA immunoreactivity (PCNA-IR) cells were observed. After the application of 5% and 10% hydrogels, the tested samples showed decreased nuclear immunoreactivity to PCNA, similar to that of the control. Moreover, after application of the placebo formulation, a decreased number of PCNA-IR cells was also observed. The obtained data suggest that the topical application of CYN significantly reduces the number of T cells, mast cells and histiocytes in mouse skin with inflammation or atopic dermatitis.

Acknowledgement. This work was supported by the Medical University of Białystok (Poland). Grants: N/ST/ZB/18/001/2212 and N/ST/ZB/18/003/2215.

Abstract

COPOLYMERIZATION STUDIES OF POLYMERIZABLE MONOMERS FROM CARDANOL: A RENEWABLE RESOURCE

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The copolymerization of styrene (St) with a bio-derived monomer, pentadecylphenyl methacrylate (PDPMA), via atom transfer radical polymerization (ATRP) was studied in this work. The synthesis, morphology, and thermal and mechanical properties of these copolymers were investigated.

The copolymerization reactivity ratio was calculated using the composition data obtained from ¹H NMR spectroscopy, applying Kelen-Tudos and Finemann-Ross methods. The reactivity ratio of styrene ($r_1=0.93$) and PDPMA ($r_2=0.05$) suggested random copolymerization of the two monomers with alternation. The copolymerization conversion increased with increasing PDPMA concentration of the feed, up to 70 wt% PDPMA, but decreased thereafter. The molecular weight determined by gel permeation chromatography was lower than the theoretical values and the polydispersity increased from 1.32-2.19, with increasing PDPMA content in the feed. The influence of styrene content on the glass transition and thermal decomposition behaviour of the copolymers was studied by differential scanning calorimetry (DSC) and thermogravimetric analysis, respectively. Morphological characterization by transmission electron microscopy (TEM) revealed a phase separated soft core-hard shell type structure. The complex viscosity and adhesion properties like peel strength and lap shear strength of the copolymer on different substrates increased with increasing styrene content. The morphological characterization by TEM suggested a phase separated morphology. Rheological and adhesion tests suggest tuneability of the adhesion properties through copolymerization of styrene and PDPMA and their utility in hot melt adhesives.

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Abstract

INVESTIGATION OF THE CAUSES OF STABILITY VIOLATION OF PROPAGATING POLYMERIZATION HEAT WAVES IN THE PROCESS OF FRONTAL POLYMERIZATION

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The report is devoted to the studies of the causes of the stability violation of self-propagating heat waves in the process of frontal polymerization. Frontal polymerization is an autowave process of polymerization heat wave propagation. Owing to its specificities, frontal polymerization has entered the sphere of High Technologies with a contribution to the synthesis of high-temperature polymer superconducting composites and polymer nanocomposites with different properties [1].

In order to establish the laws of the stability loss during frontal polymerization, complexes of acrylamide with transition metals (Co, Ni, and Mn) were polymerized with and without inert additions and nanoparticles. Corresponding kinetic and dilatometric studies were made of the polymerization processes both in adiabatic and frontal conditions, and the results were compared [2].

It was shown that the process proceeding in the mode of heat wave propagation brings about polymer shrinkage, commensurate with the phase of heat wave oscillations, which disturbs the heat propagation from layer to layer, and leads to the violation of the stationarity of the process. This, in turn, results in the formation of spin-like rings on the resulting polymer, and the non-stationary mode of frontal polymerization.

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CARBONIZED POLYANILINE CRYOGEL: A SPECTROSCOPIC STUDY

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Conducting cryogels are produced by the preparation of conducting polymers in frozen aqueous media, in ice. They contain a conducting component, typically a conducting polymer, such as polyaniline [1] and suitable supporting polymer, here poly(vinyl alcohol). Raman spectroscopy allows for the analysis of swollen samples or of aqueous solutions. Freeze-dried polyaniline cryogel, an aerogel, was prepared from polyaniline and was subsequently analyzed with Raman spectroscopy. The carbonization of aerogel to carbogel has been followed by thermogravimetric analysis in inert atmosphere [2]. The macroporous morphology of polymer aerogel was retained after carbonization (Fig. 1). Raman spectra of polyaniline salt at 20 and 100°C display the bands of the phenazine-like segments in polyaniline at 1646, 1401 and 578 cm^{-1} , indicating extensive cross-linking of constitutional polyaniline units (Fig. 2). The conversion to nitrogen-containing carbon is complete at 500°C.

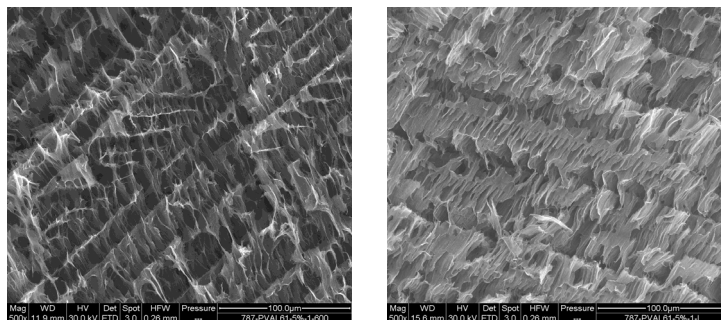


Figure 1. Morphology of polyaniline aerogel at 20°C (left) and after exposure to 600°C (right).

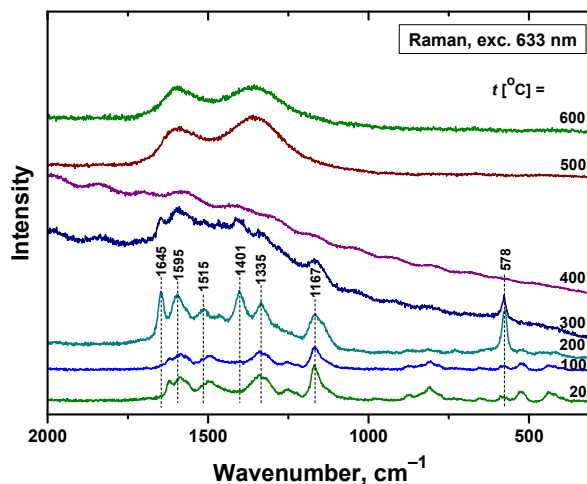


Figure 2. Raman spectra of polyaniline aerogel exposed to elevated temperature.

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MODIFICATION OF GEORGIAN NATURAL ZEOLITES

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Georgia is rich in natural zeolites endowed with a unique combination of molecular-sieve, sorption, catalytic, and ion-exchange properties, providing a wide range of their industrial and agricultural application. However, the methods of “secondary synthesis” allow us to improve properties of zeolites, and some examples of the modification of Georgian natural clinoptilolite, analcime, and phillipsite are considered in our communication.

Natural clinoptilolite has a high adsorption capacity, but a relatively low ion exchange capacity. It is shown that the processing of clinoptilolite from the Hekordzula plot of Tedzami deposit, Eastern Georgia, with dilute hydrochloric acid (approx. 0.025 N) increases the ion exchange capacity to the theoretical limit [1].

Natural analcime is a good ion exchanger, its capacity is up to 5.1 meq/g. The selectivity series for the sodium-enriched form derived from the ion exchange isotherms is as follows: $\text{NH}_4^+ > \text{Ag}^+ > \text{Li}^+ > \text{Ca}^{+2} > \text{K}^+ \sim \text{Sr}^{+2}$ [2], and the ammonia-enriched forms of analcime from the Chachubeti plot of the same deposit have been successfully used as fertilizers. On the contrary, analcime is a poor adsorbent, its compact structure prevents the adsorption and diffusion of molecules in the cages and channels. Acid treatment of analcime improves its adsorption properties: the capacity for water vapor increases from ~2 to ~6.7 mmol/g after processing in diluted HCl solutions, and the capacity for benzene increases from ~0.5 to ~1.5 mmol/g after processing in concentrated acid solutions. The acid-treated samples are characterized by a developed system of mesopores (sizes up to 200 nm, total volume up to 0.05 cm³/g). Pore size distribution depends on the origin of sample, the total volume of mesopores increases with increasing concentration and duration of the treatment. Preliminary thermal treatment results in narrowing of pore size distribution (up to 60-100 nm) and decrease of the total pore volume. It is also found that analcime and its thermally treated forms are acid-resistant, about 40% of aluminum does not come into contact with the aqueous acid phase, and unlike clinoptilolite and other silica-rich zeolites, analcime cannot be dealuminated to a high degree ($\text{Si}/\text{Al} > 7$).

Silver-, copper-, and zinc-containing zeolite materials have been prepared on the basis of Georgian phillipsite using ion-exchange reactions between zeolite and a salt of a transition metal in the solid phase followed by washing. Synthesized adsorbent-ion-exchangers are characterized by chemical analysis and water sorption data, XRD patterns, FTIR spectra, SEM images; they remain the crystal structure and general properties of phillipsite, contain up to 230 mg/g of silver, up to 66 mg/g of copper, and up to 86 mg/g of zinc, and show bactericidal and bacteriostatic activity towards *Escherichia coli*. The procedure of ion-exchange synthesis leads to a significant increase in the dispersion of the material. The compliance of proposed „dry“ method with high environmental standards is confirmed by its low Sheldon’s factor E in comparison with the similar green chemistry metrics of conventional „wet“ methods of the ion exchange in solutions. The resulting materials have sorption and bactericidal properties, sufficient for their use in the purification and disinfection of water [3].

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Abstract

HIGH TEMPERATURE LASER SINTERING OF A POLYIMIDE NANOCOMPOSITE POWDER

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Laser sintering (LS) is one of the most advanced and promising fabrication methods among the polymeric additive manufacturing technologies. This process builds 3D-structured parts by selectively sintering successive layers of powdered material under a laser. Currently, polyamide powders dominate the majority of the current market of polymeric materials for LS. New processable polymeric materials could substantially broaden their applications. The high-temperature polymer - semi-crystalline polyimide is interesting for its processing by the method of LS. However, current LS materials cannot completely meet the needs of all products [1]. A possible way to get the requirements for various applications is polymers modification with carbon nanoparticles [2]. The aim of the present work is to obtain thermoplastic heat-resistant polymer powder materials modified with carbon nanoparticles for the processing of their SLS.

A semi-crystalline polyimide R-BAPB was synthesized by chemical imidization from R dianhydride (1,3-bis (3,3', 4,4'-dicarboxyphenoxy) benzene) and BAPB diamine (4,4'-bis (4''-aminophenoxy) diphenyl). Carbon nanofibers (VGCF) of ~ 150 nm in diameter, ~ 10-20 µm in length (Showa Denko) and single-wall carbon nanotubes (SWCNT) with diameter ~ 1.5 nm, length ~ 1.5 µm (OOO «Carbon ChG») were used as nanoparticles.

The resulting nano-modified polyimide powders were analyzed for powder properties (part size, size distribution, bulk density) as well as for intrinsic properties of polymer powder (viscosity of the melt, temperature of melting and crystallization and thermal degradation limit).

The study of the technological properties of the powder (bulk density) showed that nanomodified polyimide powders had an increased bulk density compared with unmodified sample.

Analysis of the mechanical properties of the samples obtained by the SLS method revealed that the maximum strength characteristics were observed at a concentration of 0.5% VGCF and 0.2% SWCNT in the polyimide matrix. The introduction of 0.5% VGCF and 0.2% SWCNT leads to a noticeable increase in tensile strength ~ by 42% and 30% and tensile strain by 50% and 40% respectively.

Thus, the modification of polyimide with carbon nanoparticles is an effective way of improving the characteristics of the initial powder for laser sintering and the formation of high-quality samples using the SLS method.

Acknowledgment. This work was supported by the by the Russian Foundation for Basic Research (RFBR) grant № 17-03-00733 A

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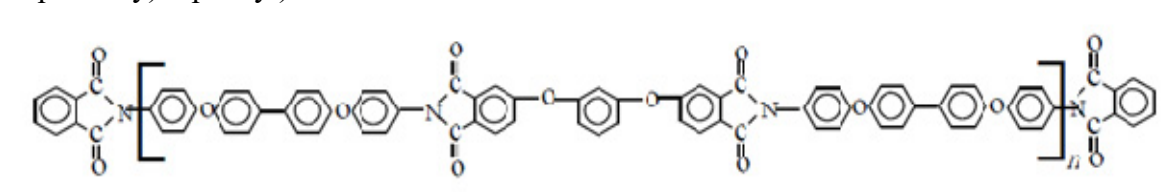
Abstract

INFLUENCE OF CARBON NANOTUBES ON THE PROPERTIES OF ORIENTED MELT-EXTRUDED SEMICRYSTALLINE POLYIMIDE FIBERS

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Aromatic polyimides are known for their outstanding thermal stability, excellent mechanical and electrical properties, and chemical resistance. These properties make them attractive for many applications. Much of the research to date has concentrated on polyimide films, coatings, resins and laminates. Another application of polyimides that has recently gained more attention is fibers. It is also of great importance to develop a way of producing such fibers by melt-extrusion, since it is much more ecologically friendly than solution-spinning. The oriented fibers are one of the possible ways to enhance the anisotropic effect and the mechanical properties of the material using nanoparticles with a high degree of anisometry, for example carbon nanotubes. The aim of the present work was obtaining melt-extruded thermally stable nanocomposite fibres based on the semi-crystalline polyimide modified with carbon nanotubes and studying their structure and properties. In this work, semi-crystalline polyimide R-BAPB was synthesized by thermal imidization from R dianhydride (1,3-bis (3,3', 4,4'-dicarboxyphenoxy) benzene) and BAPB diamine (4,4'-bis (4"-aminophenoxy) diphenyl).



To increase the mechanical characteristics of polyimide fibers, single-wall carbon nanotubes (SWCNT) with diameter ~ 1.5 nm, length - 1.5 μm (OOO «Carbon ChG») was used.

Nanocomposite fibers based on polyimide were produced with the help of twin screw microextruder. In order to increase their mechanical properties, the polyimide fibers were subjected to an orientation thermal drawing at 230°C. The SEM study revealed very good distribution of the carbon nanotubes throughout the volume of the polyimide fiber.

The introduction of single-walled carbon nanotubes leads to a modification of the morphology of the fiber. In this case, carbon nanotubes act as initiators of crystallization with the formation of a transcrystalline region near the surface of the nanotubes.

The mechanical testing of non-oriented nanocomposite fibers showed that the introduction of SWCNT led to an increase in tensile strength and modulus, while deformation at break decreased. High-temperature drawing allows obtaining polyimide nanocomposite fibers with significantly increased mechanical properties.

Acknowledgment. This work was supported by the by the Russian Foundation for Basic Research (RFBR) grant №18-03-00963 A

NEW SEGMENT COPOLY(URETHANE-IMIDE)S AS POLYMERS FOR MATERIALS WITH SHAPE MEMORY

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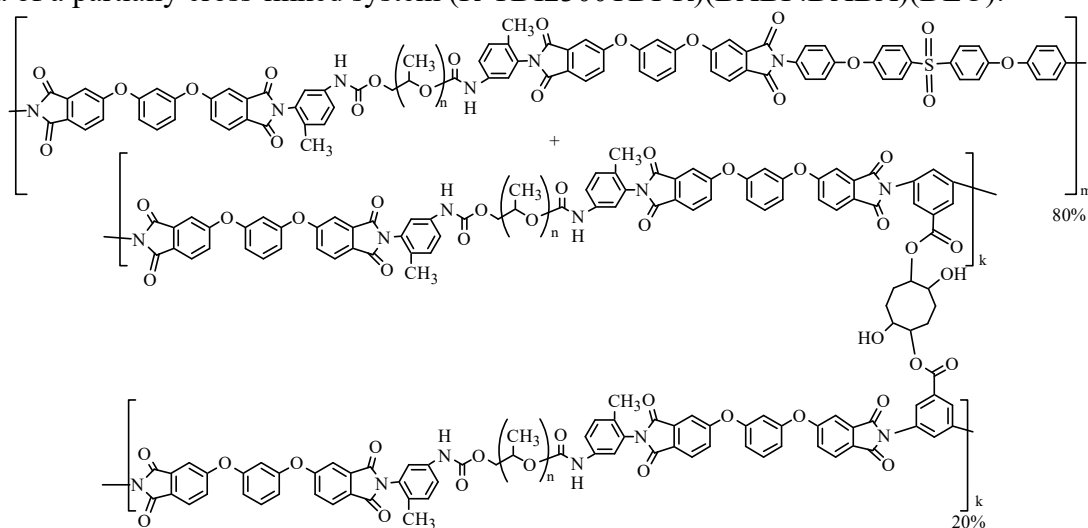
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Copoly(urethane-imide)s is a new subclass of heat-resistant polymers. These polymers are promising as the basis of highly heat-resistant thermoplastic elastomers. These copolymers combine the properties of two polymers: polyimide and polyurethane.

To obtain such polymeric materials, both the modification of the copoly(urethane-imide) unit and the introduction of monomers with free reaction groups into the polymer chain were carried out in order to form chemical crosslinks between macromolecules. Such an approach will provide a promising new material with shape memory effect.

In the present work, cross-linked copoly(urethane-imide)s systems were obtained based on poly(diethylene glycol)adipate diol ($M_n=2500$) (**2500**) и polypropylene glycol ($M_n=2300$) (**2300**), tolylene-2,4-diisocyanate (**TDI**), bis(3',4-dicarboxyphenoxy) benzene dianhydride (**R**), diamine 1,4-bis(4'-aminophenoxy) diphenylsulfone (**BABP**). In the course of the synthesis, 3,5-diaminobenzoic acid (DABA) was introduced as units for cross-linking the chains in a ratio with a diamine of 20%:80%. Tolylene-2,4-diisocyanate (**TDI**), methylene diphenyl diisocyanate (MDI), 1,2,5,6-diepoxy-cyclooctane (**DEO**) were used as cross-linking agents. The example below shows the final formula of a partially cross-linked system (R-TDI2300TDI-R)(BABP:DABA)(DEO):



Synthesized cross-linked systems were investigated by thermal analysis methods (TGA, DSC, DMA). In addition, the deformation and strength properties of the films were evaluated.

By varying the type of aliphatic units and cross-linking agents, the final performance characteristics of the material can be adjusted.

The results suggest a possible use of copoly(urethane-imides) as a new material with shape memory.

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NEW CATIONIC POLYMERS COMPOSED OF NON-PROTEINOGENIC α -AMINO ACIDS

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The importance of cationic polymers (CPs) is universally recognized because they exhibit unique biological properties [1]. CPs are of interest as active biological compound carriers to be used in both gene therapy and biotechnology. They show inherent bioactive properties such as antimicrobial, antioxidant, antitumor, and anti-inflammatory stimuli responsiveness make CPs more promising for enhanced therapeutic potential. CPs that can be cleared from the body following executing their function, that is biodegradable, look especially valuable. One of the most convenient approaches for constructing biodegradable CPs is the incorporation of hydrolysable ester bonds in the polymeric backbones. This could be achieved e.g. by the application of diamino-diester monomers – made of cationic amino acid arginine (R) and diols bis-(arginine)-alkylene diesters (TRD) [2].

Promising building blocks for constructing biologically active polymers are non-proteinogenic amino acids (NPAAs) [3]. Among NPAAs amino acids containing unsaturated bonds in the lateral groups attract a special attention [4]. Such amino acids were used as selective inhibitors of Endothelin-converting enzymes, inhibitors of thrombin and cathepsin B, inactivators of pyridoxalphosphate-dependent γ -cystathionase, growth inhibitors of B. Subtilis B-50 [4,5], etc. We have decided to combine these two classes of biologically active polymers and to construct new hybrid-polymers (co-polymers) bearing the biological activity of both „parent“ polymers – CPs made of amino acid R and unsaturated polymers made of NPAAs. In other words to construct new polymers which are expected to have new biological activities.

In the present study we have synthesized and characterized such kind of the hybrid-polymers.

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Abstract

STUDY OF AN INFLUENCE OF ADDITIVE AMOUNTS OF J@CNT ON THE CUMENE CHAIN OXIDATION REACTION

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The purposeful use of carbon nanostructures in materials science has led to producing the extraordinary outputs. However, it is important to perform specific requirements to use them in a particular application, (for example, the compatibility of properties in the area to be used or the surface modification to ensure that the process is in a certain direction) to optimize carbon nanostructures. The ends of the carbon nanotubes are more reactive than the side walls, allowing them to combine different types of atoms. On the contrary, there are a number of studies on the chemical changes in both the internal and external walls of the nanotube. In this regard, we have modified carbon nanostructures by iodine modification and modified chemical composition and investigated their effects on oxidation reaction of cumene.

The J@CNT sample used in the oxidation process was synthesized from cyclohexane by a vapor-phase chemical-deposition method (CVD) and the modification of J2 over the MWCNTs.

The activity of the J@CNT sample acquired in the main phase of the study was researched in oxidizing reactions of the cumene. The kinetic laws of the oxidation reaction were studied according to the amount of oxygen absorbed in the equipment for oxygen uptake at constant pressure. In experiments, various quantities of cumene and J@CNT were used and, as a standard, experiments were carried out at temperatures of 60°C at 20 kPa of oxygen. In all experiments, an induction period was observed at the beginning of the reaction and in some experiments the induction period has reached 17 and even 40 minutes.

The results of experiments have shown that iodine-containing carbon nanostructures have a considerable impact on the course of reaction in oxidizing reactions of cumene powder it caused a decrease in its speed (2 times reduction (from 101 to 45 mm³ O₂/min)) and this has led to a delay in the reaction and stopped the practice after a certain period of time. A remarkable reduction in the catalytic activity of carbon nanostructures has been determined by the iodine atoms that are impregnated to the surface of carbon nanotube, confirming the results of iodine experiments. It is believed that this is due to the change in the electron structure of carbon nanoparticles by the addition of iodine. Based on these results, kinetic charts have been established and additionally, the speed constants of the oxidation reaction of the cumene in carbon nanotube containing iodine are calculated. The research has provided a new guide to the effects of iodine-containing nanocarbon catalysts on the oxidation reaction in liquid phase.

Abstract

OBTAINING A POLYETHYLENE COMPOSITION CONTAINING METAL NANOPARTICLES

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The development of the science of nanoscale and cluster metal-containing particles in polymer matrices is stimulated by the ever-growing interest in this problem in many areas of chemistry, physics, and materials science. The development of such studies has largely contributed to the creation of metal-polymer composite materials with specific physicochemical and operational properties: increased thermal and electrical conductivity, high magnetic susceptibility, and the ability to shield ionizing radiation [1, 2].

One of the methods for the formation of metal polymers is the high-rate thermal decomposition of precursors in a solution of a polymer melt. In the melt, the short-range order of the structure of the initial polymer is preserved, and the voids present in it become accessible for localization of the formed particles. First of all, they are introduced into the inter-spherulitic regions of the polymer matrix, into the space between the lamellae and into spherulite centers. At this point, there is a strong interaction between nanoparticles and polymer chains.

The presented work is devoted to obtaining metal-containing nanoparticles in a polyethylene matrix without using solvents by decomposing organic acid salts in a polymer medium under conditions of high shear deformations and studying the properties of the resulting nanocomposites.

Nanoparticles of metals in the matrix of high-pressure polyethylene (PE) were obtained in two stages by the method of high-speed thermal decomposition of organometallic compounds under conditions of high shear deformation. In the first stage, at a temperature of 130-140°C, a binary mixture of polymer and precursor was prepared on laboratory rolls. In the second stage, the mixture was heated in a Brabender microextruder in a nitrogen atmosphere at a temperature of 200-210° C for 10-12 minutes. Acetates of copper, cobalt and lead are used as precursors.

The phase composition and structure of the obtained nanocomposites were studied by XRD methods. It was shown that reflections from the planes of the crystal lattice of metals corresponding to the ASTM card index d_{hkl} of copper oxide I (Cu_2O), cobalt oxide (CoO) and lead oxide (PbO) were observed in the studied nanocomposites.

The resulting composites containing nanoparticles of metal oxides can be used as catalysts for organic and petrochemical synthesis, as well as modifying agents of industrial polymers in order to improve their operational properties.

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NANO-CATALYSIS IN DECALINE OXIDATION

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There is no doubt that the processes of aerobic, peroxide and other types of gaseous and liquid-phase oxidation of hydrocarbons are among the most important in the petrochemical and organic synthesis. It is also known that without catalysts, these processes take place in harsh conditions, are characterized by low selectivity for products obtained, suggest the use of highly active aggressive non-ecological oxidants containing chlorine, manganese and other heavy metals, leading to the formation of a large number of toxic by-products. Therefore, it is obvious that the problem of finding catalysts for the selective oxidation of hydrocarbons of various structures for a long time will remain relevant. It is important to note that the catalysts in such processes are aimed at selectively obtaining the primary reaction products, hydroperoxides, and all calculations are made on the basis of this premise.

In recent years, nanocatalysis has been strongly developed. In this area, nanocarbon compounds occupy a significant place, which are used as catalysts and as carriers for catalysts. There are many examples in the literature on this issue, and our research also confirms this.

As one of the samples, we report the results of the liquid-phase aerobic oxidation of decahydronaphthalene in the presence of a composite catalyst nano-TiO₂ (brookite)@MWNT. The selected hydrocarbon is a structural element of more complex organic compounds and can be considered as a model frame. For comparison, we simultaneously conducted the air oxidation of decahydronaphthalene, initiated by benzoyl peroxide at temperatures of 80°C and 130°C.

Results of oxidation process at various temperatures and reaction times are reported. It has been established that at temperature range 70-90°C the decaline peroxide not detected at measureable concentrations. However, already at 100°C and 5-20 hours reaction time 3,4-7,4% decahydronaphthalene is converted to hydroperoxide, which is stable at this conditions and does not contribute to chain ramification. The following main products of oxidation are detected: decalol (20.6%), trans-1 decalone (7.96%). It was found that at temperature 130°C, 14.5% of the oxidate consists of decahydronaphthalene hydroperoxide.

The results obtained make it possible for the first time to evaluate the specific features of the effect of the composite nano-TiO₂ (brookite)@MWNT on the aerobic oxidation processes of naphthenic hydrocarbons.

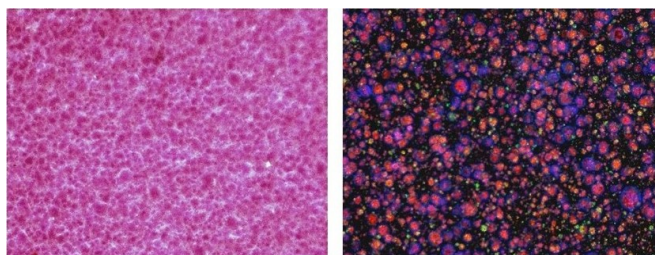
Abstract

INFLUENCE OF THE TECHNOLOGICAL CHARACTERISTICS OF PHOTOCROMIC LIQUID CRYSTAL POLYMER FILMS ON ITS OPTICAL PARAMETERS

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The liquid crystal (LC) composites obtained by the combination of liquid crystalline and photochromic properties, represent the base for the creation of polymeric materials with novel optical parameters, which enable to fabricate the photo optically controllable devices with advanced parameters. In this work, by using of the innovative technological method of microencapsulation elaborated by



SP doped photochromic liquid crystal polymer film

the authors [1], is prepared a new kind of photochromic LC films, consisting of spiropyran (SP) doped nemato-chiral LC matrix [2]. By controlling of technological characteristics (size of microcapsules, thickness of film, stretched as well as non-stretched film) at all the stages of microencapsulation, it is possible to obtain films with corresponding optical parameters for practical application. As was shown optically and microscopically, the photosensitivity of the films depends on the technological characteristics. The reduction of the sizes of microcapsules significantly increases the efficient photosensitivity and improves the spatial resolution of films. An increase of film thickness does not affect on the reflection intensity of LC matrix, but increases efficient photosensitivity. Stretching of polymer film slightly improves photosensitivity and significantly increases the reflection intensity.

The presented photochromic LC films have great potential for the development of high-performing optically gated photonic devices such as rewritable papers, real-time holograms, light-controlled molecular and fluorescent switches, real-time UV irradiation dosimeters. Further, the proposed material is promising for the production of mechanically flexible, environment-friendly, lightweight, large-area devices that can be fabricated by room-temperature solution processing.

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