

Fourth International Caucasian Symposium on Polymers and Advanced Materials

ICSP & AM 4

Batumi
2015

Welcome

Dear Colleagues,

On behalf of the Organizing Committee I wish to extend cordial welcome to all participants of the 4th International Caucasian Symposium on Polymers and Advanced Materials. eight years ago, 2007, this symposium took place in Tbilisi, Georgia. We are delighted to host you in this year in very beautiful seaside city on the Black Sea coast and capital of Adjara, an autonomous republic in southwest Georgia.

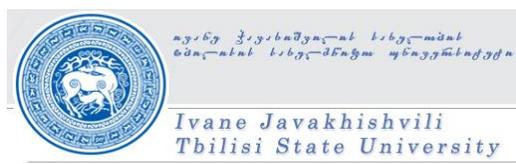
This year is significant for the Shota Rustaveli Batumi State University. He celebrated his 80th anniversary of its founding. This year also marks the 165 year anniversary of the first rector of Iv. Javakhishvili Tbilisi State University Peter Melikishvili

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 4" 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 100 participants, shall provide a good platform for academic and industrial scientists to discuss recent advances in the area of polymers and advanced materials.

Professor Omar Mukbaniani

Sponsors:



Organizing committee:

Chair – Prof. Omar Mukbaniani
Co. Chair – Dr. Vazha Tskhovrebashvili
Co. Chair – Prof. Marc J.M. Abadie

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Conference Secretariat – Lali Qemkhadze, PhD
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Leila Kalatozishvili, PhD

SYMPOSIUM SCHEDULE

1st July

09.00–10.30 Registration

10.30–11.00 Opening ceremony (Prof. Omar Mukbaniani, Prof. Marc Abadie)

Coffee break 11.00-11.20

Co-chairmen: *Prof. J.V. Grazulevicius and Assoc. Prof. V. Tskhovrebashvili*

Polymer Synthesis

11.20:11.40 *V.G. Syromyatnikov* - “Some aromatic azides and pentazenes in multistep radical polymerization”.

11.40:12.00 *M. Bratychak* – “Functional oligomers based on Phenol-formaldehyde resins”.

12.00: 12.20 *S. Remita* – “Radiation chemistry as a new way for the synthesis of nanostructured conducting polymers”

12.20:12.40 *P. Dobrzynski* – “Functional aliphatic polycarbonates and poly(ester carbonates) – synthesis and properties”.

12.40:13.00 *A.A. Hovhannisyan* – “On the mechanism of latex particles formation in polymerization in heterogeneous monomer - water system”.

Lunch break 13.00-14.30

Co-chairmen: *Prof. Marc J.M. Abadie and Prof. B. Mamedov*

14.30:14.50 *A.O. Tonoyan* – “Free-radical frontal polymerization of acrylamide in the presence of nano and micro additives”.

14.50:15.10 *G.A. Ramazanov* – “Methylene dioxolanes: synthesis, properties and ring-opening polymerization”.

15.10:15.30 *O. Kharchenko* – “Synthesis, characterization, and optical properties of styrylquinoline containing polymers”

15.30:15.50 *N.V. Kutsevol* – “Synthesis and characterizations of Ag and Au sols in star-like water soluble polymer matrices”

15.50:16.10 *O. Shyshchak* - “Synthesis and properties of carboxy-containing oligomers based on polycondensation resins”.

16.10:16.30 *O. Mukbaniani* - “Brush type methylsiloxane polymers: synthesis, properties & application”.

16.30:16.50 *Hammed H.A.M. Hassan* – “Synthesis, characterization and photoluminescence study of new aromatic polymeric nanoparticles containing pendent substituted aramides”.

Coffee break

Poster session p. 4-44 (“Polymers” and “Advanced Materials”)

16.50:17.50

18.30–20.30 Welcome reception

Co-chairmen: Prof. Sevan Davtyan and J.T. Haponiuk

09.00:09.20 N.A. Durgaryan - "Azoarylene and triazenearylene group containing polymers: syntheses, conductivities and trends in developments".

Structures/Properties Relationships

09.20:9.40 A. Heimowska - "The influence of polyurethanes structure on their surface morphology"

09.40:10.10 N. Kreiveniene - "Structure-properties relationship of carbazole-based 1,2,3-triazole derivatives".

10.10:10.30 C. Coletta - "Electron-induced growth mechanism of conducting polymers: a coupled experimental and computational investigation"

10.30:10.50 A.M. Guliyev - "cyclopropane containing bioactive polymers: synthesis, structure and properties"

10.50:11.10 W. Brostow - "brittleness and toughness of polymers and other materials".

Coffee break 11.10:11.40

Co-chairmen: Prof. W. Brostow and Prof. N. Lekishvili

Composites & Nanostructures

11.40:12.00 H. Janik - "Degradation of modified tps in the natural compost".

12:00 :12.20 J.T. Haponiuk - "Polyurethanes and polyurethane composites based on renewable resources".

12.20:12:40 S.P. Davtyan - "On the possibilities of obtaining current-carrying superconducting polymer-ceramic nanocomposites".

12:40:13:00 J. Aneli - "Composites based on sawdust and some organic binders".

Lunch break 13.00-14.30

Co-chairmen: Prof. E.B. Zeynalov and Prof. H. Janik

14.30:14.50 T. Agladze - "Synthesis of functional bi-component nanoparticles".

14.50:15.10 G. Meskhi - "Emission of nanoclusters during N⁺, O⁺, N₂⁺, O₂⁺, AR⁺ ions bombardment of al and si surfaces".

Materials

15.10:15.30 Marc J.M. Abadie - "Fundamentals and challenges in curing process".

15.30:15.50 J.V. Grazulevicius - "Organic ambipolar molecular materials for optoelectric devices".

15.50:16.10 C. Coletta - "Electron-induced growth mechanism of conducting polymers: a coupled experimental and computational investigation".

16.10:16.30 I. Savchenko - "New polymer metal complexes based β -diketones and lanthanides for oleds".

Coffee break

16.30:16.50

Poster session p. 45-85 ("Polymers" and "Advanced Materials")

3 July

<u>Co-chairmen:</u>	<i>Prof. M. Bratychak and Prof. G. Papava</i>
09:00–09:20	<i>E.B. Zeynalov</i> “Fulleropyrrolidines as promising antioxidant moieties in polymer materials”.
09:20–9:40	<i>B.A. Mamedov</i> “Preparation of Nanopolyaniline and its Polymer-polymer Nanocompositions with High and Stable Electro-conductivity”
9:40–10:00	<i>S. Robu</i> - ”Polymeric recording media based on carbazole containing copolymers and benzoxaphthalocyanines of transition metals”.
10:00–10:20	<i>B.A.Mamedov</i> - “Regularities of synthesis and properties of phenol resins and their nanocompositions”.
10.20:10.40	<i>Ch. Kirsch</i> - “Derivatizing the $[B_{12}X_{11}OH]^{2-}$ -cluster (X = Cl, Br) for new ionic liquids”.
10.40:11.00	<i>K.G.Guliyev</i> - “Optically transparent polymers on the basis of cyclopropylstyrene”.
Coffee break 11.00-11.40	
<u>Co-chairmen:</u>	<i>Prof. A. Tonoyan and Prof. R. Katsarava</i>
Green /Environment	
11.40:12.00	<i>H. Janik</i> – “Degradation of modified tps in the natural compost”.
12.00:12:20	<i>B. Kaczmarczyk</i> – „Characterization of shape memory biodegradable polyester blends”.
12.20:12.40	<i>R. Katsarava</i> – “Amino acid based biodegradable polymers - promising materials for numerous biomedical applications “.
12.40:13.00	<i>O.L. Figovsky</i> - Nonisocyanate environment friendly polyurethanes and their application”.
Lunch break 13.00:14.30	
<u>Co-chairmen:</u>	<i>Prof. V. Syromyatnikov and L. Nadareishvili</i>
14.30:14.50	<i>T.K. Jumadilov</i> - “Intergel systems – high effective instrument for rare earth elements extraction from industrial solutions”.
14.50:1510	<i>N. Lekishvili</i> – “Advanced materials based on natural and secondary resources of Georgia”.
15.10:15.30	<i>Siti Farhana Hisham</i> - “Study on covalent and ionic cross-linked in chitosan film by genipin and tripolyphosphate as potential material in medical applications”.
15.30:15.50	<i>M. Rukhadze</i> - “Study of structure of nanodroplets of water in reverse micelles: influence of kosmotropes and chaotropes”.
Coffee break	
15.50–16.50	<i>Poster session p. 85-126 (“Polymers” and “Advanced Materials”).</i>
17.00	<i>Closing lecture (young scientists awards, raffle prizes).</i>

4 July

<u>Co-chairmen:</u>	
9.00	Excursion around of Batumi.
18.00	Gala Dinner in restaurant.
<i>Farewell</i>	
Tbilisi V. Sarajishvili State Conservatory Small Hall concert of Georgian pianists and Bronislaw Abadie.	

Abstract

FUNDAMENTALS AND CHALLENGES IN CURING PROCESS

Marc J.M. Abadie

Institute Charles Gerhardt of Montpellier - Aggregates, Interfaces and Materials for Energy (ICGM – AIME, UMR CNRS 5253)

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In structural materials and composites based on thermoset matrices, it is important to control reactions related to the crosslinking network. A fully cured system appears when a physical property become non variable and reaches a plateau such as T_m , T_g , hardness, etc.

The gel time is defined as the time when a liquid resin (open time) starts to form microgels, before the gelation (initial cure) and the formation of solid state (final cure). Above this time processing cannot be properly done. Therefore it is important, when processing a composites, to be able to measure and control the gel time.

Depending of the applications, sometime gel time has to be increased (Marine) or reduced (Aerospace, civil planes).

For marine applications we will give some results from our experience when I was CEO of « Appli Composites Co. Ltd. ». Cheap matrices that have decent properties such as Unsaturated resins UPR or low cost system so-called Vinyl ester resins VER are taken as examples to reformulate the catalyzer/accelerator system by using either complexing or retarding agents agents for cobalt salt, varying the temperature and the concentration of the catalytic system or adding a co-solvent to the styrene. For better properties (mechanical, temperature, etc) similar attitude is used for epoxy resins EPR which cross-link with a hardener based amine or acid in presence of activator TBA. Therefore the control of the gel time is crucial for vacuum bagging lay-up such as Vacuum Infusion Processing (VIP), RTM Light (LRTM, Resin Infusion, VARTM, SCRIMP™).

For aerospace applications in maintenance, repair and overhaul (MRO) the objectives are :

- Find solutions for repairing structural damages of composite
- Assure fast and effective curing of resins and composites
- Shorten delivery time, as aircrafts are grounded and off of service until structural damages are not repaired

We have studied some flexible resins such as sealants (Urethanes modified epoxies - qualified to Boeing BMS 5-63) used for repairing tank leaks. Wide infrared emission spectrum of the 28Vdc Thermo reactor developped by SUNAREO (Lyon, France) allows to speed up the cross-linking reactions without any chemical modification of the system resin/hardener. For example, DAPCO 18-4F Sealant cures @ 65°C in 10h whereas with 28Vdc @ 50°C it cures in 90 min.

In conclusion, depending of the application, it is possible to reduce or increase the gel time allowing the optimization processing materials.

Abstract

POLYBENZIMIDAZOLE : NEW CONCEPTS OF ABPBI SYSTEMS FOR PEMFCS

Deborah Jones, Jacques Rozière & Marc J.M. Abadie

Institute Charles Gerhardt of Montpellier - Aggregates, Interfaces and Materials for Energy (ICGM – AIME, UMR CNRS 5253)

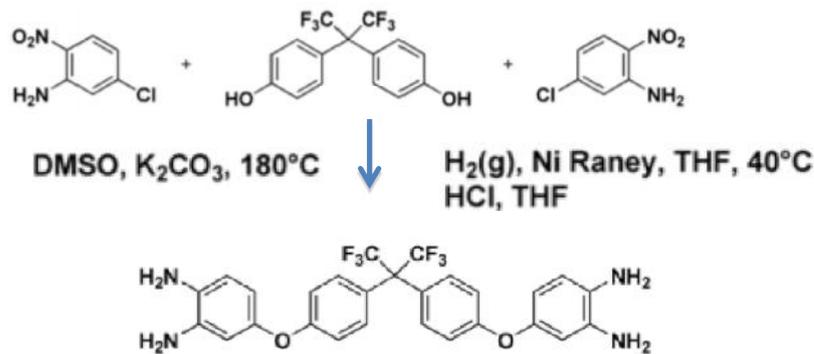
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The current industrial development model is based on a massive use of fossil fuels. Besides diponibles quantities of oil are limited or exhausted, are added the effect on the environment by significant increase in greenhouse gas emissions in the atmosphere produced during combustion. Hydrogen through an electrochemical generator, the fuel cell, is one of the industrial vector the most promising with respect to the environment. The proton exchange membrane in a fuel cell - PEMFC is the subject of numerous studies for nearly 20 years.

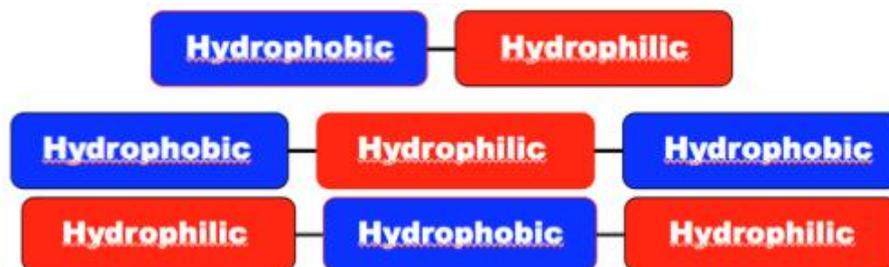
As the tetraminic derivatives for synthesis of PBI is considered as carcinogenic, we present here two aspects of our research based on diaminic compounds :

- The results and properties of membranes obtained in our laboratory on the synthesis of polybenzimidazol copolymers based on bis-benzimidazole precursors



- The perpectives and research in progress that address ABPBI. They involve two fundamental aspects,

- one by formation of block-copolymers with phase separation,



- the other related to a technical problem due to the insolubility of ABPBI which makes it difficult to process.

We try to provide solutions to obtain efficient and friendly environmental membranes.

Abstract

GREEN SYNTHESIS OF SILVER-MONTMORILLONITE NANOCOMPOSITE USING SATUREJA HORTENSIS L LEAF WATER EXTRACT AND EVALUATION OF ITS ANTIBACTERIAL EFFECTS AGAINST STAPHYLOCOCCUS AUREUS AND ESCHERICHIA COLI

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In this study, the biosynthesis and characterization of Silver-montmorillonite nanocomposite using *Satureja hortensis L* leaf water extraction by a green method is reported. Silver-montmorillonite nanocomposite were prepared using silver nitrate and montmorillonite as precursor and water extract of *Satureja hortensis L* leaf as reducing agent and stabilizer [1,2]. *Satureja hortensis L* was found to display strong potential for the synthesis of silver nanocomposite as antibacterial agents by rapid reduction of silver ions (Ag^+ to Ag^0) [1]. The characterisation of the obtained nanocomposite were studied using different methods, which including: ultraviolet-visible spectroscopy (UV-Vis), powder X-ray diffraction (XRD), scanning electron microscopy (SEM) and transmission electron microscopy (TEM). The SEM study showed that Silver-montmorillonite nanocomposite were spherical shape and were formed without agglomeration. The TEM study showed that mean diameter and standard deviation for the formation of Silver-montmorillonite nanocomposite were 17.99 ± 12.68 nm. The formation of silver nanocomposite using UV-Visible spectroscopy at wavelength 385 nm was confirmed. The XRD showed that the particles are crystalline in nature, with a cubic structure. The antibacterial effects of nanocomposite on Gram positive and Gram negative bacteria were also performed.

References

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2. Shameli K., Bin Ahmad M., Md Zin Wan Yunus W., Nor Azowa I., Gharayebi Y., Sedaghat S. International Journal of Nanomedicine., 2010, **5**, 1067.

Abstract

SYNTHESIS OF FUNCTIONAL BI-COMPONENT NANOPARTICLES

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Instrumental approaches for surface functionalization of a free standing metal NPs are in an emerging state. We proposed surface technology to improve functional properties of a spatially stabilized by organic shell molecules metal nanoparticles via localizing oxidation (LO) of shell material. The LO technique provides easy control over formation of metal (I)/metal (II) oxide nanocomposites and over their properties by means of variation in temperature and duration of shell substitution reaction. The two-step technology is used for preparation of Ag/MnO₂ bi-composites. The first step involves electrosynthesis [1] of silver-core/oleic acid-shell (average 20nm size) soles in hexane (a, fig.) and the second - coating of silver NPs by manganese oxide monolayer (b-d, fig.) via surface red/ox reaction:

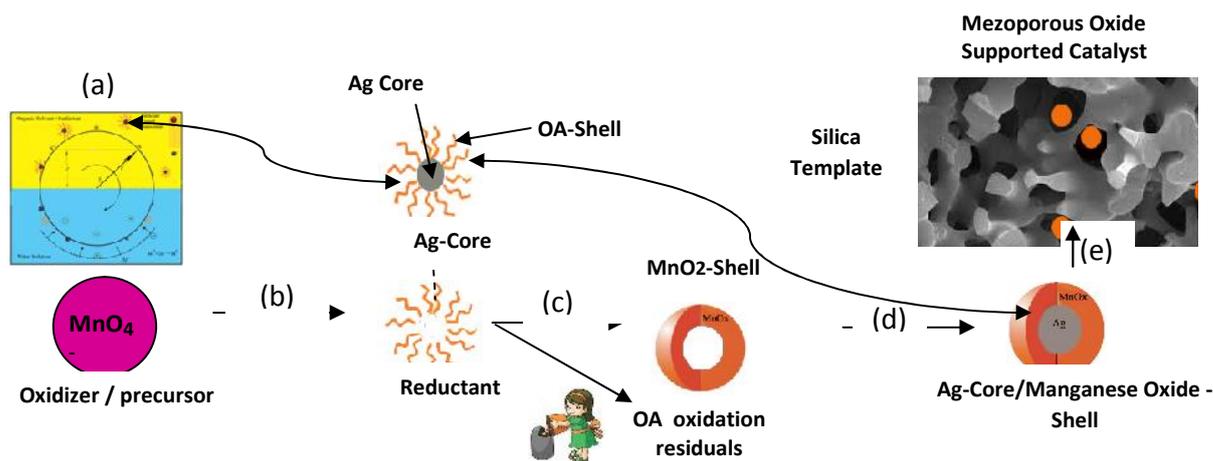


Fig. Preparation of Ag/MnO₂ mezoporous oxide-supported catalyst. (a) Electrosynthesis of Ag/OA NPs. (b-d) Reduction of potassium permanganate to manganese dioxide via localized shell oxidation reaction (1). (e) Preparation of mezoporous-oxide-supported Ag/MnO₂ catalyst.

References

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Abstract

STRUCTURE AND PROPERTIES OF THE POLYSTYRENE/FULLERENE COMPOSITE FILMS

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Incorporation of nanocarbonic particles (fullerenes) into a polymeric matrix is one of perspective methods for modification of the polymeric materials. The composites produced get novel physical and chemical properties that considerably expand the areas of their application as sorbents, separating membranes, sensors, antimicrobial drugs. Polystyrene is one of the polymers capable to content nanocarbonic particles. The present paper includes the detailed study on the structural properties and biological activity of both polystyrene films and polystyrene films filled with fullerene.

The structural characteristics of polystyrene films modified by the incorporation of fullerenes were researched by the infrared spectroscopy, ultraviolet spectroscopy, and X-ray diffraction technique. According to IR-spectroscopy data it was suggested that intermolecular interaction between polymer's phenyl ring and fullerene molecule occurs in the composite material. Semi quantitative analysis of IR spectra of the studied films with application of a method of a base line and internal standard was carried out. Analysis of UV spectra confirms the assumption that there is the interaction of polystyrene electron-donor molecule with π -electronic system of fullerene.

By the X-ray diffraction technique it is shown that there is the intermediate-range order in these materials. Incorporation of fullerenes into polymer matrix does not change the value of the repetitive characteristic distance in structural arrangement, but increases a correlation length (a scale of the intermediate-range ordering) in the disordered phase.

The glass transition temperatures, T_g , and specific heat capacities, C_p , in range of 293-423 K have been determined for the films by DSC technique. The plasticization of the polymer is observed in thermal properties of the films under influence of small fullerene additions. The values of T_g and C_p decrease and thermal coefficient of heat capacity increase as fullerene content increases up to 0.02 wt. %. The effect of interaction between polymer and fullerene molecules on thermal properties becomes evident at higher fullerene content in range from 0.02 to 0.1 wt. %.

To assess bioactivity of pure polystyrene and filled composite with fullerene the laboratory tests were conducted in biologic fluids (blood serum). We studied the influence of polymer materials researched on free-radical processes in blood serum in vitro. Lipid peroxidation was evaluated by induced chemiluminescence. We supposed that fullerene-containing polystyrene films may inhibit peroxidation processes.

Antimicrobial activity of the polystyrene-fullerene composites was tested against gram-positives (*Staphylococcus aureus*) and gram-negative (*Escherichia coli*, *Pseudomonas aeruginosa*) microorganisms and mushrooms of the type *Candida albicans*. The test results showed absolute death of the microorganisms under the modified film. It should be noted that dynamics of the microorganisms inactivation persists during a month. Results of work have very important practical significance for materials science, because polystyrene is used often for various modifications with low molecular compounds of special properties, including fullerenes.

The study was supported by the Russian Foundation for Basic Research (project no. 15-43-03034-a).

Abstract

COMPOSITES BASED ON SAWDUST AND SOME ORGANIC BINDERS

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During last decade the attention of specialists grows intensively to composites on the basis of wood polymer composites (WPC). Simple technology of manufacture, wide possibility of variation of exploitation properties and recurring processing, ensure low price of these materials. Our work is devoted to obtaining and investigation of mechanical and thermal properties of composites on the basis of high dispersive and dry sawdust with different organic binders. It was shown that the mechanical strength of composites based on some silicon-organic binders obtained at increasing temperature in the range 90 -120°C and fixed pressure (15 MPa) monotonically increases in the range 4.5 up to 21 MPa. By mean of the selection of the optimal regime of thermodynamic conditions it is possibility to obtain the composites with sufficient high stable strength at bending and impact viscosity. It was shown that introduction to the composite additionally only 5 wt% of polyethylene leads to formation of composite, the strength of which reaches 22 MPa. Besides of at decreasing of average sizes of the sawdust particles lower than 50 micron this parameter increases up to 33 MPa. This result obviously is described in terms of increasing of integral area of the inter-phase surface between sawdust particles and binders. In result of investigation of thermal stability of the composites with use of method Vicat it was shown that the composites with enhanced mechanical strength, in general, is in accordance with level of thermal properties (the higher mechanical strength the higher thermal stability).

On the basis of obtained experimental results it is made a conclusion that right selection of composition and technological conditions of obtaining by us WPC is a main way to creation of such materials with high exploitation properties.

Acknowledgments the financial support of Science & Technology center in Ukraine (Grant #5892 is acknowledged).

Abstract

RELAXATION PHENOMENA IN THE STRETCHED POLYMER COMPOSITE FILMS WITH GRADIENT DISTRIBUTION OF THE FILLER PARTICLES

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It is known that at stretching of thermoplastic polymers above glass temperature the material in orientation state is formed. Such polymers are characterized with mono-axis crystal symmetry. In this state the principal direction of macromolecules coincides with the direction of stretching. If the polymer filled with different dispersive fillers, particularly with electric conductive ones (graphite, carbon black, metal powders), the particles distribution transforms from chaotic state to orientation one. The change of polymer microstructure significantly defines the material electric properties as well as all physical properties.

In the presented work the character of change of electric conductivity of polymer composite films based on polyvinyl alcohol and graphite at their mechanical relaxation has been investigated.

Early it was shown by us that distribution of the electric conductivity values of separate parts of the rectangular film based on conducting polymer composites after their stretching parallel to any side of the film obeys to Gauss rule with minimum of conductivity in the center of the film along any line passing through the center of film from one side to another independently of direction, the reason of which is in character of redistribution of filler particles in the film after stretching.

Investigations of the relaxation phenomena obtained for each part of the film show that the relaxation time at creep changes practically with same manner as for electric conductivity or, more exactly, this time is the bigger the near is micro-part from the center of a film. This result is in accordance with known phenomenon – the macromolecules in the parts near the film center are in more stressed state than that far from center. Therefore for film parts near the center the time of restoration of the initial state demands a time higher than for other parts. For the analogical films with more complex geometric forms stretched along various directions the dependence of relaxation time for separate parts of the films is more complex.

Abstract

THE USE OF POLYMERS IN DRYING AGRICULTURAL PRODUCTS

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Polymeric materials are widely used in the food industry and agriculture (ac). Georgia is rich with ac products. Resources of fruits, berries and vegetables in some areas of Georgia are not used to the desired extent. Hence the use of the helio drying units (hdu) during drying of the agricultural products can significantly enlarge the quantity of the dried fruits in our country Georgia. The use of polymeric materials, in particular, the use of polycarbonates in helio drying units gives excellent results.

Due to the high shockproof capacity and toughness// shockproof glutaminous character (250-500 kJ/m²) polycarbonates are used as construction materials in various areas of Industry. Polycarbonates are produced from various polymers.

Polycarbonate is a synthetic thermoplastic polymer; it is one of the types of complex polyesters of carbonic acid and duo atomic alcohols having a general formula [-ORO-C (O) -] n, where R is an aromatic or aliphatic residue. It is the aromatic polycarbonates that are mainly used in industry, especially polycarbonate that is based on bisphenol A; this is because of the greater availability of bisphenol A synthesized by condensation of phenol and acetone.

Food that has a polycarbonate coating and is dried in the hdu-s has better consumer properties than food dried naturally. The results of the analyses for vitamin composition of the products before and after drying procedure have revealed that the loss of vitamin C in case of the use of the hdu-s is 2 or 3 times lower than the loss in case of natural drying in the open air. The drying rate compared to conventional drying in the open air increases by 3-5 times, and in case of drying grass-like vegetables it increases by 24 times. The dried fruits obtained in this way are ecologically clean and have high-quality, despite the fact that additives for coloration, for flavors and for preservation have not been used. Period of preservation of ac products processed in hd units is better than that of the products dried in the natural way.

References

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Abstract

NEW COMPOSITE POLYMER ELECTROLYTE BASED ON PVDF WITH THE ADDITION OF TiO₂

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Composite polymer electrolytes have received a special attention as one of the perspective electrolytes for lithium-polymer batteries. These heterogeneous materials are composed of polymer matrix having distributed lithium-conducting solid electrolyte in the form of a separate phase. The main problem of composite polymer electrolytes is low ionic conductivity at room temperature, due to difficulties of migration of lithium cation in the volume of the polymer membrane. Semicrystalline polyvinylidene fluoride (PVDF) was selected as matrix having high mechanical and thermal strength as well as sufficient electrochemical inertness. It was established that introducing the inorganic filler - TiO₂ in the polymer matrix creates additional coordination centers for lithium cation and suppresses polymer crystallization. To increase the lithium ion conductivity various ways of filler addition and physico-chemical properties of the filler particles have been studied in this work.

Two series of samples synthesis were performed. According to the first one the membranes were prepared by casting an organic polymer solution in advance by dissolving polymer in a solvent mixture of N,N-dimethylformamide : Acetone = 1: 1, with a measured amount of the inorganic filler in the solid phase, followed by drying at 50⁰ C to complete removing of the solvent. Alternative method of forming membranes has performed more complicated step of preparing a polymer solution. The inclusion of filler in the liquid phase in a form of a highly dispersed suspension is accompanied by the implementation of complete homogenization of the heterogeneous agent in the bulk of membranes. In addition, a lithium salt is added as a dopant.

There was obtained a composite polymer electrolyte based on PVDF, which was carried functionalization by distribution of high dispersion titanium dioxide and dissolution of lithium perchlorate in the resulting system. The research of membranes' electrochemical properties showed an 10000-fold increase of the ionic conductivity of the second series of membranes in comparison of first series composites at the room temperature. We found that the ionic conductivity of the polymer membrane is directly depend on particle shape and distribution of lithium-conductive agent in the matrix.

Abstract

OLIGOMERS WITH PRIMARY HYDROXY GROUPS BASED ON EPOXY RESINS

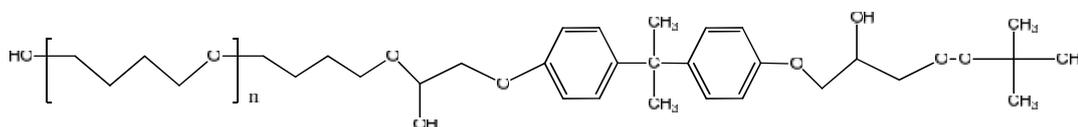
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Oligomers, the molecules of which contain different by nature functional groups, are used as active additives for the polymeric mixtures. The compounds with functional groups capable to react *via* both radical and condensation mechanisms are of special interest.

This work deals with the obtaining procedure and synthesis of oligomer with peroxy, primary and secondary hydroxy groups on the basis of peroxy derivative of ED-24 epoxy resin (PO) and PolyTHF-2000 oligoether. The structure of the hydroxy derivative of ED-24 resin with free peroxy group (HPO) may be represented as following:



The effect of catalyst nature and amount, temperature and process time on the reaction rate between PO and PolyTHF-2000 was studied.

The structure of the synthesized oligomer was confirmed by chemical and IR-spectral investigations. The presence of peroxy group in HPO molecule was confirmed by the doublet of hemidimethyl vibrations at 1395 and 1368 cm^{-1} , the hydroxy group – at 3448 cm^{-1} . The synthesized oligomer may be used as an active additive during formation of polymeric films based on ED-20 industrial epoxy resin and TGM-3 oligoesteracrylate.

Cross-linking of epoxy-oligomeric mixtures was carried out stepwise: first at room temperature for 24 h and then at heating to 383 or 423 K for 15, 30, 45, 60 and 75 min. The structural changes were controlled by the determination of gel-fraction content and films hardness.

Using the synthesized HPO as an additive for epoxy-oligomeric mixture based on ED-20 industrial epoxy resin and TGM-3 oligoesteracrylate both gel-fraction content and film hardness increase compared with the mixture without HPO.

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

SYNTHESIS AND PROPERTIES OF CARBOXY-CONTAINING OLIGOMERS BASED ON POLYCONDENSATION RESINS

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The simultaneous presence of carboxy, epoxy, peroxy and other functional groups in the oligomer or polymer molecule allows to use such compounds as initiating (crosslinking or curing), as well as modifying agent for different polymeric mixtures. The compounds containing labile –O–O– bonds are the source of free radicals and therefore can be used as the initiators for the polymerization reactions or as the curing agents for polymeric systems. The compounds with epoxy groups are characterized by good thermal stability, high hardness and easy ability to chemical modification. Presence of carboxy groups increases chemical and thermal stability, improves hardness, elasticity, adhesion, tensile and impact strength.

Taking all mentioned into account such compounds can be used as active additives to the polymeric mixtures to improve physical-mechanical properties.

Thus, for the synthesis of multifunctional oligomers we chose oligomer with epoxy group (epoxy dianic resins) and peroxy ones (peroxy derivative of epoxy resin). Moreover, we used different carboxy-containing oligomers and dicarboxylic acids.

The synthesis was carried out in accordance with the following reactions:

- interaction between epoxy resin and carboxy-containing oligoester based on pyromellitic dianhydride, polyethylene glycol and n-butyl alcohol preserving the epoxy and carboxy groups;
- interaction between peroxy derivative of epoxy resin and carboxy-containing oligomer based on pyromellitic dianhydride, polyethylene glycol and tert-butyl hydroperoxide preserving the carboxy and peroxy groups;
- interaction between epoxy resin and different dicarboxylic acids preserving the epoxy and carboxy groups;
- interaction between peroxy derivative of epoxy resin and different dicarboxylic acids preserving the carboxy and peroxy groups.

The basic kinetic regularities of the mentioned reactions have been studied. The effect of the catalyst nature and amount, as well as reagents ratio, temperature and process time has been studied. Benzyltriethylammonium chloride was used as catalysts [1, 2]. The synthesis procedure was suggested and new multifunctional oligomers were synthesized. The structure of the synthesized oligomers was confirmed by the spectral investigations. The areas of synthesized compounds application were proposed. In particular, the oligomers have been studied as active additives to epoxy-oligoesteric mixtures on the basis of industrial dianic epoxy resin, oligoesteracrylate and polyethelenpolyamine and to obtain bitumen-polymeric mixture with improved physical-mechanical properties.

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Abstract

AN EFFICIENT METHOD FOR ALLOCATION OF NATURAL POLYMERS FROM PLANT RAW MATERIAL

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We propose a new combined, ecologically clean, waste-free technology for pectin obtaining from plant waste of juice production, in particular electro dialysis for obtaining pectin isolates and ultrafiltration for concentration

During the processing of fruits for juices, a large amount of waste in the form of push-ups (rind with pulp) are obtained, that is thrown by the roadside, or into natural water, which on one hand is uneconomical, and on the other hand violates the environmental protection.

The waste in large quantities contains polymers, natural polysaccharides, pectins, which are cheap and effective source of natural sorbent for removing heavy metals.

In this work, we propose a new method for pectin isolation by combined, waste-free, environmentally friendly technology, which combines classical methods with membrane technology - electro dialysis, and ultrafiltration.

The method consists in that for the separation of pectin isolates is used heated to a specific temperature an aqueous solution of hydrochloric acid, obtained by the method of electro dialysis. Obtaining of isolates takes place in several stages with varying the temperature of the acid solution during 24 hours, then isolates are being filtered and the filtrates are being concentrated by ultrafiltration method on hollow fibers of polyamide a with degree of concentration - 10-12 times. Isolation of pectin from the concentrated pectin isolates carried out with 95% alcohol at a ratio of 1: 1, dried at a temperature of 70-80⁰C.

The proposed technology is quite effective as it allows obtaining high quality pectin, without the expense of costly reagents, reducing the consumption of alcohol by 5 times. In addition, the above method of pectin obtaining is ecologically clean and waste-free.

Pectin is obtained by the proposed technology, cheap, high quality, a high degree of esterification and gelling ability. With further appropriate treatment of pectin is an effective sorbent for removing metals.

By processing wastes and using pectin important ecological, economical and social problems will be solved.

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Abstract

PREPARATION OF POLYMER MEMBRANES BY USING OF SOME AROMATIC POLYAMIDES

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At the main the development of membrane science and techniques is bonded with membrane materials' creation and processing, which would ensure the separation quality and effectiveness close to biological membranes (maximal wade, selectivity and stability of functional features). Membrane, Catalyst and Hybrid processes for sure, are the processes which would give the possibilities for fast and effective transformation of fundamental researches into high-tech and competitive technologies of the future.

Recently, great importance is attached to the use of membranes which are made from polymers for filtration, concentration and fractionation of different liquids. For preparation of membrane are widely used such polymer materials as are: acetylcellulose, the polysulfones, the polioxa-diazols and the polyamides.

The goal of researches is the creation of membranes from some mentioned polymer materials, and the studying of some technological parameters' influence on membrane functional groups.

During membrane samples' preparation, besides of polymers, was used different modifiers. Dissolve of polymers was occurred in organic solvents, in some cases with addition of metal chlorides.

Was studied the influence of modifiers' concentration on morphology and filtration ability of received membrane samples, and the influence on membranes' pore sizes and its scatter range.

Were worked out operating parameters of solvents' evaporation from mixtures which are used during the preparation of different membranes.

Abstract

STUDYING ADHESION ABILITY OF POLYVINYLPIRROLIDONE COMPOSITIONS

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The study of influence of low-molecular additives with different surface activity on the structure and activity of the adhesive polymer matrix allowing to control their regulation, is the necessary condition for the development of water-soluble adhesives of biomedical purposes. The effect of the low molecular additives concentration and nature on the adhesive properties of polyvinylpyrrolidone (PVP) with 2-hydroxyethylmethacrylate (HEMA) has been examined. For this purpose the compositions of polyvinylpyrrolidone with molecular weight of 28000 and content of 0.5, 1, 1.5 and 2% were prepared on the basis of HEMA in the presence of benzoyl peroxide. The additives with different physical and chemical, structural and other properties were used: ortho-phosphoric acid, isopropyl alcohol, lecithin with 0.3 and 1% concentration [1]. Linings of different nature, such as "organic glass", "glass silicate", "ceramics of glossy surface", "ceramics of untreated surface", "steel plate", "bone" were used in the work. To determine the adhesion strength of the glue seam the composition were applied over previously prepared metal plates and maintained at the temperature of 60 ± 5 °C for 5 h. The value (σ) of adhesion strength was calculated according to the formula:

$$\sigma = \frac{P}{S}$$

P – the load, which destroys sample, kgf; S – adhesion area, cm².

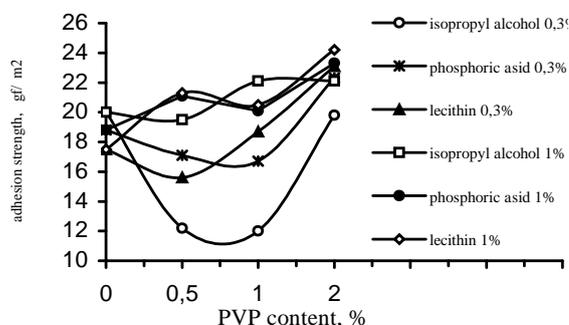


Figure 1. Influence of the additive nature and PVP concentration on adhesive strength (σ) of the HEMA compositions

The adhesive strength of the compositions with 0.5% of PVP in HEMA has an unstable character regardless of the additive nature and the increase of concentrations. The increase of PVP content in HEMA leads to increased adhesion strength for all additives. In case of the composition without additives the adhesive strength with the increase of PVP concentration is reversible.

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Abstract

FUNCTIONAL OLIGOMERS BASED ON PHENOL-FORMALDEHYDE RESINS

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Phenol-formaldehyde resins (PFR) are one of the oldest materials. The products based on them are available and cheap and have high thermal stability, stiffness and hardness. However, such products have insufficient adhesion to non-metallic surfaces and chemical resistance to some aggressive environments, brittleness and incompatibility with other macromolecular materials. One of the methods aimed to improve the properties of materials using phenol-formaldehyde resins is introduction of functional groups into their structure that can improve the properties of the products. This aim is achieved in two ways. According to the first method PFR functionalization takes place at the stage of the oligomer synthesis using peroxide compounds as comonomers capable of reacting with phenol and formaldehyde via condensation mechanism. The second method is the introduction of functional groups of different nature due to PFR chemical modification by furfurylglycidyl ether, glycidylmethacrylate, peroxide derivative of dianic epoxy resin, 1,2-epoxy-3-tert-butylperoxypropanol as well as polyglycidylphenolformaldehyde resin modification by methacrylic acid.

The structure of the synthesized functional phenol-formaldehyde oligomers (PFO) was confirmed by IR and NMR spectroscopic analysis and chemical methods. The resulting oligomers were studied as components for protective coatings and bitumen-polymer mixtures.

Polymer films with functional oligomers are homogeneous ones, have good physical and mechanical properties, sufficient chemical resistance, high hardness and gel fraction content, high thermal stability and good elasticity. In addition PFO with methacrylate and peroxide groups may be used for the production of bitumen-polymer materials with increased adhesion and ductility.

Abstract

BRITTLENESS AND TOUGHNESS OF POLYMERS AND OTHER MATERIALS

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Materials are often characterized in terms of their toughness, though more than one definition of toughness exists. Likely the most widely recognized means of defining material toughness, denoted here as τ , is by the area under the stress vs. strain curve from a tensile test. Another important feature describing the nature of materials is that property known as brittleness, which has for a long time been much less quantitatively understood. Using a quantitative definition of brittleness defined in 2006, we demonstrate the existence of a relationship between τ and brittleness B, valid for polymers with a very wide range of chemical structures and properties, for some polymer-based composites, and also for steel and aluminum. We provide an equation relating toughness to brittleness, while for polymers we mark the determining influence of chemical structures on the properties B and τ .

Abstract

ELECTRON-INDUCED GROWTH MECHANISM OF CONDUCTING POLYMERS: A COUPLED EXPERIMENTAL AND COMPUTATIONAL INVESTIGATION

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Today conductive polymers have many applications in several devices. For these reasons, they have received much attention in recent years. Among all conductive polymers poly(3, 4-ethylene-dioxythiophene) (PEDOT), a derivate of polythiophene, has gained some large scale applications for its chemical and physical proprieties. Despite intensive research, the mechanism of conducting polymers growth is still poorly understood and the methods of polymerization are limited to two principal ways: chemical and electrochemical synthesis.

The present work has as objective the development of a new method of PEDOT synthesis in aqueous solution by accelerated electrons radiolysis (Figure 1). This new radiolytical alternative method, developed in our laboratory^[1,0], enables polymerization under soft conditions: ambient temperature and pressure, without dopant. Pulse radiolysis has been used to study the mechanism of HO[•]-induced polymerization of, PEDOT, in aqueous solution. A step-by-step mechanism was found and it involves a recurrent oxidation process by hydroxyl radicals produced by water radiolysis. The value of rate constants and the attribution of transient and stable species were confirmed by molecular simulations and spectrokinetic analysis. Moreover we demonstrated that PEDOT polymerization is possible by using an electron beam (Figure 1).

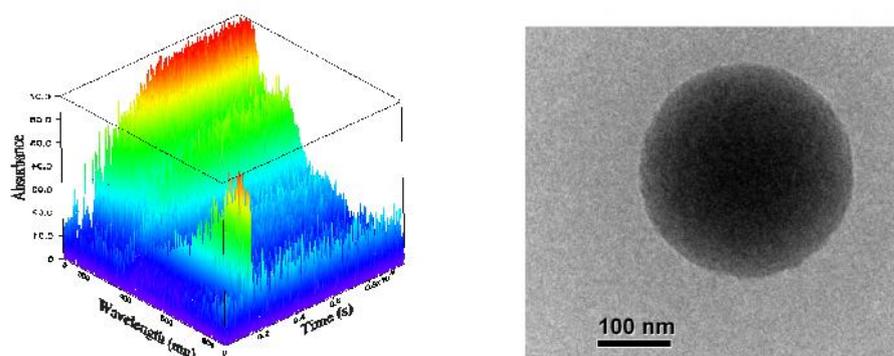


Figure 1 : Time evolution absorption spectrum in the first 1 μ s after the pulse obtained by pulse radiolysis of an aqueous solution containing 1mM in EDOT (on left) and CryoTEM image of polymer synthesized by pulse radiolysis (on right).

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Abstract

SPECTRAL SELECTIVITY OF AZOCHROMOPHORE-CONTAINING POLYMER FILMS IN POLARIZED LIGHT

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At the time of research study of the azochromophore-containing polymer materials properties in some high-efficient media, we have observed the anomalous dispersion of photoanisotropy, depending on the energy exposure of linearly polarized actinic radiation. Later, the phenomenon has been called light induced vector polyphotochromism [1].

A sharp change in the transmission spectrum of the material have been observed when we place an irradiated area of the sample between crossed polarizers while the transmission spectrum of the sample remained practically unchanged in case of illumination by unpolarized light with the same exposure values Fig. 2.

Hereinafter, the experimental result for the material TFAPh (Fig.1) is shown as an example. In order to carry out experiments on inducing the effect and its study we used samples of 20-micron films coated on a glass substrate and irradiated them with linearly polarized actinic radiation of the DPSS laser with a wavelength of 445 nm.

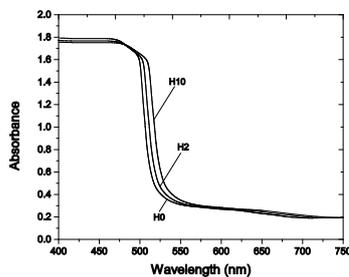
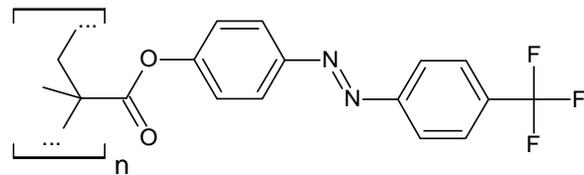


Fig. 2. Absorption spectra of the sample material in case of linearly *unpolarized* probing beam and different exposure from 0 up to 250 J/cm²

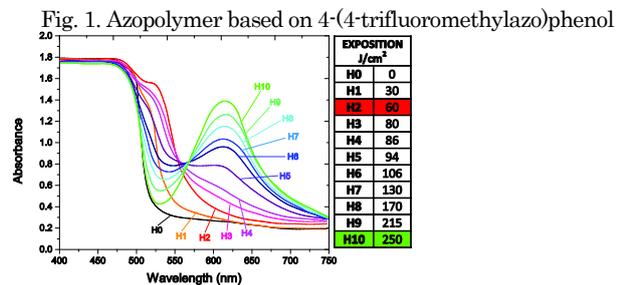


Fig. 3. Absorption spectra of the sample material in case of linearly *polarized* probing beam and different exposure from 0 up to 250 J/cm²

Figures show the spectral dependence of absorbance of material TFAPh in case of different radiant exposure from 0 up to 250 J/cm². A significant difference in transmission of polarized light is observed for different wavelengths and exposures. Measurements were carried out on spectrophotometer SF-18 modernized by us for polarization measurements. Fig. 3 clearly shows a light-controlled spectral selectivity of the samples activated by the various doses of the stimulating radiation.

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Abstract

ORGANIC-INORGANIC COMPOSITES BASED ON NANO ZERO-VALENT IRON

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Nanotechnology methods plays a major role to produce of innovative products. Nanoscale materials can be successfully used to reduce the level of contamination and thus contribute to the environmental remediation. Nano zero-valent iron (nZVI) has a special feature to remove persistent organic pollutants (POPs) from water, including chloroorganic, nitrozo, nitro compounds, dyes, preparations for plant and animal protection, heavy metal ions, including radionuclides. Due to such combined multifunctional properties of nZVI, it is widely used in USA for treatment of ground waters and sewages, applying simple technological processes [1-4]. We present preliminary results on the development of methods for immobilization of the nZVI nanoparticles in biopolymers such as carboxymethyl cellulose, diethylamino-ethylcellulose and crystalline cellulose and various plants' wood. Immobilized Fe⁺³ and Fe⁺² in biopolymers has been conducted by chemical reagents (by sodium borohydride) and plant extracts. The experiments confirm that obtaining sorbents with nZVI are effective to remove from water CrO₄⁻², Cr₂O₇⁻², Hg⁺², Pb⁺² and other ions.

Microstructure of sorbents has been studied by optical and electronic scanning microscopes (Nikon ECLIPSE LV 150, NMM-800TRF, Nanolab-7). Sorbents have been analyzed by X-ray diffractometer DRON-3M (Cu-K, Ni filter, 2°/min), FT-IR (VARIAN 660-IR) and UV (OPTIMIZEN POP) spectrometers.

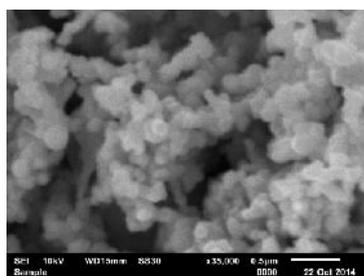


Figure 1. Micrographs of nZVI

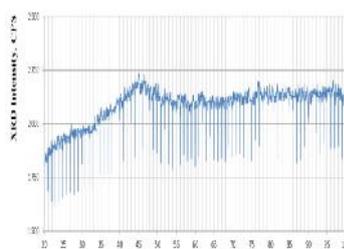


Figure 2. X-ray pattern of nZVI

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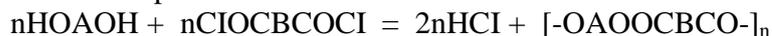
Abstract

SYNTHESIS OF CARD TYPE AROMATIC POLYESTERS ON THE BASE OF DIPHENYIOXIDEDICARBONIC ACID

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



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

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

From the solutions of organic solvents polymers form transparent, stable films, which possess good mechanical and dielectric properties. Thus, e.g. tangency of angle of dielectric losses for polymers containing norbornane and indane card groups, equals to $6 \cdot 10^{-3}$ and $5 \cdot 10^{-3}$, correspondingly. Tensile strength equals to approximately 400 kg/cm². Polymers retain high mechanical and dielectric indices at high temperature too. Thus, at heating at 200°C, they retain more than 50 % of strength. Specific volumetric resistance of polymers is within 10^{17} ohm. cm, at heating at 200°C it falls only to 10^{13} , which refers to the fact that they are good dielectrics and can be successfully used as insulation materials.

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Abstract

UNSATURATED BIODEGRADABLE POLY(ESTER-AMIDE)S AND THEIR ENZYME CATALYZED *IN VITRO* BIODEGRADATION

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Unsaturated biodegradable poly(ester-amide)s is intrigued by the interesting properties of polymers for biomedical purposes [1,2]. One such feature is the ability of their biodegradation. *In vitro* biodegradation (weight loss) study was carried out under the conditions close to physiological (pH 7.4, 37°C) as we have reported previously [3]. The two enzymes (hydrolases) used in this study were α -chymotrypsin and lipase, and two USPEA substrates with various contents of fumaric acid - FA_{0.25}/8_{0.75}-Leu-6 and FA_{0.40}/8_{0.60}-Leu-6.

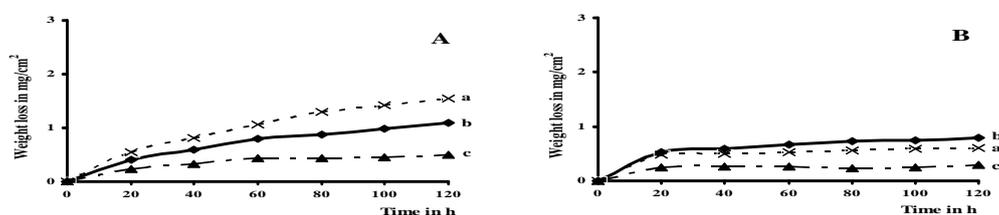


Figure 1. The *in vitro* biodegradation of USPEAs (weight loss in mg/cm²): A) FA_{0.25}/8_{0.75}- Leu-6 and B) FA_{0.40}/8_{0.60}- Leu-6; a – lipase, b - α -chymotrypsin, c - control in pure buffer (0.2 M phosphate.)

The weight loss data in Figure 1 show that, both enzymes catalyze the hydrolysis of tested UPEAs. The higher is FA content in the backbone the lower is the biodegradation rate that can be connected with increasing chain rigidity that restricts chain mobility and interaction with enzymes' active sites and/or with covalent attachment of the enzymes to the polymers *via* active double bonds that causes their inactivation. Two enzymes α -chymotrypsin and lipase, 4 mg each in 10 mL of 0.2 M pH 7.4 phosphate buffer were used. In brief, after 24 h of incubation at 37 °C in an enzyme solution, the polymer circular disks (d = 4 cm, m = 500 - 600 mg) were removed, washed with distilled water and dried to a constant weight at 50 °C over phosphorus pentoxide. This procedure was repeated 5 times (total 120 hr).

The biodegradation rates of unsaturated PEAs can also be influenced by both curing (*via* decreasing chain mobility) and chemical modifications (*via* decreasing double bond content). The study of these issues as well as a role of possible covalent attachment of the enzymes to the unsaturated PEAs is in progress now.

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Abstract

GOLD NANOPARTICLES STIMULATED LUMINESCENCE ENHANCEMENT IN POLYMER NANOCOMPOSITE FOR THE MODELING OF CANCER CELLS DETECTION

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The use of light as a diagnostic tool for the detection and visualization of cancer cells at the early stage of development has grown considerably in recent years. Due to the distinguished optical properties, the combination gold nanoparticles (GNPs), with the fluorescent dyes are increasingly used as labeling tools in biological imaging. The interaction of luminescent molecules with plasmons in metallic nanostructures and the physical phenomena related to nanoscale confinement of light have attracted the interest of physicists over recent years [1-3]. Fluorescence resonance energy transfer (FRET) is a nonradiative process whereby an excited state donor transfers energy to a proximal ground state acceptor through long-range dipole–dipole interactions [4]. Recently we have demonstrated that the emission of visible light from the polymer matrix doped with luminescence dye and GNPs can be enhanced with the use of surface plasmon coupling [5]. GNPs can enhance the luminescence of nearby luminescent dye because the interactions between the dipole moments of the dye and the surface plasmon field of the GNPs. By matching the plasmon frequency of GNPs to the frequency of pumping light source we have observed a luminescent enhancement of the nanocomposite consisting of GNPs coupled luminescent dye Nile blue 690 perchlorate. The increase of luminescence of the Nb 690 results from its interaction with GNPs surface plasmons. The wavelength of the excitation light source on the GNPs, the distance between GNPs and the dye molecules has a significant effect on the luminescence intensity. This tool for luminescence manipulation can be highly beneficial for optical, molecular sensing and imaging, for biotechnology applications, such as those needed in clinical diagnostics, for food quality control and drug delivery. Perhaps the most important application can be found as a revolutionary tool for ultrasensitive and noninvasive detection, visualization and diagnostics of the cancer cells at the early stage of its development.

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Abstract

ON THE POSSIBILITIES OF OBTAINING CURRENT-CARRYING SUPERCONDUCTING POLYMER-CERAMIC NANOCOMPOSITES

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With the use of yttrium and bismuth ceramics' powders ($Y_1Ba_2Cu_3O_{6.97}$ and $Bi_2aSr_2Ca_2Cu_2O_8$), on the basis of super-high molecular polyethylene binder, current-carrying polymer-ceramic nanocomposites are obtained. It is shown that the implementation of the proximity effect between the ceramics' grains leads to obtaining superconducting polymer-ceramic nanocomposites with a transport current. Additives of silver and aluminum nano-scale powders cause significant increase of current density, and the application of acoustic fields during the formation of samples allows to further increase the density to $\sim 4 \cdot 10^3 A \cdot cm^{-2}$. Physical and mechanical properties of current-carrying polymer-ceramic nanocomposites have been investigated and it is shown that nano-sized aluminum additives increase the breaking strength and the elasticity modulus of the samples. The morphological features of current-carrying polymer-ceramic nano-composites' interphase layer on the basis of various binders (polymethylmethacrylate, polystyrene, super-high molecular polyethylene and isotactic polypropylene) have been studied.

Abstract

PHOTOSENSITIVE HYBRID - SPAZ COMPOUNDS

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Spiropyrans are one of the most popular class of photochromic bistable compounds that change their optical and structural properties in response to external inputs such as light, protons, metal ions, heat, mechanical stress, electric and magnetic fields, etc. This "smart materials" are present unique for photonics, optoelectronics, information record and storage, filters with regulated optical density, optical switches, different types of sensors, medical instruments, drug delivery, ecology etc. Among the different dyes, the azobenzene derivatives attract particular interest due to their ability reversibly undergo to trans-cis-trans isomerization, which is accompanied with strong changes in some properties. It is expected that the combination of photoactive Az and photochromic Sp could lead to an interesting light-controllable molecular device to control on-off switching of photoinduced processes. To extend their functional properties, we synthesized photobifunctional compounds SpAz based on spiropyran and azobenzene, which combine two photosensitive fragments in one molecule. The molecule of SpAz combines the spiropyran and azobenzene fragments in such a way that conjugation exist between the π -electronic systems of the indoline and azobenzene moieties. Photochromic organic hybrid materials have attracted considerable attention owing to their potential application in photoactive devices. The growing interest in this field has largely expanded the use of photochromic materials for the purpose of improving existing materials and exploring new photochromic hybrid systems. Practical application requires photochromic compounds to be incorporated by dissolution of the dyes into a polymer (Fig.1). The spectra are shifted bathochromically with respect to model compounds due to conjugation chain.

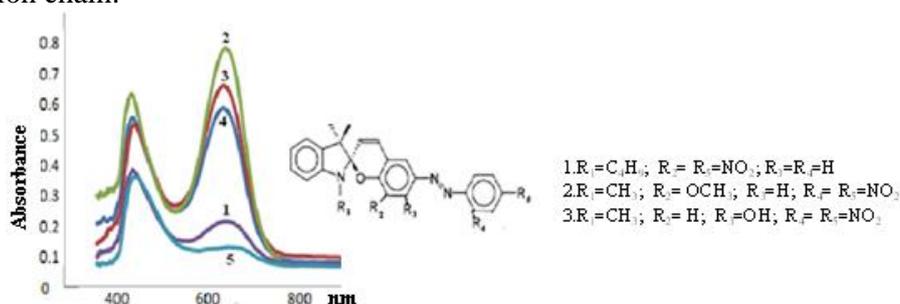


Fig.1 Absorption spectra of SpAz(1) incorporated in PMMK. 1-thermodynamic equilibrium; 2- after UV irradiation; 3,4 – dark relaxation process, 5- after visible irradiation.

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Abstract

NOVEL PHOTOCHROMIC LIQUID CRYSTAL POLYMER FILMS WITH IMPROVED SENSITIVITY AND SPATIAL RESOLUTION

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Photochromism is the light-driven reversible transformation between two isomers possessing different absorption spectra and geometrical structures. Photoswitchable molecules are a perfect candidate since they change their physical and chemical properties upon exposure to light. One of the most unique examples of molecular switches is spiropyran (SP), whose closed-ring, hydrophobic isomer transforms into a highly polar, open-ring merocyanine (MC) form upon exposure to ultraviolet light, whereas the reverse reaction can be induced by visible light. SPs have been extensively investigated due to their potential applications in molecular devices, sensors and fluorescent switches [1]. In this investigation we demonstrate novel rewritable photochromic liquid crystal polymer films (LCPFs) with advanced properties, such as high spatial resolution and improved photosensitivity. Due to the unique properties of liquid crystal materials, liquid crystal doped SP system is assumed to have many advanced optical attributes quite different from those of isotropic liquids, semiconductors and polymer doped ones. The use of the method of microcapsulation and an icy acetic acid as the suitable emulsifying agent, allowed us to obtain a stable dispersive system incorporated in the PVA matrix [2,3]. The obtained system consists of a dispersed phase – separated compositions, aggregated in the form of capsules in the dispersive medium of the polymer solution, which preserves at most the initial properties of the dispersive composition doped with SP and conditioned the production of polymer films with high photosensitivity. By controlling all stages of microcapsulation we obtained process-perfect uniform, elastic films which meet the requirements of practical application. Microscopic investigation of the films confirmed that the polymer matrix in the form of microcapsules did not suffer disintegration upon the UV/Vis irradiation, and hence the properties of spiropyran-doped compositions did not change. We have demonstrated the improved photosensitivity and high spatial resolution of the prepared LCPFs. For this reason we irradiated LCPFs with UV light. Upon the irradiation samples were interconverted from the colorless SP into a colored MC form in a few seconds. Using different masks with gray scale images, we have exposed LCPFs by UV light and recorded corresponding images with high resolutions. Designed LCPFs hold promise for the realization of mechanically flexible, lightweight, multifunctional, high-performance large-area photo sensitive films for the non-destructive and rewritable recording of optical information with high sensitivity, optical density and resolution. Furthermore, proposed films possess a very good resistance to mechanical stresses and to degradation, and they can be ideal candidates for a plethora of applications.

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Abstract

MORPHOLGY AND MECHANICAL PROPERTIES OF COMPATIBILIZED RECYCLED PET/PP BLENDS

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In this study, Binary blends of polypropylene (PP)/recycled poly(ethylene terephthalate) (r-PET), and ternary blends of PP/r-PET (80/20 w/w) compatibilized with various amounts (2.5, 5 and 10 wt%) of maleic anhydride grafted polypropylene (PP-g-MA) were prepared on a twin-screw extruder. The effect of the compatibilizer content on the morphological and mechanical properties of PP/recycled PET blends was investigated. Tensile strength, and tensile strain at break, improved with the addition of the compatibilizer. The compatibilized blends had a smaller size of dispersed phase compared with the uncompatibilized blends. This may result from the enhanced interaction between the matrix and dispersed phase.

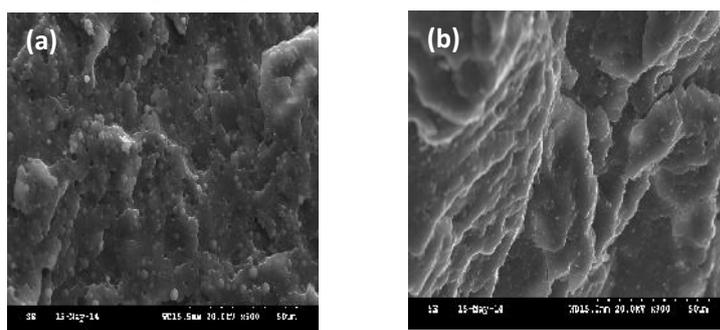


Figure 1: SEM micrographs (a) PP/r-PET 80/20 (b) PP/r-PET/PP-g-MA 80/20/2.5

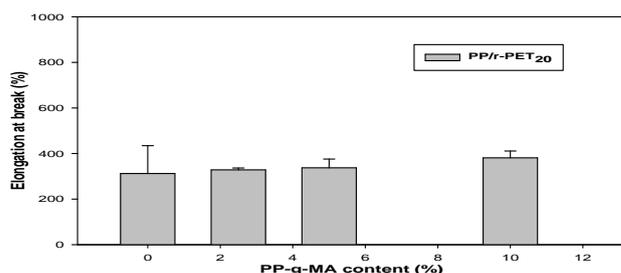


Figure 2: Elongation at break of PP/r-PET₂₀ as function of PP-g-MA content.

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Abstract

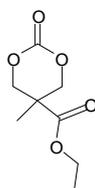
FUNCTIONAL ALIPHATIC POLYCARBONATES AND POLY(ESTERCARBONATES) – SYNTHESIS AND PROPERTIES

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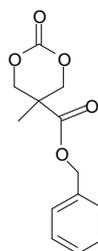
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The aim of presented study is to develop a new method of synthesis of functional copolycarbonates and copolyestercarbonates by copolymerization of ethyl 5-methyl-2-oxo-1,3-dioxo-5-carboxylate (MTC-Et), benzyl 5-methyl-2-oxo-1,3-dioxo-5-carboxylate (MTC-Bz) with 1,3-trimethylene carbonate (TMC), or - caprolactone (CL) with the use of selected initiators - $Zr(acac)_4$, $Zn(Acac)_2 \times H_2O$ and $La(acac)_3 \times H_2O$, practically nontoxic, previously successfully tested in similar ROP reactions. Obtained copolymers might find potential application in formation of bioresorbable scaffold for living cells and drug delivery systems for achieving controlled drug release.



MTC-Et



MTC-Bz

The reaction conditions as well as selected initiators were aimed at obtaining relatively low intermolecular transesterification. Preserving this condition made it possible to obtain copolymers not containing gel fractions in most cases. When the reaction was conducted at higher temperatures, parallel transesterification reaction attacking side ester bonds induced formation of heavily branched chain structure, which finally led to creation of a large number of cross-linking intermolecular bonds. During the study, reaction ratio, reactivity coefficients, chain microstructure and basic thermal properties of the obtained copolymers were determined on the basis of NMR, GPC and DSC analysis. Part of the results was presented in the table below.

monomers	initiator	Time [h]	Conv. [%]	M1/M2 ^N [% mol.]	M _w [kDa]		T _g
TMC/MTC-Bz	La(acac) ₃	2	97	45 : 55	24	4,7	21,2
TMC/MTC-Et	La(acac) ₃	2	~100	49 : 51	27	3,3	-12.3
CL/MTC-BZ	Zr(acac) ₄	24	98	50:50	58	3.1	17.1
CL/MTC-ET	Zr(acac) ₄	48	94	39:61	71	5.8	-18.5

Copolymerization of equimolar reaction mixture, performed in bulk, at 120 °C with initiator to monomer ratio (I/ M) as 1 : 1000, where: Conv – monomers total conversion, M1/M2^N – comonomers molar ratio, M_w – average molecular mass, – molar mass dispersion, T_g – glass transition temperature determined with DSC (II run)

The work was performed within the framework of the research project funded by the National Science Centre Poland, project # UMO-2012/07/B/ST5/00616

Abstract

AZOARYLENE AND TRIAZENEARYLENE GROUP CONTAINING POLYMERS: SYNTHESSES, CONDUCTIVITIES AND TRENDS IN DEVELOPMENT

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The conjugated polymers and polyaniline find [1]. The incorporation of azo chromophores into the main polymer chain due to the possibility of E- and Z- isomerization can potentially widen the application of these polymers in areas such as reversible optical storage systems, EO modulators, holographic gratings and sensors [2].

In this presentation the progress in the synthesis and investigation of different classes of organic conjugated polymers containing in their main polymer chain triazenearylene, azoarylene, benzotriazole, quinonediimine, aminophenylene oligoaniline, group containing conjugated polymers have been discussed. First step in this direction was the oxidative polymerization of 4-aminoazobenzene by different oxidizing agents - potassium peroxydisulphate, iron trichloride potassium permanganate and bichromates, iodine [3,4].

Further syntheses were based on cheap monomers – aniline, p- and m-phenylenediamine, benzidine. Two easy and useful methods have been used for the syntheses of target polymers - diazotation-azocoupling and oxidative polymerization. The advance of these classes of polymers is in their solubility and in the possibility that gives the polycondensation reaction - by changing the molar ratio of monomers to regulate the molecular mass and so the solubility of these polymers. Dependence of electrical conductivities and ESR data on solubility, incorporation of different groups, doping level have been discussed. As a result of doping with different agents- acids, iodine, the electrical conductivities of these polymers increases in the range of 10^{-3} - 0.2 S mol^{-1} . According to the ESR spectra, at the doping with iodine and perchloric acid electroconductivity enhances generally due to the mobility increase of the charge carriers (polarons) [5-8]. Exploration of polymers containing aniline oligomers connected with azoarylene and triazenearylene linkages have been discussed.

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Abstract

THE COMPARATIVE STUDY OF GROWTH REGULATING POLYMERIC COMPOUNDS IN CELLS WITH DIFFERENT DEGREE OF TRANSFORMATION

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The modern bio-therapeutic approach to cancer treatment includes the usage of a targeted therapy with a natural compounds (e.g. growth factors) reducing the uncontrolled cell growth. Most of these factors are polymer compounds produced in a living system. It is shown that the active components of the protein complex, which are identified in the intact kidney cells, does not revealed in malignant transformation (human kidney cancer cells) (1).

Goal: Identification of the polymers- thermostable protein complexes from benign and malignant tumor and comparative study of components.

Materials and Methods: BCLL cell culture and postoperative tissue from children's heman-gioma were used. Obtaining of thermostable protein complexes was made by the alcohol ext-raction. The native electrophoresis in polyacrylamide gel was performed for comparative analysis of biopolymers components.

The results: Investigations have revealed that the quantity of low-molecular components is obviously reduced in the thermostable protein complexes derived from tumor cells (both mali-gnant and benign tumor) unlike the intact cells. There are differences in range of components with high molecular weight.

Conclusion: The cancerous transformation causes the quantitative and qualitative changes of the polymer compounds that regulate the cells proliferation (thermostable protein complex).

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Abstract

STUDY ON COVALENT AND IONIC CROSS-LINKED IN CHITOSAN FILM BY GENIPIN AND TRIPOLYPHOSPHATE AS POTENTIAL MATERIAL IN MEDICAL APPLICATIONS

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High water affinity and low mechanical properties of film wound dressing based chitosan has limited its usage period that is required during the application, thus a chemical modification is needed to overcome the problem. The aim of this study was to investigate the effects of covalent and ionic cross-linked reactions which were respectively done by using genipin and tripolyphosphate (tpp), on the chemical, physical and mechanical properties of chitosan film. Both cross-linked and uncross-linked films were prepared and characterized. FTIR spectra showed no characteristic of $-OCH_3$ peak from genipin at 1444 cm^{-1} which resulted by new covalent bonding in chitosan film that was cross-linked by genipin. An absorption peak at 896 cm^{-1} in chitosan cross-linked genipin/tpp film was due to the stretching of P-O. UV-Vis spectroscopy showed the covalent cross-linked by genipin on the chitosan had reduced the film's transparency from 77% to 63% while ionic cross-linked by tpp gave slight changes on the properties. As expected, chitosan film with combination of covalent and ionic cross-linked network showed the higher mechanical strength with average tensile stress value at 68.07 MPa. The water contact angle on the surface of covalent/ionic cross-linked chitosan film also reached the highest at 100.93° indicated more hydrophobic surface area occurred. All finding results demonstrated that cross-linked modification on the chitosan film had successfully reduced the film's hydrophilicity and increase the mechanical properties of the film.

Abstract

GETTING HIGH INDEX BASE OILS

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The essence of the research is achieving of base oils having higher viscosity index. For this purpose, -olefins (with reserves cheap raw materials, in particular, hexene-1), aromatic hydrocarbon in composition – oligomerization in toluene decisive environment. The advantages of toluene in the presence of oligomerization is that the toluene by forming a complex with aluminum chloride plays the role of so catalyst and process (oligomerization and alkylation) is going fuzzy, toluene cyclic cheaper than monomers and finally the active center of oligomers in environment is alkylated of toluene as a result of obtained product having a smaller unsaturated and it allows to produce hydrogenation stage of the technological process.

Temperature, the amount of toluene in decisive composition, duration term of the reaction and the effect of catalyst consumption studied in the process and the reaction conditions enable to get necessary a physical and chemical property of oligoalkyltoluene was found. As a result of studying of synthesized composition and structure with modern physico-chemical methods of oligoalkyltoluene, determined that at this time basically half substitute benzene (825 cm^{-1}) is obtained and -olefins fragments corresponding to absorption lines are observed in IR-spectrum 720, 760, 780, 825, 860 and 880 cm^{-1} frequency. In order to increase the viscosity index of petroleum oils of received oligoalkyltoluene was used as a synthetic component by the addition - 20-30% amount of oligomer to the oil is possible to get base oil with high viscosity index.

Acknowledgment: The financial support of the Science Foundation of SOCAR Grant #19 is gratefully acknowledged.

Abstract

DEXTRAN-GRAFT-POLYACRILAMIDE COPOLYMERS AS THE VECTORS FOR TARGETED DELIVERY OF MEDICAMENTS INTO TUMOR CELLS

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Non-specific delivery to tumor cells and poor biodistribution of drugs are among the limitations in current cancer therapy. Controlled targeting of drugs and reduced time of exposure at non-targeting tissues improve treatment of cancers and lower side effects. Macromolecules of soluble polymers, due to their biocompatibility with living cells and tissues and their possible load dosage forms, are used as nanocontainers (nanocarrier) or nanotechnology-based drug delivery systems.

This study based on using of the branched biocompatible polymer Dextran-graft-Polyacrylamide of various internal macromolecular structure as templates for preparation nanocarrier containing simultaneously both Ag nanoparticles and *anticancer drugs*.

The Ag nanoparticles of certain size and morphology were synthesized in situ in polymer matrices and characterized by UV-vis spectroscopy and Transmission electron microscopy and Zeta-sizer. It was shown that Ag nanoparticles were spherical in shape, 10-20 nm in size and sols were stable in time. Polymer/Ag nanoparticles systems were loaded by cisplatin and tested for cytotoxicity in both U-937 histiocytic lymphoma cells and K-562 myeloid leukemia cells. U-937 lymphoma cell line possesses a phagocytic activity, as well as K-562 cells have only slight phagocytic activity. The cytotoxicity of the nanoparticles was assessed by both MTT assay and trypan blue staining. Both assays gave consistent data on cytotoxic effects of the nanoparticles tested. The results of MTT assays showed a dose-dependent decrease in viability for both cell types exposed to the Ag nanoparticles and the ones conjugated to cisplatin. It was shown that dextran-polyacrylamide copolymers are not toxic at any concentration. At the same time the polymers loaded with cisplatin caused cytotoxic effect in both cell lines at 10 µg/ml (40-44% in U-937 and 81-83% in K-562 measured by MTT assay), and so did the Ag nanoparticles at the same concentration (72-76% in U-937 and 86-92% in K-562 provided by MTT assay). The data from our cytotoxic studies indicate that nanosilver induces toxicity in cells. The polymers conjugated to both nanosilver and cisplatin displayed less cytotoxic effect compared to conjugates of cisplatin and the polymers, and that was especially obvious in U-937 cells (57-60% for polymer/Ag/cisplatin and 40-44% for polymer/cisplatin at 10 µg/ml). These findings suggest that nanosilver attenuates cytotoxic function of the cisplatin. The data also indicate that U-937 and K-562 cells (more tolerant to the nanoparticles tested than U-937) show different responses to the nanoparticles, and presumably, this is the consequence of the difference in phagocytic activity of these cell lines.

Abstract

NONISOCYANATE ENVIRONMENT FRIENDLY POLYURETHANES AND THEIR APPLICATION

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The endless variety and adaptability of polyurethane (PU) along with its continued contribution to our daily lives, makes its importance and hence demand to increase in comparison with other thermosetting polymer materials. Polyurethane plays a vital role in the coating industry. However the use of highly toxic isocyanates in its synthesis leads to environmental hazards. This coupled with its inherent weakness to weatherability and poor chemical resistance becomes a serious challenge for its long term survival.

Network nonisocyanate PUs is formed as a result of the reaction between cyclocarbonate oligomers and primary amine oligomers. An intramolecular Hydrogen bond, through the OH group at the carbon atom of PU moiety improves the hydrolytic stability well above that of conventional PUs. Moreover materials containing intramolecular H-bonds display chemical resistance 1.5-2 times greater than the materials having similar chemical structure without such bonds.

A recent development in making polyurethane that does not utilize toxic isocyanates at any stage of the production results into better and safer health working environment and possibility of widening and easing the use of polyurethane. The new product is called hybrid nonisocyanate polyurethane (HNIPU). Use of HNIPU significantly improves the working environment and completely eliminates any health risk connected to the isocyanates since none are used in the process. HNIPU have been developed to the commercial level use in the following areas of PU application – paints, varnishes, adhesives, caulking compounds, flooring/industrial coatings applications, rigid foams and composite materials. At the same time absence of isocyanates in the process allows for making floorings and industrial coatings with no porosity and consequently increased hydrolytic stability and chemical resistance. An independent laboratory test on ECPU-2851 has confirmed no sensitizing effect.

By using elaborated dendroaminosilane oligomers it is possible to introduce siloxane fragments to the structure of hybrid nonisocyanate PU network. During curing process, additional hydrolysis of amino silane oligomers creates the secondary nanostructured network polymer that improves service properties of coatings, such as wear, thermo-and UV resistance and adhesion properties. We have also a novel HNIPU with using as nanostructured agent soluble organic modified fullerenes. We have also developed an extensive product range of such active nano-fillers for upgrading the most common polymers against a wide variety of aggressive media including acids, sea water, fluorine, alkalis and more.

Abstract

THE INFLUENCE OF FERRUM COMPOUND ON THE PERCOLATION THRESHOLD IN POLYURETHANES WITH CARBON NANOTUBES

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Polymers with high electrical conductivity are critical for applications in different areas [1, 2]. To provide the conductivity to dielectric polymer matrix such conductive fillers, as carbon black, carbon nanotubes, carbon fibers or metallic particles are used. Conductivity in such materials is established by percolative network formation of the fillers and limited by carrier transport between filler particles [2]. The conductive properties of composites on the base of cross-linked polyurethane (CPU) and carbon nanotubes (CNTs) were analyzed. Moreover, the influence of adding $\text{Fe}(\text{acac})_3$ in matrix CPU/CNT was investigated. CPUs were synthesized in two stages according to standard procedure described in detail elsewhere [3] using PPG-1000 and TDI based prepolymer. TMP was used as cross-linking agent to obtain CPU.

The series of composites CPU/CNT with amount of fillers from 0,02 to 3% wt. were synthesized. It was established that for systems CPU/CNT the percolation threshold achieved at the filler content of 0.65% wt. Hereby, the level of conductivity increases by 4 orders from $4,5 \cdot 10^{-11}$ S/cm to $7,8 \cdot 10^{-7}$ S/cm at the CNTs contents 3% wt. (see table). This effect caused by formation of 3D percolation cluster in the bulk of polymer matrix.

However, at the modification *in situ* of the systems CPU/CNTs with $\text{Fe}(\text{acac})_3$, the percolation threshold significantly decreased to 0,02%wt. Herewith, the level of conductivity for such systems at the filler content 3%wt. is equal to $1,1 \cdot 10^{-4}$ S/cm. These results were caused by catalytic effect of $\text{Fe}(\text{acac})_3$ on the formation of the polymer matrix [4]. Such increasing in rate of CPU formation could stabilize dispersion of nanoparticles and prevent CNT aggregation. Therefore, in CPU matrices with catalyst addition the formation of conductive CNT network with plenty interparticle contacts is much more likely.

System	Percolation threshold, % wt.	Maximum values of conductivity (σ_{dc}), S/cm
PU-0	-	$4,5 \cdot 10^{-11}$
PU-CNT	0,65	$7,8 \cdot 10^{-7}$
PU-CNT- $\text{Fe}(\text{acac})_3$	0,02	$1,1 \cdot 10^{-4}$

Moreover, the significant increasing in the tensile strength for composites CPU/CNT- $\text{Fe}(\text{acac})_3$ was observed. Thus, the tensile strength increased from 4,3 (for unmodified CPU) to 14,3 MPa (for the system CPU/2%CNT-1% $\text{Fe}(\text{acac})_3$).

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Abstract

SYNTHESIS OF NANOCLAY/POLYETHYLENE TEREPHTHALATE NANOCOMPOSITE

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Polyethylene terephthalate (PET) is thermoplastic polyester which is widely used in the food industry. Nowadays, for the improvement properties of PET, they can be combined with nano materials. In this project, nanoclay/PET composite was prepared by melt-blending polymerization. For this synthesis, modified nanoclay was prepared with ammonium quaternary salts by ion exchange of sodium in natural nanoclay. Then they were combined with melted PET in the Extruder. The morphology and microstructure of this nanocomposite was characterized by scanning electron microscopy (SEM) and transmission electron microscopy (TEM) that showed PET were influenced into spaces of nanoclay layers. Also, X-Ray diffraction (XRD) was showed that distance between layers of modified nanoclay was increased and confirmed existence of organic moiety in nanoclay. These results were showed that of the nanocomposites were mechanical properties, thermal stability and young's modulus better than pure PET.

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Abstract

PRODUCTION OF THERMO- AND CHEMICALLY STABLE, REINFORCED AND UNREINFORCED POLYMERIC MEMBRANES, RESEARCH OF THEIR PROPERTIES

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The aims of this research include production of ultrafiltration membranes made of hydrophilic polymeric materials which may be used for purification, separation and concentration of liquid mixtures. The main requirement to membrane includes selectiveness and capacity, resistance to high temperature and aggressive environment, mechanic resistance and stability in the process of operation.

For the purpose of production of ultrafiltration membrane we used so called method of “dry-wet” formation in which membrane is formed by the way of partial evaporation of volatile components and dividing of systems into phases by means of its sinking in liquid (water) [1,2]. For the purpose of production of polymeric reinforced and unreinforced ultrafiltration membranes we used polysulfonamide and polyoxadiazol. Molecular weight of polymers is 30-45 thousand. They are well-soluble in aprotic solvents.

For the purpose of obtaining of solution for polymeric membrane formation we chose aprotic solvent N-methylpyrrolidone which meets the following requirements: fully dissolves above polymers, absolutely mixes with water, does not cause destruction of polymers. Resulted research and testing of properties of membranes made of polymeric solutions of various concentrations (8-22%) we chose 18% solution of polysulfonamide and 20% solution of polyoxadiazol [2]. We produced both reinforced and unreinforced membranes with the named solutions. For the purpose of production of reinforced membranes we used nonwoven fabric made of fluoroplastic material as a substrate.

The produced membranes have anisotropic (asymmetric) structure. It is one of the important properties for maintenance of high efficiency in filtration. We researched selectiveness and capacity (efficiency) of the membranes produced. As our researches prove, the properties synthesized by us comply with the standard properties of ultrafiltration membranes. Efficiency of reinforced membranes is much higher than that of unreinforced membranes. Besides, efficiency of fluoroplastic substrate membranes is higher than that of polypropylene substrate membranes. Data of pores average size prove their correlative relation to efficiency data. We researched thermo- and chemical stability of the membranes produced. Resulted our tests, we found that polyoxadiazol membrane is resistant to alkali, acids, sodium chloride, hypochlorite and other aggressive solutions and it may be used in wide pH range. As for polysulfonamide membrane, it is found resistant to pH range 1-11. After treatment with these solutions efficiency rate relative to distilled water is unchanged. The produced membranes are stable at 80-90°C, but higher temperatures cause their deformation.

The ultrafiltration membranes produced by us were used in filtration of orange juice, tea extract, and various biopreparations for extraction of colloids.

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Abstract

FLUOROPLASTIC MEMBRANES MICROFILTERS FOR HOUSEHOLD DISINFECTION OF DRINKING WATER

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For improvement of drinking water quality various filtration equipments are used. They differ in principle of operation, functional purpose and design. Multistage filtration modules at the various stages provide mechanic filtration, sorption (on coal activated or covered with silver ions), ion exchange, sterilization (ultraviolet radiation, ozone) and filtration with use of ultra- and reverse osmotic membranes [1].

For disinfection of drinking water we used fluoroplastic microfiltration membrane which cleans drinking water from undissolved colloids and suspended particles which sizes exceed 0.1 μm (bacteria, parasites, cysts).

Fluoroplastic membrane which is produced by the way of high-temperature sintering of polymeric fluoroplastic granules is resistant to chlorine and various acid and alkaline agents. Its application in filtration of foodstuffs is permitted.

We have produced a drinking water microfiltration device of individual use, which is furnished with an exchange cartridge of corrugated fluoroplastic membrane. Upon improvement of design and operating practices it will become fit for household disinfection of drinking water at the last stage of water supply. Pressure in water supply system allows filtration without pump.

For the purpose of multiple use of the drinking water microfiltration device of individual use we have chosen the agents for regeneration of clogged membranes: lemon acid, fluorocarbon acid, sodium hypochlorite) and regenerants which provide regeneration of filtration cartridges.

Purification of drinking water with microfiltration method is provided without any chemical agents. The filtered water is not only of good taste, but contains all the microelements and salts necessary for human organism [2].

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Abstract

ORGANIC AMBIPOLAR MOLECULAR MATERIALS FOR OPTOELECTRIC DEVICES

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Growing interest has been recently focused on finding materials with ambipolar charge-transporting characters for the application in organic light emitting diodes (OLEDs) and in some other optoelectronic or electronic devices.

Carbazolyl-containing polyethers, exhibiting high triplet energies were found to be effective host materials for the emitting layer of phosphorescent OLEDs [1,2]. There is an indirect evidence that these materials when protected from air are capable of transporting both positive and negative charges [1]. Carbazolyl-containing glass-forming stable free radicals have appeared to be effective ambipolar organic semiconductors, with electron mobilities approaching 10^{-2} cm^2/Vs and hole mobilities reaching 10^{-3} cm^2/Vs at high electric fields in air [3]. Carbazole trimers with the different linking topology represent another group of glass-forming ambipolar molecular materials [4]. 2,7-Di(9-carbazolyl)-9-(2-ethylhexyl)carbazole was found to show very high electron mobility ($\mu_e = 2 \times 10^{-3}$ $\text{cm}^2\text{V}^{-1}\text{s}^{-1}$ at an electric field of 1.8×10^5 V/cm) and reasonably high hole mobility ($\mu_h = 8 \times 10^{-4}$ $\text{cm}^2\text{V}^{-1}\text{s}^{-1}$). 3,6-Di(9-carbazolyl)carbazoles exhibiting high triplet energy and ambipolar charge-transporting properties were successfully used for the development of single layer electrophosphorescent devices with external quantum efficiencies of 8-9% for blue and 13-14% for green and 10% for white devices. They also showed good performance in the single-layer fluorescent OLEDs [5] and as electron-injecting materials in OLEDs based on the triple-singlet energy transfer [6]. Ambipolar charge transport was also observed in carbazolyl substituted perylene bisimides under ambient conditions [7]. Depending on the linking topology of carbazolyl groups either hole transport or electron transport is more efficient. Time-of-flight mobilities in these materials reach 10^{-3} $\text{cm}^2\text{V}^{-1}\text{s}^{-1}$ at high electric fields for both holes and electrons. Molecular glasses of the recently synthesized conjugated derivatives of triphenylamine and 1,8-naphthalimide were also found to be capable of transporting both holes and electrons in air [8,9].

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Abstract

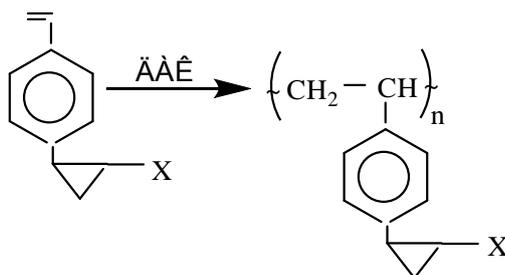
OPTICALLY TRANSPARENT POLYMERS ON THE BASIS OF CYCLOPROPYLSTYRENE

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This work has been devoted to the synthesis and study of optically transparent polymers prepared on the basis of cyclopropyl styrene and its derivatives. As the object of investigation of polymerization there have been chosen the monomers $\text{-}(2\text{-gemdichlorocyclopropyl styrene})$ (CCPS) and $\text{-}(2\text{-methoxycarbonylcyclopropyl})$ styrene (MCPS). The synthesis of CCPS has been carried out by interaction of p-divinylbenzene with chloroform in the conditions of interphase catalysis in the presence of triethylbenzyl- ammonium chloride and 50% solution of NaOH. MCPS has been synthesized by methyldiazoacetate reaction with p-divinylbenzene in the presence of catalytic quantity of anhydrous CuSO_4 . CCPS and MCPS polymerization was carried out in the presence of dinitrilazoisobutyric acid (AIBN) in mass and in benzene solution at 70° . It has been established by data of IR- and PMR-spectroscopy that the polymerrization of these monomers proceeds on double bond of vinyl group with keeping of cyclopropane ring on scheme:



$\text{=gemdichlorine, -CO}_2\text{CH}_3$

The prepared polymers after corresponding purification and drying were the white powders, soluble in benzene, toluene and chlorinated hydrocarbons. It has been shown that the cyclopropane-containing polymers possess more high physical-mechanical and heat-physical properties and also good optical indices ($n_d^{20}=1,5870 - 1,5960$). It has been revealed that the synthesized polymers keep transparency up to 100° at their endurance for 1,0-1,5 h.

It has been shown that the light transmission in the visible part of spectrum is 85-90% and slightly depends on thickness of the sample to 6-8mm; at relatively high thickness it takes place a partial deterioration of optical properties, which is characteristic for all known transparent polymers.

Thus, it can be concluded that an introduction of gemdichlorocyclopropyl and methoxycarbonylpropyl substituents into p-position of aromatic nuclei leads to the improvement of optical, heat-physical, adhesion and physical-mechanical properties of purposeful polymers and allows to prepare the impact-resistant materials with high optical indices

Abstract

OBTAINING OF COMPOZITES ON THE BAZE OF CARBAMIDE-FORMALDEHYDE POLYMERS AND THEIR APPLICATION IN AGRICULTURE

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

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

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

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

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Abstract

SYNTHESIS OF AROMATIC POLYESTERS BASED ON CARD TYPEDIOLS AND DIPHENYLCARBONIC ACID

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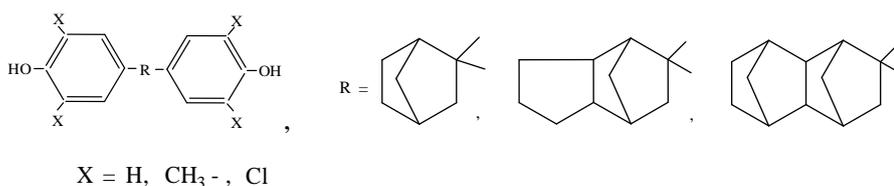
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Progress of many branches of modern technology requires creation of new type materials, which at strict terms of exploitation - at high temperature and high mechanical charges will retain high strength, will be characterized by high heat- and thermal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

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

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

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



Acid that was used as a component was 4,4¹-diphenyl-di carbonic acid dichlorane hydride. Polymer synthesis was realized by the method of high-temperature polycondensation in ditolyl methane. Polymers obtained on the base of polycyclic bisphenols and aromatic dicarbonic acid are characterized by high thermal resistance. Polymers are characterized by high thermal resistance. Reduction of their mass at heating on air starts above 300-400°C.

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

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

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Abstract

GENERATION AND CHARACTERIZATION OF THIN FILM MATERIALS BASED ON POLYHYDROXYBUTYRATE AND VULCANIZED NATURAL RUBBER

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Over the last decades much attention of scientists and industrial companies all over the world is concentrated on creation and production of novel polymeric materials decomposable under natural environmental conditions without releasing any harmful substances. Environmentally friendly biodegradable polyhydroxybutyrate (PHB) can be produced via microbial synthesis that makes undeniable advantage for the PHB-based compositions. However, certain rigidity decelerates the potential of neat PHB. A solution can be found in development of PHB-based blends comprising high-elasticity components. Natural rubber (NR) is a perfect candidate possessing high strength characteristics, modulus of elasticity etc. Thus, development of PHB/NR blends as a perspective "replacers" of synthetic polymers is of a great matter. Moreover, NR vulcanization allows extending the operating temperature range and improving chemical resistance of the neat rubber etc. Therefore, in the present work an attempt of generation of PHB-based blends with partially vulcanized NR (vNR) was made. To produce thin film materials (thickness up to 200 μm) three-stage process was applied. At the first stage the homogeneous PHB/NR mixture comprising 1.5 phr of dicumyl peroxide (Vulcanizing agent) in chloroform was prepared. Then traditional polymer casting solution technique was applied. Finally, vulcanization procedure of NR in the presence of PHB was performed (under $T = 170^\circ\text{C}$ for ~ 30 min). The rubber content in the compositions was varied from 0 to 30 wt %.

FTIR studies allowed concluding that during synthesis along with partial vulcanization of NR side reaction between the vulcanizing agent and PHB macromolecules took place. As a result, decreasing crystallinity degree of PHB component in the blend was fixed (DSC measurements) and total content of amorphous phase in PHB/vNR mixture increased, perhaps due to the generation of branched (or crosslinked) fragments. Significant inhibition of segmental mobility for both NR and PHB macromolecules due to partial crosslinking (in case of NR) and branching (in case of PHB) caused by the reaction with free radicals of dicumyl peroxide was observed. The post-vulcanization effect of NR was also revealed and characterized.

Abstract

THE EFFECT OF ENVIRONMENTAL CONDITIONS ON THERMAL CHARACTERISTICS OF MICROBIAL POLYHYDROXYBUTYRATE

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Nowadays utilization of continuously accumulated plastic wastes based on synthetic polymers is a global problem. However, substitution of large scale production of different goods made from conventional synthetic polymers by novel renewable environmentally friendly and biodegradable polymers for various applications still remains challenging. Microbial polyhydroxybutyrate (PHB) and PHB-based materials being entirely produced and degraded by living cells thereupon went forward at a steady gait.

The present research discloses the changes in thermal behaviour of thin PHB-based film materials (thickness up to 200 μm) after exposure to different types of soils under natural environmental conditions for up to 4 month. Sheets of polyhydroxyalkanoate under the trade name Biomer[®]P-209 were kindly supplied by Biomer (Germany) and used as the initial material for producing thin films.

DSC investigations of the initial films have shown the presence of two melting processes corresponding to the melting of crystallites of individual PHB and that of some additive. After exposure to soils, the samples demonstrated significantly higher glass transition temperatures together with lower both the heat capacity changes and the melting enthalpy representing PHB-component. Along with that a growth of melting enthalpy arising in higher temperature range for the additive was also established. TGA data showed increasing thermal stability of the samples after exposure to soils.

Thus, it was concluded that the primary process of biodegradation of PHB-based samples studied occurred through the destruction of less thermally stable PHB-component of the compositions and was accompanied by a redistribution of the ratio between crystalline and amorphous phases within the samples investigated.

The work was fulfilled under the Grant of the President of Ukraine for the gifted youth (order N.72/2012).

Abstract

SYNTHESIS, MOLECULAR STRUCTURE PROPERTIES, CATECHOLASE AND CATALASE-LIKE ENZYME ACTIVITIES OF NOVEL DINUCLEAR CU(II)-NI(II) IMINOOXIME COMPLEX

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A novel heterodinuclear Cu(II)-Ni(II) complex of iminooxime ligand has been prepared by employing several steps. The characterization and nature of bonding of the complexes have been deduced from elemental analysis, ICP-OES, FT-IR, molar conductivity, magnetic moment measurements and thermal analysis. Elemental analyses, stoichiometric and spectroscopic data of the metal complex indicated that the metal : ligand ratio of the dinuclear Cu(II)-Ni(II) complexes have been found to be 2:1. Additionally the complex has been tested both for its ability to catalyse the oxidation reaction of 3,5-di-*tert*-butylcatechol to the 3,5-di-*tert*-butylquinone in the presence of O₂ and disproportionation of hydrogen peroxide with added base imidazole to the medium. Kinetic studies have been also performed and found that the complex has been exhibited good both catecholase and catalase-like activity.

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Abstract

THE IMPACT OF POROUS STRUCTURE ON THE TRIBOLOGICAL PROPERTIES OF FRICTIONAL POLYMER COMPOSITES

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The article deals with the role of porous structure during the development of frictional polymer composites. It is shown that the porosity, represented by the component having either artificial or natural pores, anyway improves the tribological properties of frictional polymer composites: the stability of their friction characteristics improves, the metal counter body wear decreases and the service properties of items improve in general. The authors studied the positive effect of introduction of natural nanoporous components, diatomite [1,2] and clinoptilolite, into the composition of developed composites on their wear and friction characteristics.

Materials presented by authors have some competitive advantages: ecological safety, high resistance to wear and friction coefficient stable value both in dry and wet friction conditions, small number of ingredients in the friction material, reduced wear out of car braking disks (2-4 times).

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Abstract

POLYURETHANES AND POLYURETHANE COMPOSITES BASED ON RENEWABLE RESOURCES

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Each year, more than two million tons of PUR is produced in the EU by reacting isocyanates with polyols made from fossil fuel. In addition, there are appreciable quantities of petroleum based functional additives applied in the industry nowadays for both polyols and PUR materials. It is therefore of key importance to develop sustainable economically viable polyols with enhanced functionalities, and thereby reducing the need for polyols and additives made from non-renewable fossil fuel

By basing PUR on biomaterials, the carbon footprint is reduced, and using biomass waste/by-products will further improve the environmental profile. Many studies show that materials from renewable can almost fully substitute their petrochemical analogs. Also polyurethane industry shows increasing interest in polyols derived from renewable resources. Relatively new materials from renewable resources that can be incorporated into polyurethane technology are glycerol and its polymeric form. Incorporation of these compounds is related to the production of biofuels, based on fatty acid methyl esters. Glycerol is a by-product in biodiesel production, 100 kg of glycerol is obtained for each tone of fuel. According to European Biodiesel Board, consumption of biodiesel in EU will exceeds yearly 15 Mt, what gives 1.5 Mt of waste glycerol to utilize which can be polymerized and successively used in PU.

This work, based on the literature and personal research, presents the status of knowledge about application in the synthesis of polyurethanes of renewable raw materials and waste materials, mainly derived from natural oils, waste glycerol from biodiesel production and biomass.

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Abstract

OBTAINING OF SILICA-CHITOSAN COMPOSITE

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It is well known that chitin and chitosan containing systems are widely used in water treatment (purification) processes and sorption of heavy metals. However, the issue of increasing the efficiency of the sorption properties of such system arises. One method of increasing the surface area of such composite materials is to obtain particulate materials.

The most promising among structure-forming particulate materials is silica gel. The process of entering of chitosan into the structure of silica hydrogel was investigated to obtain a composite sorbent. Due to the fact that chitosan has a moderate solubility in neutral and alkaline conditions, it was necessary to obtain acidic silica sol in order to ensure homogeneous mixing chitosan with the silica sol. As silica sol was used, alcohol stabilized silica sol obtained by the following procedures. The dilute sodium silicate ($M = 3.0$; 12% by mass of SiO_2) with vigorous stirring dropwise is added to a 20% aqueous sulfuric acid solution (avoiding the local formation of SiO_2 precipitates). Having added the entire quantity of liquid glass in the system the volume ethanol was immediately injected in an amount of from 1/3 to 1/2 of the total volume of the resulting mixture. The result silica sol contents 8-10 mass% by SiO_2 . Having cooled the crystals of sodium sulfate precipitates which is removed from silica sol by means of filtering, the obtaining stabilized silica sol is stable and can be kept without gelation within 5-8 hours.

Simultaneously 1.0-1.5% - chitosan solution was being prepared in acidified with acetic acid water medium. The made chitosan solution was added at the time of stirring to silica sol so that the weight ratio of SiO_2 /chitosan is from 4/1 to 10/1. Further there is gelling. Aging the gel after which it was dried at 80°C for 4 hours.

Porous characteristics of obtained composite sorbent were measured by the BET method on the instrument Accosorb 2300A (Micromeritics firm, USA).

Abstract

SYNTHESIS, CHARACTERIZATION AND PHOTOLUMINESCENCE STUDY OF NEW AROMATIC POLYMERIC NANOPARTICLES CONTAINING PENDENT SUBSTITUTED ARAMIDES

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Substituted aromatic polyamides are a characteristic of luminescence materials that produce electroluminescence or photoluminescence phenomena, upon exposure to an electric current or due to absorption of photons causing re-radiation. The film formation properties and outstanding mechanical properties of aramids make these polymers suitable for the production of organic light emitting diodes (OLED).

In this work, we describe the preparation of novel aromatic polyamides nanoparticles with pendant structures comprised of substituted benzamides or naphthamides, where the groups act as signalling units due to their fluorescent and chromogenic characteristics. These model compounds were also used to study the influence of the structure modification on the thermal stability and photoluminescence behaviour of the polymers.

From OLED efficiency point of view, the investigated polymeric series of the materials will serve as good examples of how the molecular structure influences optical and electronic performance. A high polymer molecular weight will guarantee an adequate conjugation length and enhance interchain interactions, yielding an increased hole mobility through strengthened intramolecular charge transport properties and intermolecular hopping.

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Abstract

INFLUENCE OF THE PH ON THE STRUCTURE OF THE CATIONIC POLYMER ZETAG 9014[®] TYPE

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The structure of cationic polymer ZETAG 9014[®] was studied under the influence of changes in pH in an aqueous solution. The goal of this study was to prepare an aqueous solution of a polymer concentration of 0.5 g/l in order to see the changes in particle size and particle size distribution (PSD) in a broad range of pH. When reducing the pH of the medium, there is a clear trend, in which the average particle size reduces and the size distribution narrows. Conversely, at higher pH values (alkaline region), the average particle diameter broadens the PSD. It is important to note that the type of pH modifying agent (in particular, acid) can also affect the polymer structuring process. The chemical agents used to modify the pH of the suspension (medium and polymer) were NaOH, KOH, Ca(OH)₂, NH₄OH, HNO₃, HCl, H₃PO₄, H₂SO₄, CH₃COOH.

For many years, cationic polyacrylamide flocculants have been used in the sludge dewatering process. Optimizing the dewatered bio-solids is essential to maintain the sustainability and efficiency of the process. Higher cake solids reduce the energy required for transporting and disposing at a landfill. The water treatment chemicals including flocculants and coagulants, are specially designed for the solid/liquid separation process in the industrial and municipal wastewater treatment sector. It is known that many wastewater treatment processes utilize polymeric flocculants comprising cationic, anionic and non-ionic polymers which are often added during the primary treatment of the wastewater in order to aid afterwards in the flocculation of solids by lowering the charge of the contaminant particles as well as causing inter-particle bridging, thereby increasing the size of the particle aggregates. Flocculation improves the dewatering rate of many types of suspended solids, including those used in mineral, paper manufacture, wastewater treating and oil field applications. Synthetic polymer flocculants have been utilized in the industry since the 1950's as aggregation agents in the treatment of suspended solids.

The main applications of organic polyelectrolytes in potable water production are in coagulation and flocculation, and in the dewatering of the produced sludge. The water production processes are usually followed by sedimentation and filtration, although with only slightly contaminated waters the sedimentation step may be omitted. The sludge's obtained from the various separation processes have very high water contents and must be further concentrated to minimize transportation costs; polymers have a role in this sludge conditioning.

Hydrolysis of the ester groups and consequent loss of cationic charge has been found to be charge density (CD) and pH dependent with hydrolysis encouraged mainly by alkaline conditions. It has been observed that some degradation occurs even at pH 6 for polymers having a CD of 24%, with a half life of 24h at pH 7 and 0.25h at pH 8.5. The polymer is stable at pH 4. There is no hydrolysis of acrylamide units up to pH 8.5. For a CD of 30% the process is also very slow, especially for pure solutions, whereas with salts or pH levels above 8 causes easily a degradation that is not observed for the polymer of 100% charge. In addition to the loss of cationic sites, there is a change in the chain conformation on hydrolysis because of the formation of anionic carboxylate groups, which reduces the chain extension and makes the polymer less efficient as a flocculent.

Abstract

PREPARATION OF N-(2,6-DIISOPROPYLPHENYL)-2,5-DI(2-THIENYL)PYRROLE-BASED LOW BAND GAP MOLECULES AND APPLICATION TO SMALL MOLECULE ORGANIC SOLAR CELLS

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Organic Bulk heterojunction solar cells (OSCs) made up with the blends of electron donating organic small molecule and electron accepting fullerene derivative are believed to be a promising candidates for renewable energy sources due to their advantages such as low cost, light weight, solution processable, and the capability to fabricate flexible large-area devices.^{1,2} The solar to electrical energy conversion efficiency (*PCE*) of OSCs prepared via the solution processability method exceed over 8.6%.³⁻⁶ Whereas, the tandem OSCs made with two or more organic small molecules display its absorption at different region of the solar spectra afforded an improved *PCE* of 10.7%.⁴ The higher *PCE* inspires us to develop new small molecules for SMOSCs application. In this study, we prepared two new *N*-(2,6-diisopropylphenyl)-2,5-di(2-thienyl)pyrrole (TPT)-based organic small molecules and studied their optical, electrochemical and photovoltaic properties. The TPT units were attached to the both sides of 4,8-bis(2-ethylhexyloxy)benzo[1,2-b:4,5-b']dithiophene (BDT) unit and then two different electron deficient units such as ethyl cyanoacetate (ECA) and tricyanovinyl (TCV) groups were incorporated on the end thiophenes of TPT units to afford molecules BDTTPT-ECA and BDTTPT-TCV, respectively. The estimated optical band gaps of BDTTPT-ECA and BDTTPT-TCV were 2.34 eV and 1.32 eV, respectively. The determined HOMO/LUMO energy levels of BDTTPT-ECA and BDTTPT-TCV were -5.22 eV/-3.29 eV and -5.16 eV/-3.86 eV, respectively.

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Abstract

THE INFLUENCE OF POLYURETHANES STRUCTURE ON THEIR SURFACE MORPHOLOGY

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Polyurethanes are used often in medical device applications and their use continues to grow. They are often chosen because they can fulfill product requirements that cannot be met by other biomedical materials. Their biocompatibility and unique chemistry and processing make them ideal for numerous medical applications.

The presence of polycaprolactone (PCL) and polyhydroxybutyrate (PHB) with sensible to hydrolysis ester bonds and presence of polyoxytetramethylene (PTMG) sensible to oxydation in structure of polyurethanes make them possible degradable under natural conditions. What more synthetic poly([R,S]-3-hydroxybutyrate) (R,S-PHB) used for soft segments building is almost completely amorphous what affected the crystallinity of polyurethanes and should facilitate they degradation. The surface morphology of polyurethanes is also very important for degradation.

Synthesis of polyurethanes was carried out in a two-step reaction, with molar ratio of NCO:OH = 4:1 on prepolymer step for crosslinked and NCO:OH = 2:1 for linear polyurethanes [1]. The hard segments of obtained new polyurethanes were synthesized with aliphatic 4,4'-methylene dicyclohexyl diisocyanate (H₁₂MDI, Aldrich) and 1,4-butanediol (1,4-BD, Aldrich). The soft segments were built of polycaprolactonetriol (PCL-triol, Mn 900, Aldrich) and synthetic R,S-PHB (Mn 1700) in case of crosslinked polyurethanes and polycaprolactonodiol (PCL-diol Mn 2000, Aldrich) or polyoxytetramethylenediol (PTMG-diol, Mn 2000, Aldrich) in case of linear polyurethanes. R,S-PHB was obtained by anionic ring opening polymerization of (R,S)- β -butyrolactone initiated by 3-hydroxybutyric acid sodium salt/18-crown-6 complex at room temperature and terminated with 2-bromoethanol [2]. The prepolymer was obtained in mass and next dissolved in dimethylformamide and after that was extended by 1,4 butanediol.

The aim of this study is the estimation of influence of polyurethanes structure on their surface morphology. The thermal analysis and surface morphology observation were performed on polyurethane samples which description is above.

The result of microscopic observations confirm the influence of polyurethanes structure on their crystallinity and surface morphology and indicate that crosslinked polyurethanes have more oriented surface morphology than linear polyurethanes.

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Abstract

DEGRADATION OF MODIFIED TPS IN THE NATURAL COMPOST

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Nowadays there is a big interest in a new class of polymeric materials that can be degradable after usage by natural environment or industrial composting. Biodegradable/composting polymers are converted by the action of micro-organisms (bacteria, fungi, algae) to carbon dioxide, water and biomass. There are several factors influencing the process of biodegradation/composting: the structure and composition of the polymeric material, temperature, humidity, compost content, type of enzymes produced by various microorganisms. The aim of the study was to determine the degree of decomposition of commercial foils for packaging advertised as compostable (Castorama, BioBag) and newly designed by us materials of modified thermoplastic potato starch (TPS). TPS was modified by epoxidized soybean oil and gum Arabic and tested in the environment of compost consisting of sewage sludge at normal weather conditions. For comparison the samples obtained only from TPS were studied. All samples were placed under open roofing. The tests were carried out for 2 weeks in July, in the north of Poland (Władysławowo). The degree of sample degradation was analyzed by examining the changes in weight loss and visual view of the samples after 1, 2, 3, 6, 7 and 14 days of composting. The results of studies have shown bigger changes in weight loss and visual view in the samples of modified TPS by epoxidized soybean oil and gum arabic in comparison to commercial samples.

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Abstract

THE INFLUENCE OF RUBBER RECYCLATE MORPHOLOGY ON THE PROPERTIES OF RUBBER-ASPHALT COMPOSITE

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Rubber product, particularly those used in the automobile industry, is responsible for a vast amount of wastes, mostly in the form of used tyres. One of the methods of waste tyre management is use them as a modifier of asphalt. However, the properties of rubber-asphalt composites depend on the morphology of waste tyre granulate and kind of tyre recycled (car/truck). In the paper we present the morphology of waste tyre grinded via standard granulation process and innovative flat-die granulation process. Rubber-asphalt composites were performed using two types of waste tyre granulates. The influence of grinding methods of waste tyre on the properties of rubber-asphalt composites was studied. SEM analysis indicates that waste tyre granulate obtained using granulator with flat-die granulation process have a higher specific surface area. In this case the higher quality of the rubber-asphalt binder may be achieved. It has been proved that waste tyre granulate, used as asphalt modifier, grinded with granulator with flat-die granulation process caused a lower viscosity and better value of the penetration of rubber-asphalt binders in comparison to standard granulation process. Moreover better stability, miscibility and more homogeneous at the macro scale composition was noticed.

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Abstract

SYNTHESIS AND CHARACTERIZATION OF CONDUCTIVE POLYURETHANE COMPOSITES CONTAINING POLYANILINE-CuO NANOCOMPOSITES

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Polyurethane (PU) is one of the most important polymers and widely used in commercial applications, including construction, automotive, food packaging, storage, transportation, textiles, footwear and wound dressing materials. Polyurethanes have appropriate mechanical properties such as film-formation, so with the preparation of composites of polyaniline and polyurethane can improve the mechanical properties of polyaniline [1, 2].

PANi-CuO nanocomposites have mechanical disadvantages such as film- not formation that for removal these problem synthesized PU-PANi-CuO composites. In this paper, Polyurethane was synthesized and then PU-PANi-CuO composites were fabricated with different contents of PANi-CuO nanocomposites (1, 2.5, 5 wt% CuO).

PU-PANi-CuO composites films were prepared and then curing of the films were completed in the Ultraviolet curing device. Morphological, electrical conductivity, thermal properties of the products were characterized by electron microscopy (SEM), DSC thermogram analysis and four point probe resistivity measurements.

The morphological studies (SEM) showed uniform distribution PANi-CuO nanocomposites in Polyurethane matrix. Glass transition temperature (T_g) value of the PU-PANi-CuO composites to higher value which indicates that PU-PANi-CuO composites are more stable than pure polyurethane. Result showed the electrical conductivity of polyurethane increased with increasing content of PANi-CuO nanocomposites (table 1). We suspect that the enhancement of the electrical conductivity and the mechanical properties may result from the increase in contact points among PANi-CuO moieties and chemical bonding between particles and PU matrix.

Sample	CuO nano particles	$\sigma \cdot 10^{-3}$ (at 300 K) S cm
Pure PU	–	0.001
PU-PANi-CuO	5 wt%	5.7
PU- PANi-CuO	2.5 wt%	7.3
PU-PANi-CuO	1 wt%	3.1

Table1. conductivity of pure PU, and PU-PANi-CuO (1–5wt%) composites films.

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Abstract

ON THE MECHANISM OF LATEX PARTICLES FORMATION IN POLYMERIZATION IN HETEROGENEOUS MONOMER - WATER SYSTEM

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At polymerization in micellar monomer-water emulsions, starting from the very beginning of the initial stage of polymerization, the micelles start to disappear. Simultaneously with the disappearance of the micelles polymer-monomer particles appear in the system (monomer microdrops containing polymer molecules). Up to the deep conversion of the monomer (approx. 60%) the number of polymer-monomer particles (PMP) does not change, and their diameter increases continuously and reaches about 100 nm.

These results have become the basis for creating a model of the emulsion polymerization (EP), according to which the PMP are generated in aqueous phase at the initiation of the polymerization in the micelles. However, the possibility of the latexes synthesis in the absence of emulsifiers (micelles), and the effective proceeding of thermal polymerization in monomer-water heterogeneous system indicates that nucleation of PMP is caused by polymerization taking place at the highly-developed interface. The presentation includes photographs of demonstration experiments of polymerization in static systems of styrene-water, vinyl acetate-water and chloroprene-water, from which is clearly visible the topological picture of PMP generation in a narrow interface of monomer – water system.

Using in the presentation the fundamental theory of phase formation from solutions it was shown that generation of polymer-monomer particles in such a system is a process of nucleation of microdroplets from saturated aqueous monomer solution. The driving force of this process is the supersaturation, which is specified and maintained by the heat of polymerization taking place at the interface.

Abstract

SELF-ASSEMBLY OF SPIN-LABELED POLY(AMINO ACID)-BASED BLOCK COPOLYMERS

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Amphiphilic block copolymers are of the great interest in biomedicine chemistry and, in particular, in drug delivery due to their ability to self-assembly into nanoparticles of various size and morphology. Among the most promising block copolymers are poly(amino acids) that combine advantageous features of synthetic polymers with those of protein-like polymers. Incorporation into the polymer structure responsive (fluorescent, isotopic, spin labeling, etc.) fragments allows visualization of the nanoparticles using different detection techniques. This research is devoted to the development of spin-labeled poly(amino acid) block copolymers with spin label localized in the end of hydrophilic chain.

The block-copolymers of poly(glutamic acid)-b-poly(phenylalanine) with different hydrophobic chain length (pGluPhe100, pGluPhe150, pGluPhe200) were synthesised. The spin-label 4-amino-TEMPO was incorporated into polymer as initiator of ring-opening polymerization of γ -benzyl-glutamate γ -N-carboxyanhydride. Self-assembly of the pGluPhe100, pGluPhe150, pGluPhe200 was investigated in borate buffer solution (pH=8.6) at concentrations 0.50 and 0.25 mg/mL by TEM, DLS and ESR methods.

The TEM microphotographs revealed that obtained polymers form hollow spherical nanoparticles with aqueous core surrounded by double-layered membrane.

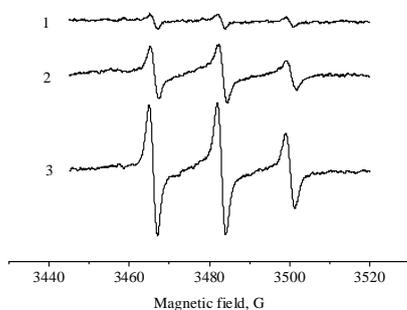


Figure 1. EPR spectra of nanoparticles suspension: 1 - pGluPhe100, 2 - pGluPhe150, 3 - pGluPhe200

4.1×10^{-10} s for pGluPhe100, pGluPhe150, pGluPhe200, respectively. The increasing value of τ may be caused by the different distance of the spin labeled fragment from the hydrophobic part of the membrane due to the dependence of the membrane thickness on the hydrophilic/hydrophobic block balance.

The size distribution was determined by DLS method and for all samples at concentration 0.50 mg/mL the hydrodynamic diameter value (R_h) was in the range of 100 – 350 nm. Obtained results demonstrated strong R_h dependence on the concentration of the nanoparticles showing the R_h increased value with concentration growth.

The integral intensity of the EPR spectrum of nanoparticle suspensions increased from pGluPhe100 to pGluPhe200. All the spectra are characterized with the same hyperfine splitting constant $a_N = 18$ G that confirms that the spin labeled end of polymer chain is located on the surface of the nanoparticle in the polar medium of the solvent (Figure 1). The calculated values of correlation time (τ) are 7.7×10^{-10} , 4.5×10^{-10} ,

Abstract

SYNTHESIS AND PROPERTIES OF OLIGOMER WITH METHACRYLIC AND PEROXY GROUPS BASED ON ED-24 EPOXY RESIN

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The presence of functional groups different by their nature in the structure of oligomeric products allows to use them as additives for cross-linked structures and initiators of radical polymerization. The introduction of unsaturated double bonds into the structure allows to use such oligomers as comonomers in the radical processes.

We obtained new oligomer (OMP) with unsaturated methacrylic fragment and labile peroxy group on the basis of ED-24 epoxy resin which is dioxydiphenylpropane dicyclydyl ether.

OMP was synthesized via two stages: At the first stage the compound with methacrylic fragment and free epoxy group was synthesized via the reaction between ED-24 and methacrylic acid using tetrabutylamm-
onium iodide as a catalyst. The reaction temperature was 373 K, reaction time – 2.0 h. At the second stage the synthesized product was treated by tert-butyl hydroperoxide at 333 K for 5 h using 18-Crown-6+ZnCl₂ catalytic system. The obtained OMP had the following characteristics: molecular weight 510 g/mol; active oxygen 2.3%, bromine number 27.5 g Br₂/100 g product.

The structure of the synthesized OMP was confirmed by IR-spectra.

Since OMP may be used as comonomer of the polymerization reaction with styrene, we studied the reaction using toluene as reaction medium. Azo-bis-butyric acid dinitrile was the reaction initiator.

At 333 K and different ratios OMP:styrene two rates of the copolymerization reaction were calculated. The higher was the OMP amount in the initial mixture, the higher were monomer conversion and copolymerization rate. Alternating copolymers were formed during copolymerization.

The structure and content of peroxy groups in the obtained copolymers were confirmed by IR-spectral and chemical investigations.

The presence of free peroxy groups in the side chains of the synthesized products allows to use them further for the obtaining grafted comb-shaped polymers with different structures.

Abstract

SILOXANE BASED LITHIUM SALTS CONTAINING POLYMER ELECTROLYTE MEMBRANES AND THEIR STRUCTURE

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The aim of presented work is obtaining of solid polymer electrolyte membranes on the basis of siloxane matrix. For this purpose the hydrosilylation reactions of tetrahydrotetramethylcyclotetrasiloxane with allyl di(tri)ethyleneglycol monomethyl ether and vinyltriethoxysilane at 1:3:1 ratio of initial compounds in the presence of Karstedt's catalyst, platinum hydrochloric acid (0.1 M solution in THF) and platinum on the carbon catalyst in 50% solution of anhydrous toluene have been studied. Via polymerization reaction of obtained organocyclotetrasiloxanes in the presence of potassium hydroxide corresponding copolymers have been obtained.

The synthesized oligomers are vitreous liquid products, which are well soluble in organic solvents with specific viscosity $\eta_{sp} \approx 0.05 - 0.06$. The synthesized oligomers were analysed with FTIR, ¹H, ¹³C, ²⁹Si NMR spectroscopy. Synthesized polysiloxanes were investigated with wide-angle X-ray, gel-permeation chromatography, and DSC analyses.

Via sol-gel processes of doped with lithium trifluoromethylsulfonate (triflate) or lithium bis(trifluoromethylsulfonyl)imide polymer systems vitreous solid polymer electrolyte membranes have been obtained. The surface of obtained membranes has been carried out via optical and scanning electron microscopy.

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Abstract

INTERGEL SYSTEMS – HIGH EFFECTIVE INSTRUMENT FOR RARE EARTH ELEMENTS EXTRACTION FROM INDUSTRIAL SOLUTIONS

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Production of rare metals, rare earth metals and their compounds in Republic of Kazakhstan can be characterized as unstable, not corresponding to its potential. In some enterprises production of these metals decreased sharply and suspended. However, the world demand for rare earth products increases every day. Due to this fact production of clean rare and rare earth metals and their compounds is highly profitable. Consequently, production of pure rare and rare earth metals and their compounds may be priority direction in future for Republic of Kazakhstan.

Previous studies showed that in result of remote interaction hydrogels, which are in intergel systems, have significant changes in volume-gravimetric, sorption properties [1-2].

Intergel system polyacrylic acid hydrogel (gPAA) – poly-4-vinylpyridine hydrogel (gP4VP) was used for sorption of lanthanum ions from lanthanum nitrate. Electrochemical properties of solutions was studied by conductometry and pH-metry, volume-gravimetric of hydrogels properties was studied by gravimetry.

In presence of gPAA-gP4VP intergel system specific electric conductivity increases for all ratios with time. However, character of electric conductivity change for various molar ratios is different. Minimum values of specific electric conductivity are due to sorption of La³⁺ ions by both hydrogels and binding of cleaved proton from carboxyl group by nitrogen heteroatom. High conductivity values indicate that at certain ratios there is domination of lanthanum nitrate and carboxyl groups dissociation process over proton association process by nitrogen heteroatoms.

At initial moment of time solutions pH has low values, when there is predominance of polyacid. With polyvinylpyridine share increase pH of solution gradually increases, and reaches maximum value at ratio gPAA:gP4VP=0:6. There is a decrease in hydrogen ions concentration with time.

Polyacid swelling coefficient undergoes changes as a result of polymer hydrogels long-range effect. There is a significant increase of polyacid swelling when there is increase of polyvinylpyridine share. With increase of interaction time there is a decrease of polyacrylic acid swelling coefficient. This results evidence to a phenomena of La³⁺ ions sorption.

Increase of polybasic swelling occurs in presence of polyacid. Maximum area of cationic hydrogel swelling at all values of interaction time appears at hydrogels ratio 5:1. With increase of polyvinylpyridine share swelling decreases and reaches minimum at ratio 0:6.

Relatively fast speed of hydrogels regeneration and ions separation, high selectivity of ion separation are intergel systems advantages over existing analogues in industry.

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Abstract

CHARACTERIZATION OF SHAPE MEMORY BIODEGRADABLE POLYESTER BLENDS

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Biodegradable and biocompatible polymer materials on the basis of polylactide are the one of the most frequently used in medicine. The shape memory properties of these bioresorbable materials would significantly extend possibilities of their application. That property depends on capability of return from transient shape, obtained via mechanical deformation, to the early original shape, caused by defined stimulus, the most frequently, temperature.

Among many investigated copolymers, terpolymers and blends containing polylactide also the blends consisting of the poly(l-lactide-co-glicolide) (PLLAGL 85:15) and biodegradable and biocompatible aliphatic esters, i.e. butylene succinate (BS), triethyl citrate (TC) and butylene succinate-co-triethyl citrate (BSTC) oligomers show the shape memory properties [1-4]. It was proved that the addition of oligomers, especially the o-BSTC, to PLLAGL copolymer decreased the glass transition temperature, significantly changed the rigidity of the material and shape memory parameters. It was demonstrated that among the investigated compounds, the blends containing of 10 and 20% of oligomers were the most prospective for biomedical applications. These blends showed one glass transition temperature and compatibility of ingredients. The addition of 40% of oligomers caused that the resulting blends were not fully compatible. In that case two glass transition temperatures appeared; the lower connected with the oligoester and higher with the PLLAGA copolymer phases.

A detailed study of the shape memory compounds obtained showed that the PLLAGA/o-BSTC blends were characterized by interesting property, the existence of two separated shape memory; one related to the glass transition phase and the second to the intermolecular interactions. The presence of intermolecular interactions was confirmed by FTIR spectroscopy. Due to the fact that the differences between recorded spectra of the blends studied were rather small, the second derivative spectra were calculated. These investigations proved the presence of interaction between hydrogen atoms from the CH₃ groups and oxygen atoms from the C=O groups. These interactions were the strongest in the case of blends with o-BSTC. It was probably related to the presence of hydroxyl groups in the o-TC side chain. These groups formed stronger hydrogen bonds than the CH₃ ones and the same played a crucial role in that case.

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Abstract

AMINO ACID BASED BIODEGRADABLE POLYMERS - PROMISING MATERIALS FOR NUMEROUS BIOMEDICAL APPLICATIONS

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The basic limitation of α -amino acid (α -AA) based natural (proteins) and synthetic (poly- α -AAs) polymers as biomaterials is *immunogenicity* that restricts their applications. The immunogenicity of the said polymers is caused by their spatial organization that, in turn, is determined by the primary structure in which α -AAs have „head-to-tail“ orientation. We developed a new family of α -AA based bioanalogous polymers (ABBAs)¹ in which α -AAs have „head-to-head“ and „tail-to-tail“ orientation and, hence, a new macromolecular architecture less recognizable by the immune system.

Among the ABBAs the most promising for practical biomedical applications are those containing hydrolysable ester bonds in the backbones - Amino Acid Based Biodegradable Polymers (AABBP). Various classes of AABBP were obtained on the basis of α -AAs and other non-toxic co-building blocks like fatty diols, and dicarboxylic, β -hydroxy and carbonic acids [1-3]. The selection of appropriate building blocks and optimal polycondensation method allowed the synthesis of AABBP with tailored material properties. Either non-functional or functional AABBP suitable for subsequent chemical modifications were obtained using polyfunctional α -AAs and other functional/unsaturated co-building blocks. Numerous cationic AABBP having a high positive charge density along the polymeric chains were also synthesized using amino acid L-arginine [4,5] and some other cationic building blocks.

Ex vivo cell-based assays have strongly supported recent human trial data indicating the polymers are blood and tissue compatible, with advantageous properties for implantation into tissue. AABBP's biodegradation and drug release proceed by surface erosion and primarily follows zero-order kinetics. Several AABBP have been successfully tested, for example, as medicated wound dressing, and in animals and humans for cardiovascular applications. The polymers are promising also as micro and nanocontainers for target drug delivery. The studies using these micro/nanocontainers to support stem cells transplanted in the ischemic damage (lesion cavity) with the purpose to restore brain function, and to deliver drugs through the biological barriers are in progress now. Cationic AABBP showed a high compatibility with eukaryotic cells suppressing at the same time prokaryotic cells, i.e. revealed antibacterial activity. They are also promising carriers for intracellular delivery (transfection) of nucleic acids [4,5].

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Abstract

ACTIVITY OF CHOSEN METAL ACETYLACETONATES IN HOMOPOLYMERIZATION OF MODEL BIS-MPA-BASED CARBONATES

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Functional synthetic polymers have received considerable scientific interest and attention in recent years for their potential as promising novel materials enhancing properties of well-known polymers. Recently, attention has been directed towards aliphatic polycarbonates for the manufacture of temporarily used materials thanks to their biodegradability and biocompatibility [1]. In combination with their ready hydrolysis and low toxicity, aliphatic polycarbonates are attractive materials in (bio)medical and pharmaceutical field as gene carriers, drug delivery systems based on either nanoparticles, microspheres or hydrogels. Although the choice of commercially available monomers is relatively limited, several routes have been developed to prepare functional cyclic carbonates. At the moment scientific literature describes more than 80 functional cyclic carbonates with different pendant functions designed to improve properties of polymeric materials. Of the most versatile precursors are glycerol, pentaerythritol and 2,2-bis(hydroxymethyl)propionic acid (bis-MPA) [2].

Herein, results of ring-opening polymerization of 5-methyl-2-oxo-1,3-dioxane-5-carboxylate (MTC-Et) and benzyl 5-methyl-2-oxo-1,3-dioxane-5-carboxylate (MTC-Bz) - functional model aliphatic carbonates mediated with coordination catalysts (acetylacetonates hydrates of zinc (II) ($\text{Zn}(\text{acac})_2 \times \text{H}_2\text{O}$), lanthanum (III) ($\text{La}(\text{acac})_3 \times \text{H}_2\text{O}$) and yttrium (III) ($\text{Y}(\text{acac})_3 \times \text{H}_2\text{O}$) as well as scandium (III) tris(2,2,6,6-tetramethyl-3,5-heptanedionate) hydrate) are presented. The polymerization experiments were carried out in bulk at temperature from 80°C to 150°C.

Acetylacetonate hydrates of zinc (II), lanthanum (III) and yttrium (III) were found to be efficient initiators of ring-opening polymerization of model functional cyclic carbonates carried out in bulk. Number-average molar masses of the obtained polycarbonates were relatively low but high-molar-mass fractions reached molar mass higher than 1'000'000 g/mol which is unusual in case of aliphatic carbonates ROP. Relatively broad molar mass distributions of polymers were observed in majority of products the most probably as a consequence of the carbonate pendant ester group transesterification. Noteworthy, bulkier substituent (benzyl) in vicinity of the ester group did not retard the secondary reactions. It was also noticed that even in case of one initiator relationship temperature-molar mass of products is relatively complex phenomenon.

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Abstract

HIGH PERFORMANCE MATERIALS FOR MEMBRANE

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Polyamides (PA) are widely used as high-performance polymers in technical applications due to their combination of outstanding thermal, optical, mechanical and chemical properties. The synthetic aromatic polyamides differ from the aliphatic polyamides (nylons) on the highly aromatic nature of the polymer backbone. Both nylons and aromatic polyamides are considered engineering materials, but the aromatic structure of the main chain of the aramids endow this polymers with specialty characteristics making them less sensitive to oxidation, higher solvent resistant, and conferring the materials with superior thermal and mechanical resistance, thus being classified as high-performance materials. Both of these polymers can be transformed into flame, cut-resistant and high-tensile strength synthetic fibers, with technological applications in the field of coatings and fillers in the aerospace and armaments industry, in asbestos substitutes, electrical insulation, industrial filters, sport fabrics, gas separation membranes, ion-exchange membranes.

The preparation of asymmetric membranes by the phase-inversion process is a standard technique nowadays. During the study we tested the solvent resistance of the membrane, also investigated the effect of the concentration of polymer solution, the evaporation time of solvent and the temperature of coagulation bath on the membrane performance. The structure of porous membrane is related to the characteristics of the interacting polymer and solvent, components concentration, molecular weight, temperature and storing time in solution. Dimethylsulfoxide (DMSO), dimethylacetamide (DMAC), n-methylpyrrolidone (NMP) and acetone served as solvents for the preparation of the casting solutions. Several additives such as benzene, tetrahydrofurane (THF), formamide were used in the casting solution. Water, methanol, glycerole, formic acid and mixtures of these components were used as precipitants the polymer concentration in the casting solution was varied between sand 25 wt % polymer.

The mechanical properties and chemical structural changes during the photochemical aging process were studied by using appropriate techniques including infrared spectroscopy (FTIR), X-ray diffraction (XRD), differential scanning calorimetry (DSC), scanning electron microscopy (SEM), atomic force microscopy (AFM) and permeability measurements.

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Abstract

IN VITRO ANTIMICROBIAL ACTIVITY STUDY OF SOME NEW ARGININE-BASED BIODEGRADABLE ESTER-POLYMERS

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The development of synthetic antimicrobial agents is an emerging need due to antibiotic resistance of bacteria causing fatal infectious diseases [1]. One of the most promising weapons in a battle against bacteria are organic cations (OC). Starting from 1980s three classes of OC have become the most important as bactericidal agents: (i) naturally occurring peptides and their analogs, (ii) low-molecular-weight non-peptide organic molecule, and (iii) bactericidal polymers.

The low-molecular-weight antimicrobials have one common limitation which consists in short-term antimicrobial ability. The polymeric bactericides containing *guanidine* group are one of the most promising for therapeutical applications [2, 3]. The bactericidal polymers are characterized by prolonged action, as well as higher antimicrobial ability due to a high local concentration of the active groups.

Very recently we have reported on a family of arginine-based cationic ester-ether polymers [4] of various classes - poly(ester amide)s, poly(ester ether amide)s, poly(ester urethane)s, poly(ester ether urethane)s, poly(ester urea)s, and poly(ester ether urea)s synthesized by solution active polycondensation of tetra-*p*-toluenesulfonic acid salts of bis-(L-arginine)-alkylene diesters with activated diesters of various classes. Seven arginine-based ester and ether-ester polymers of urethane and urea classes were selected from this variety of polycations for antimicrobial activity (AA) study. Both Gram-positive and Gram-negative test-microorganisms such as *Bacillus subtilis*, *Staph. aureus*, *Mycobacterium album*, *E. coli*, *Ps. fluorescens*, as well as *Aspergillus niger* and *Actinomyces griseus* were used in this study. The AA study was performed using standard protocols of Disc Diffusion Method and Serial Dilution Method. It was found that the AA against the used microorganisms is largely determined by the chemical structure of the used cationic polymers.

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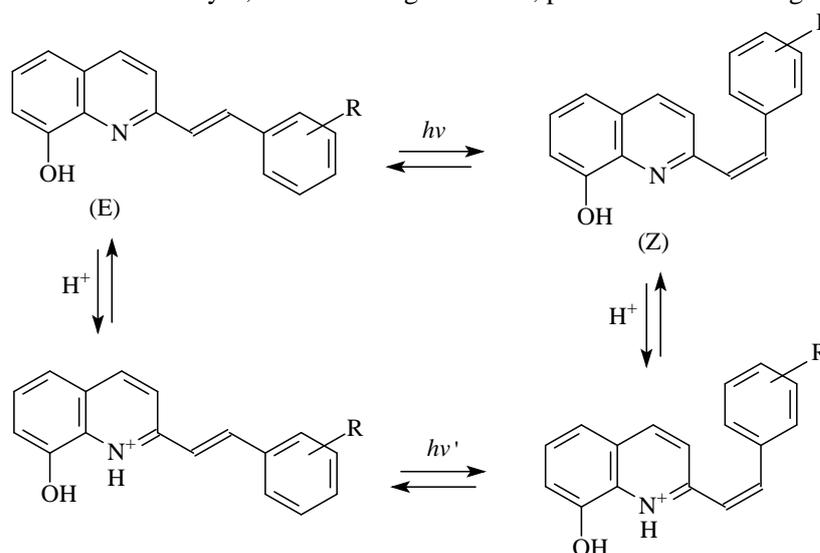
Abstract

SYNTHESIS, CHARACTERIZATION, AND OPTICAL PROPERTIES OF STYRYLQUINOLINE CONTAINING POLYMERS

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In last years one observes a growing research interest in developing materials which exhibit special optical properties for potential applications in photonics and electronics. The basic properties that are required for organic optical materials include display large optical nonlinearity, low optical losses and ultrafast response time. In this respect, styrylquinolines are promising materials for photonic applications [1,2]. The styrylquinolines are used as laser dyes, molecular logic devices, photoswitches and logic gates.



Scheme shows four form of 2-styrylquinoline: neutral E- and Z-isomers and corresponding protonated forms which are thermally stable, have different spectral properties, and are easily interconvertible by irradiation.

The polymer films based on 2-styrylquinoline are characterized by the ability for reversible photoisomerization and protonation/deprotonation. That allows us to construct the various molecular logic gates, molecular devices and switches on its base.

In this work photosensitive copolymers were synthesized by radical copolymerization of corresponding styrylquinoline derivatives with methyl methacrylate using [azobisisobutyronitrile](#) as radical initiator. We present preliminary results obtained for the methacrylic polymers incorporating styrylquinoline side-group as optically active moiety.

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Abstract

SEPARATION OF IONS BY POLYMER ELEKTROMEMBRANES

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We investigated the selective behavior of polymeric membranes MK-40 and MA-40 in out-of conditions by a method based on the precipitation of Ca^{+2} ions, SO_4^{-2} and CO_3^{-2} on the membrane surface. It was concluded that reducing the selectivity of the membranes investigated ions in the transcendental state.

Polymeric electromembrane are well-swell able film that has fixed positive or negative charges on the polymeric matrix. The high density of these charges within the macromolecule creates a so-called space charge, which is compensated by an equivalent number of charges of opposite sign [1]. Electromembranes are used for purification and separation of ions of natural and industrial wastewater. The effectiveness of the process of ion separation, for example, in electrodialysis, is defined by electrical transport properties. One of the important electrical properties of the membrane is selectiveness - selective permeability of ions of specific sign (an electric field). A quantitative measure of selectivity is the number of number of transport of counterions through membranes [2].

From a practical point of view, the particular interest is the behavior of selective membranes exorbitant conditions. With this purpose is used the method of determining transport numbers, based on the precipitation of the tested ion at the surface of the membrane. The averaged over time the number of the ion transport Ca^{+2} , SO_4^{-2} and CO_3^{-2} at the solution / membrane border at density $5 \cdot 10^{-3} \text{ A / cm}^2$ and duration of experiment 600 seconds were determined. Ca^{+2} ions penetrate through the cation membrane MK-40 from solutions CaCl_2 in Na_2CO_3 solution and precipitated on the membrane as a precipitate CaCO_3 , and SO_4^{-2} ions and CO_3^{-2} transferred through anion exchange membrane MA-40 from solutions, respectively, Na_2SO_4 and Na_2CO_3 in CaCl_2 solutions and were precipitated in the form of precipitated CaSO_4 and CaCO_3 . The change in the value of the numbers of ion transport Ca^{+2} at the joint transfer of ions and Na^+ ions and SO_4^{-2} CO_3^{-2} - ions Cl^- were determined. The regularities of changes in transport numbers of ions Ca^{+2} , SO_4^{-2} and CO_3^{-2} depending on the current density and process time were studied. A reduction in transport numbers of all investigated precipitate-producing ions during the joint transfer with non-precipitate-producing ions were determined, as well as an increase in current density and process time. The decrease of the number of ion transport is explained by characteristics of the transport in conditions of precipitation on the membranes. The formed precipitate in some way blocks the membrane surface, which leads to an increase in effective current density and in outrageous conditions reduce of the transport number of counterions.

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Abstract

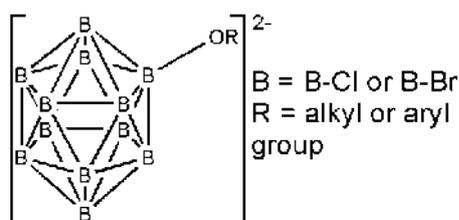
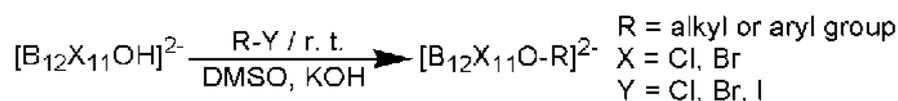
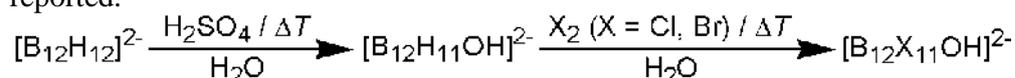
DERIVATIZING THE $[B_{12}X_{11}OH]^{2-}$ -CLUSTER (X = Cl, Br) FOR NEW IONIC LIQUIDS

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During the past decade a large variety of different cations and anions for the formation of ionic liquids were investigated. For this purpose boron cluster anions, in particular derivatives of the icosahedral $[B_{12}H_{12}]^{2-}$ anion, received attention. For instance, ionic liquids based on the alkylated ammonio-*closo*-dodecaborat [1] anions and the parent *closo*-dodecachlorododecaborat anions were reported [2]. In contrast, perhalogenated derivatives would be of higher chemical inertness. Therefore, the synthesis and characterization of perhalogenated clusters with an alkylated hydroxy group were investigated. The scheme below summarizes the reactions, leading to the new substituted boron clusters. The length of the alkyl chain could be realized for up to twelve carbon atoms to lower the inter molecular interactions with the specific cation.

The syntheses and characterization of their tetrabutylammonium and imidazolium salts by thermal analysis, NMR-, IR- and Raman spectroscopy as well as mass spectrometry will be reported.



Picture 1. Structure of the prepared boron clusters

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Abstract

MICROENCAPSULATION OF CORROSION INHIBITOR FOR SELF-HEALING COATINGS

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Among the promising new developments in the field of protection of metal from corrosion can be identified self-healing coatings. Self-healing coating represent a matrix containing in its structure a microcapsule inclusive a functional agent, corrosion inhibitor [1].

This paper presents a study of encapsulation of organic phosphorus-containing corrosion inhibitor in urea-formaldehyde polymer shell, as well as study the possibility of using it for self-healing coatings. Protective effect of an inhibitor of caused by formation of an impermeable absorption film on the metal surface, preventing its further degradation.

Used a method of manufacturing the microcapsule wall is based on the polymerization in situ of urea with formaldehyde [2] on the surface of the emulsion droplets of corrosion inhibitor in the aqueous solution.

Analysis of the external characteristics of the obtained microcapsules was carried out using microscopy. The size of the microcapsules was 0.5-5.0 microns. For protection steel articles coating was formed with microcapsules embedded in an epoxy or metallic coating. Preparation of microcapsule-based corrosion inhibitor comprises the steps of polymerization and washing with filtration for more complete removal of the initial components of surfactants. Tests were carried out on the corrosion resistance by applying a paste "Korrodkot" which showed the presence of self-healing protective properties when it is damaged.

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Abstract

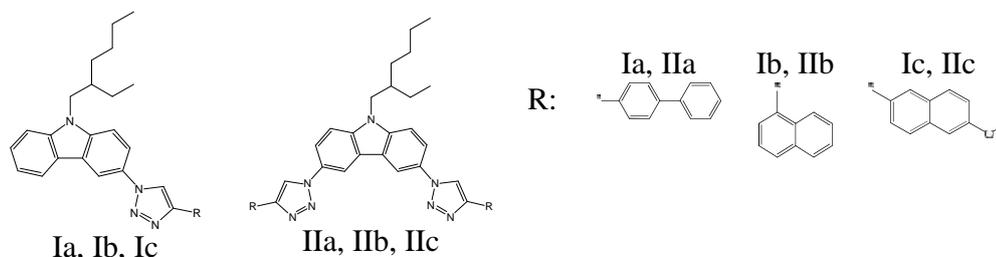
STRUCTURE-PROPERTIES RELATIONSHIP OF CARBAZOLE-BASED 1,2,3-TRIAZOLE DERIVATIVES

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Organic compounds containing carbazole units are among the most studied materials for electronic applications due to good chemical and environmental stability, and high hole mobilities of their layers [1,2]. Exploitation of copper-catalyzed azide-alkyne cycloaddition and formation of 1,2,3-triazole rings opens up the path to novel organic conjugated systems for organic electronics [3,4]. 1,2,3-Triazoles derivatives have a wide range of applications as fluorphores, chemosensors, and charge transfer agents [5].

In this study, we report on the click-chemistry synthesis and properties of carbazole-based derivatives functionalized with 1,2,3-triazole rings.



Compounds Ia, Ib, Ic, IIa, IIb, IIc were synthesized by one-pot, two-step synthesis. The appropriate mono- or di- azide was generated in situ from a corresponding bromocarbazole and immediately consumed in a reaction with alkyne. The synthesized compounds were purified by column chromatography. They were identified by ¹H and ¹³C NMR, IR and mass spectrometries. The thermal, optical, electrochemical and photoelectrical properties of the synthesized compounds were studied. Their initial decomposition temperatures were recorded above 320 °C. The synthesized compounds form molecular glasses. Their glass transition temperatures are in the range of 32-108 °C. The UV-vis absorption maxima of the dilute solutions are observed in the range of 210-315 nm. The solutions of the synthesized derivatives emit in the range of 360-430 nm. The ionization potentials of the synthesized compounds estimated by cyclic voltammetry range from 5.38 to 5.51 eV.

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Abstract

MODIFICATION OF POLYETHYLENE FILMS VIA PHOTOCHEMICAL REACTION

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Scientific resources abound in data concerning the use of organic azides for modification of polymer materials. The ability of azides for photochemical decomposition which results in forming an active nitren biradical can be used for modification of polymer surface. Surface modification is a convenient and sometimes the only way of polymer materials' acquiring necessary properties since it does not change the polymer structure in mass.



Designing the structure of modified surface by various biologically active groups is one of the issues of current importance in present day polymer chemistry. Previously there have been investigated the ways of introducing biologically active preparations into a polymer chain which results in obtaining pharmacologically active polymers. Polyethylene (PE) is one of the more widespread polymers used for industrial and biomedical applications due to its special properties which include low density, flexibility and high chemical resistance.

Firstly we have synthesized new azidobenzenesulfonamides and investigated their photochemical properties. High photochemical activity of obtained azidobenzenesulfonamides has given possibility to use them as modifiers of polymer materials.

Abstract

INHIBITION OF THERMAL-OXIDATIVE PROCESSES IN PITCH COMPOSITE

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Pitch composite is a new constructional material based on modified coal tar pitch. Pitch composite is a compositional thermoplastic polymeric material.

Upon pitch composite obtaining and exploitation products from it, the material of pitch composite is influenced by various factors – heat, oxygen, mechanical loads, etc. These factors acting singly or in combination cause pitch composite ageing.

Pitch composite ageing is combination of chemical and physical processes leading to a change in its exploitation properties.

Chemical transformations at pitch composite obtaining and processing at high temperatures occur mainly due to thermal-oxidative and mechano-chemical destruction.

Thermal-oxidative processes are the main reason of degradation of thermoplastic products exploitation properties.

For inhibition of thermal-oxidative processes in the pitch composite the first type antioxidants were studied.

An effective protection against thermal-oxidative ageing of the pitch composite is provided by using of a pair the same mechanism action antioxidants. Antioxidants have the same mechanism of action but differ by their activity (efficiency): mixture of aromatic amines AmH (melamine) and phenols PhOH (Irganox) have a synergic effect.

Synergic antioxidants pair at the optimum ratio slows the degradation reactions and can be used to protect against thermal-oxidative ageing of pitch composite.

Abstract

SOME ISSUES OF OBTAINING CORUNDUM CERAMICS

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Ceramic obtained on the base of aluminum oxide has wide application range, because of its unique properties, for example, wear-resistance, dielectric characteristics, exploitation ability at high temperatures and in corrosive atmosphere. Producing corundum ceramics is multistage process and it contains following main stages: I. synthesis of $\text{-Al}_2\text{O}_3$. II. obtaining -alumina sustainable suspensions by adding organic binders, plasticizer, dispersant and dopants. III. drying- evaporating suspensions by spraying or granulating methods. IV. Pressing powders in steel moulds under 100-200 MPa pressure and sintering at “green products“ at 1400-1700°C temperatures in a muffle furnace. Present work deals with the low-temperature synthesis of $\text{-Al}_2\text{O}_3$ conducted in a following way: Aluminum unstable oxyhydroxides have been obtained by hydrolysis of aluminum isopropoxide, nitrates, sulphate, chloride in an alkaline environment at 80-90°C temperatures. -Al(OH)_3 has been received from aluminum powder by ultrasonic development. Drying of oxyhydroxide sol has been conducted with presence of various types of seeds, which amount reaches 0,1-0,2% (mas). Neodymium, Holmium, Thorium, Lanthanum, Cerium, Gadolinium, Dysprosium nitrates and Rhenium carbonyls have been used as seeds and they have been added to the sol specimens in amount of 0.1-0.2% (mas) calculated on metals. Annealing of obtained gels is carried out at 70 – 1100°C for 2 hrs. The same specimen transforms in $\text{-Al}_2\text{O}_3$ at 1100°C. Low-temperature synthesis of $\text{-Al}_2\text{O}_3$ is energy-economical process and it is actual for the developing technologies of corundum ceramics fabrication.

Ultrafine powders, polyvinyl alcohol (PVA), polyethylene Glycol (PEG 600-15000), modified polyacrylic acid (Sokalan-10), oleic acid and others have been used to obtain sustainable suspensions of -alumina . For binding powders (astringent of powders) mixture of 3% PVA (35000-45000) and 1% PEG, used in a presence of oleic acid and dispersant. Density of “green product” obtained by pressing dry powdery composites is 45-48% of the theoretical; while by pressing granules 58-61% of the theoretical has been obtained. Annealing of “green product“ has been carried out by increasing temperature by 1-10°C/min up to 1600°C temperature, where the products were holding for 2 hrs and then the samples were cooled by 5°C/min velocity. Density of obtaining ceramic materials is 97-98,5% of the theoretical; microhardness 24-26 GPa; flexural strength 410-450 MPa, fracture toughness up to 3,3-4,1 MPa. $\text{m}^{0.5}$.

The work has been performed by following devices: X-ray diffractometer DRON-3M (Cu-K, Ni filter, 2°/min), High temperature muffle furnace JINYU-1700°C, electronic scanning microscopes (Nikon ECLIPSE LV 150, NMM-800TRF, Nanolab-7), SD-1000 Laboratory Spray Dryer, Planetary mill Pulverisette 7 premium line, SHIMADZU Dynamic Ultra Micro Hardness Tester, DUH-211S, Analysette 12 Dyna sizer.

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Abstract

PHYSICAL- MECHANICAL PROPERTIES OF BORON DOPED MONOCRYSTALLINE GERMANIUM

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Microstructure, electrophysical properties and characteristics of dynamical shear modulus and microplastic deformation of boron-doped monocrystalline germanium were investigated. Bulk crystals of germanium were obtained by Czochralski method in crystallographic direction. Boron concentration in monocrystals was changed in the $5 \cdot 10^{16}$ - $5 \cdot 10^{19} \text{ cm}^{-3}$ interval. Dislocation density determined by estimation of the quantity of etching pits was changed from 10^3 to $5 \cdot 10^4 \text{ cm}^{-2}$. It has been established, that an increase of boron concentration in monocrystalline germanium causes a decrease of current carriers mobility and an increase of the absolute value of shear modulus in comparison with undoped specimens. After hightemperture annealing tendency to increasing of current carriers mobility, dynamical shear modulus and elastic limit was revealed [1].

By investigations of internal friction and dynamical shear modulus amplitude dependences of boron doped monocrystalline germanium following results were received. The values of elastic limit, dynamical shear modulus and critical strain amplitude of Ge:B monocrystals were determined. It has been established, that weakly boron doped monocrystalline germanium is characterized by high elastic limit, critical strain amplitude and shear modulus. This is due to structure strengthening, caused by being an increase of dislocation blocking by boron atoms. In the case of high concentration of boron simultaneously with the strengthening process, “softening” process has been taken place. It is determined by fulfillment of broken electron bonds near to dislocations cores, that has caused decrease of activation energy of dislocations motion [2]. On the basis of changes of interaction nature of dislocations and boron atoms mechanisms of strengthening and “softening” processes of structure under the influence of boron were analyzed.

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Abstract

STUDY OF INFLUENCE OF IONIC ADDITIVES ON THE STRUCTURAL CHANGES OF WATER CONFINED IN THE MIXED REVERSE MICELLES BY UV-VIZ SPECTROSCOPY

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The analogous picture of normal membrane structure in cell is created by reverse micelles (RM), besides water dissolved in the core of micelle represents the best model of the confined water in biosystems [1]. The doping of most widely used sodium bis (2-ethylhexyl) sulfosuccinate (AOT) reverse micelles interface by nonionic surfactants results in the changes in elastic rigidity of the interface, which in turn stipulates the changes in water solubilization capacity and microviscosity of entrapped water. Mixing of surfactants influence also the dynamics of water in reverse micelles [2].

The goal of the proposed work was to study the influence of ionic additives introduced in the water nanodroplets of mixed RM on association degree of a molecular probes to AOT and Brij-30 (polyoxyethylene (4) lauryl ether) mixed RM by using UV-visible spectroscopy. The microenvironment of AOT and Brij-30 mixed RM was investigated by UV-visible spectroscopy via *o*-nitroaniline (*o*-NA) and methyl orange (MO) as optical probes.

The influence of both additives of water and water solutions of some kosmotropic and chaotropic salts on the association degree of methyl orange with mixed reverse micelles was studied. Association degrees of MO with AOT and Brij30 mixed reverse micelles were calculated by absorption data of MO at wavelengths of 408 and 416 nm at different water/surfactant ratio (W).

The influence of both additives of water and water solutions of some salts on the binding of *o*-nitroaniline (*o*-NA) to AOT and Brij30 mixed reverse micelles was investigated. Binding constants of *o*-NA with mixed reverse micelles were calculated by absorption data of *o*-NA at wavelengths of 376 and 400 nm in hexane. Concentrations of free and bound *o*-NA were determined by solution of equation systems at intermediate concentrations of Brij30.

Different influence of kosmotropic and chaotropic salt additives on both the association degree of methyl orange with mixed reverse micelles and the binding of *o*-nitroaniline to water-surfactant interface of mixed RM was revealed.

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Abstract

SYNTHESIS AND CHARACTERIZATION OF Ag AND Au SOLS IN STAR-LIKE WATER SOLUBLE POLYMER MATRICES

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Silver and gold nanoparticles (AgNPs and AuNPs) attract significant attention due to their unique optical, thermal, electrical properties and antibiotic properties. Reduction of metal ions into neutral clusters is commonly used treatment in chemical NPs synthesis. Ag and Au NPs raise difficulties in developing stable colloidal dispersion, since nanoparticles undergo agglomeration. Therefore, silver and gold colloids stabilized by polymers are investigated to obtain nanosystems with high storage stability.

The present study focuses on the formation and properties of silver and gold sols synthesized by reduction of silver nitrate dispersed in noncharged and anionic linear and branched polyacrylamide biocompatible polymer matrices [1, 2] using various reductants.

The UV-Vis spectroscopy revealed the formation of nanoparticles by exhibiting the typical surface Plasmon absorption maxima for both metallic nanoparticles. The position and the shape of the absorption bands were depended on the synthesis conditions (pH, temperature) as well as the internal structure of polymer matrices. Transmission electron microscopy and Zeta-sizer were used for analysis of nanoparticle size distribution in silver and gold sols. It was established that branched polymer matrices were more efficient for in situ AgNPs and AuNPs synthesis as well as for stabilization of these sols in comparison with linear ones.

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Abstract

DEVELOPMENT OF MODIFIED SELF-EXTINGUISHING EPOXY-AMINE POLYMERS

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Sphere expansion of application and increase of the requirements put forward to quality of epoxy polymeric products cause necessity of new paths searching of obtaining polymeric materials of the moderate combustibility. The solution of this problem is related with development of physicochemical methods of modifying compositions on the basis of epoxy resin. In this respect way of the including into a polymeric matrix of low-molecular chemical substances with considerable reactivity has tremendous perspective. Results of development of new self-extinguishing epoxy-amine compositions destined for production of the protective surfaces, glue, encapsulation materials, compounds, mastics, premixes *etc.* are presented in this work. Base for development of such compositions were epoxy-amine resins with different molecular weight (D-16, D-20, D-22) and amino hardener – polyethylenepolyamine. The salts of various *d*-metals have been used by us as the perspective materials for combustibility decrease of epoxy-amines compositions [1, 2]. The cause of high ability of *d*-metals salts to depress combustibility of epoxy-amine compositions consist in chemical interlinking of combustible nitrogen-containing molecules of a hardener with metal atoms of noncombustible inorganic salt and, at the same time, forming very strong coordinating bonds. The influence of a whole sequence of measurements (quantity of modifier and hardener, technological regime of obtaining and hardening of resins) onto properties of the composites has been investigated. Results of experiment have revealed that combustible properties of epoxy-amine polymers at addition even the small quantity of *d*-metal salt is appreciably lowered in comparison with unmodified composite. So, the values of ignition points and self-ignition points, burning rate as much as smoke-formation factors are much less for the modified composites than for unmodified composites.

It is typical that in case of modified epoxy polymers the decrease of their combustibility is accompanied by concurrent improvement of operational properties of such materials. In particular, adding to an epoxy resin of *d*-metal salt possessing variable valence improves plasticity of the modified polymers. The modified polymers in comparison with usual samples are characterized by increased impact strength: under impact of slog the fastness value of a covered film increases in 2-3 times and the surface hardness in turn decreases in 2-3 times. The analysis of measurement results of adherence fastness of coatings for the filled epoxy resins with the various content of inorganic salt has revealed that incorporation into an epoxy composite of some amount of salt considerably improves adherence properties of such coatings. Filling of epoxy polymers by *d*-metals salts also depresses their sorption ability in water, solutions of alkalis and acids. Thus owing to the carried out work we have composed mixture and chosen the optimum technological mode of the production of self-extinguishing epoxy-amine polymers

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Abstract

DEVELOPMENT OF RELATION OF FUNDAMENTAL AND APPLIED RESEARCHES WITH INDUSTRY AND EDUCATION IN MANUFACTURING OF POLYFUNCTIONAL COMPOSITIONS AND MATERIALS WITH SPECIFIC PROPERTIES

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One of the actual fundamental scientific directions in chemistry demanded in future is the widening of the relations with industry for development of researches in creation of principally new generation systems – multifunctional bioactive hybrid composites and materials. Considering of accessibility and diversity of suitable polymeric and bioactive components for obtaining of such materials there is a great opportunity to vary of combinations in order to improve their tribological, mechanical and other operational characteristics during their prolonged exploitation. Along with mentioned above bioactive compounds and composites we have some of interesting preliminary results for development of novel hybrid inorganic-organic compounds with wide spectrum of prolonged physiological and specific bioactivity determined by virtual bioscreening. Organic-inorganic hybrid materials do not represent only a creative alternative for scientific researches, but their improved, unusual features as a result of correct merging of properties of components allow the development of their innovative industrial applications and provide the opportunity for future large-scale application. There is no doubt that these materials will display new opportunities for combined development of many important related fields – biology, pharmacology, medicine, biosensor and membrane technologies, chemistry and physics of multifunctional protective covers, etc.

For solving of such a difficult problem there is necessary the complex use of various modern methods (structural analysis, theoretical and experimental bioscreening), the methods for determination of physical, mechanical, tribological, rheological and operational properties which requires training of young scientists and technical staff with such knowledge. In our opinion it would be useful the modernization of master (MP) and doctoral (PhD) programs with appropriate profile foreseeing the mentioned above requirements. These problems are directly connected with improvement of the education system of chemistry in high school.

Teaching of chemistry must be built on the principle of merging of continuity-innovation during transition from the high school training to the university education. Special attention should be paid to the modern methods of obtaining of significant inorganic compounds, to the “structure-properties” relationship, also to their use in modern technologies and materials. During study of theoretical questions should be considered the necessity of knowledge of the appropriate previous issues of physics and high mathematics, as well as smooth transition from the corresponding programs of integrated teaching of secondary school to the university curriculum.

As one of the ways of industrial solving of this problem we deem the putting in motion of technologically, ecologically and economically profitable and mobile small enterprises of high effective advanced multifunctional materials with little material capacious. At the same time it will also create new jobs, what is real motivation for the further development of the educational system in Georgia and will provide more effective connection between education, science and industry.

Abstract

ADVANCED MATERIALS BASED ON NATURAL AND SECONDARY RESOURCES OF GEORGIA

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Georgia is rich in mineral resources, which creates realistic prospects for the development of fine material intensive and highly effective technologies in this region. In Georgia the deposits of such important substances can be found as coal, oil and natural gas, copper and polymetals, barytes, arsenic, gold, manganese, mercury, bentonite; medicinal and prophylactic mineral waters, undeveloped reserves of hydrosulphuric acid (in the Black Sea), reach medicinal plant recourses, etc.

Waste pollution of the following three principal types is characteristic to Georgia region:

- Waste of chemical industry (including the factories not functioning currently, lithopone, barite, etc.);
- Leavings of procession of natural raw materials such as trachytes, calcites, lithopone, barite, arsenic, industrial wastes, coniferous, nut-shell, etc;
- Secondary raw materials in the shape of non-recyclable items or packing from various polymers (polypropylene, polyethylene, polychlorvinyl, polyethyleneterephtalat, etc.) which is linked with rapid development of tourism and growth of import in Georgia.

Purposeful recycling of the wastes is performed in two main directions:

1. Regeneration of precious compounds from the industrial wastes/leavings;
2. Use of the industrial waste for creation of various compounds and materials with specific properties.

By transformation of natural and secondary recourses of Georgia we have developed:

- obtaining of high purity manganese from metal-containing poor ores and tailings by microbiological method;
- metallic arsenic with high purity for use in semiconductor technology;
- pure “white arsenic” for use in pharmacopeia;
- new photo-, thermal aging and mechanical stable, hydrophobic antimicrobial/fungicidal hybrid composites, stable towards the action of combined factors (moisture, air oxygen, carbonic dioxide and scattering of visual light during a long time in closed conditions of museum premises) for human protection in case of their direct contacts with the surfaces of various synthetic and natural polymeric materials and wares and for protection of museum exhibits.

Special actual resources and skilled human resources have been mobilized for the development of modern fine medicinal and prophylaxis of natural solutions, of phyto cosmetic products and cosmetology is feasible based on medicinal plants of Georgian region. It is currently only a new trend for the development of cosmetics with specific characteristics and we currently deem it premature to suggest those as an alternative to existing cosmetic products. This creates serious opportunities to inculcate place for Georgia among the leading countries of the world in this sector and to contribute to further economic development of the Georgia region. There is created the map (associate Prof. of Department of Geography Faculty of Exact and Natural Sciences of TSU D. Nikolaishvili) describing the location of various medicinal plants in Georgia region.

Abstract

HgBa₂Ca₂Cu₃O_y SUPERCONDUCTOR PREPARED BY HG VAPOUR DIFFUSION PROCESS

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Arsenic free and arsenic doped HgBa₂Ca₂Cu₃As_xO_y (x=0.0-0.8 wt.%) superconductors were synthesized in sealed silica tubes by the solid state reaction method. The precursor bars can be prepared in a flow of oxygen. The Hg vapor pressure can be controlled by a small addition of As₂O₃ in the reactant bars. A series of experimental results obtained from the As-doped and As-free superconductors by X-ray diffraction, thermogravimetry analysis, resistance measurements and AC susceptibility measurement techniques shows that a small addition of As₂O₃ increases the volume fraction of the (HgAs)-1223 superconducting phase and thermal stability of this superconducting phase.

Temperature dependences of AC susceptibility also show a two step process, for un-doped and small doped (0.2 wt.%) samples. It is important to note that the high doped samples (0.4-0.8 wt.%) do not show two steps. The absence of two-step behavior could be explained in terms of smaller grain size in the high doping samples, so that grains are fully penetrated at a lower field value. We found that in the low level doped samples, Arsenic enhances the value of the transport critical current densities.

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Abstract

THE INVESTIGATION OF FULVATE COMPLEXES OF ZINC BY THE GEL CHROMOTOGRAPHIC METHOD

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Fulvic acids are one of the first geopolymers, which were found in natural waters. They have functional groups and that's why they take an active place in complex formation and sorption processes and stipulate migration forms of toxic metals.

In spite of researches, experimental data's on stability constants of complex compounds of fulvic acids are heterogeneous and they differ in several lines from each other. This condition is stipulated by the ionization degree and also by the changes of the value of pH in complex formation process, by the ignoring of average molecular weights of their associates, which finally causes the wrong result.

Our objective was to obtain pure samples of fulvic acids, to study complex formation process between zinc and fulvic acids on various values of pH by the gel chromatographic method and calculation of the conditional stability constants.

Taking into account the associates of fulvic acids, various pH and the average molecular weight, for the optimal determination we used sepadex G-25(the limits of Fractionating 100–5000).

The main solution of fulvic complexes were obtained by the solubility method. ZnO–FA–H₂O, pH=8, $\sim = 0.01(\text{KNO}_3)$. In such system are always formed the fulvic complexes, with containing 1:1. The obtained main solutions of fulvic complexes are divided into 4 parts, which differs from each other, only with the values of pH (9,02; 8,00; 6,03; 5,01). The complex formation process of fulvic complexes were studied on various pH by the gel filtration method. We took 2-2ml aliquots of solutions with various pH, put it one the top of the gelchromotographic column, we did the elution process with the bidilstilate which has the same pH as the solution.

If we take into consideration the datas of gelfiltration, we determined The quantity of metals connected with the fulvic acids, in such fractions which releasing volumes fits the substances with molecular weight 300 $M_w > 5000$.

On the base of experimental datas was calculated the stability constants of fulvic complexes by the (1) equation

$$\beta = [C'_{Me} - C_{Me}] / \{ [C'_{Me}][FA] \} = [C_{Me}] / \{ [C'_{Me}][FA^{2-}] \} \quad (1)$$

$C'_{Me} = C_{Me} - C_{Me}$ (2); $[FA] = C_{FA} - C_{Me}$ (3). Where C'_{Me} - the quantity of metal which was not involved in the complex in mol/L C_{Me} - The total quantity of metal in main solution. mol/L. C_{Me} - The amount of metal, connected with fulvic acids (determined fractions 300 $M_w > 5000$ mol/L $[FA]$ - free ligand mol/L; C_{FA} - the total quantity in the system mol/L.

$$\text{pH}=9: \beta = 1,50 \cdot 10^4; \text{pH}=8: \beta = 5,90 \times 10^3; \text{pH} 6: \beta = 4,63 \times 10^3; \text{pH} 5: \beta = 1,15 \times 10^3$$

We can successfully use The obtained datas for evaluation the role of geopolymer in complex formation processess for all types, groups and class of natural waters

The research was done by the support of Shota Rustaveli National Science Foundation and Georgian Research and Development Foundation.

Abstract

REGULARITIES OF SYNTHESIS AND PROPERTIES OF PHENOL RESINS AND THEIR NANOCOMPOSITIONS

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By a method of DSC it has been investigated the condensation reaction of phenol (P) with excess quantity of formaldehyde (F) in the presence of various alkaline catalysts and cross-linking agents of acidic nature both in the presence and in the absence of filler. The preparation and vulcanization process of phenol resins was carried out at various ratios of components. It has been established that the increase of ratio F/P favors formation of more high quantities of hydroxymethyl groups, as a result the vulcanization process is intensified and gel formation time (t_G) is decreased. At concentration over 20% a decrease of t_G occurs sharply, and vulcanization time (t_C) – essentially. An increase of F/P leads to the growth of parameter t_G-t_C . An use of NaOH as the catalyst leads to the sharp acceleration of gel formation and vulcanization processes and in the presence of $Ba(OH)_2$ the relatively high values of t_C-t_G are reached. It has been established that HCl structures more low t_C and t_G , and the process begins at concentrations of HCl >15%. A vulcanization of resins in the presence of H_2SO_4 begins from its 25%-s concentration and is realized by comparatively low rate and $H_2C_2O_4$ and H_3BO_3 are not effective as a vulcanizing agent.

It has been established during preparation of composition of the phenolaldehyde resins with nanoclay (catalyst $Ba(OH)_2$, vulcanizing agent HCl, F/P=1.4) that an introduction of nanoclay practically doesn't influence on t_C and t_G values at high concentrations of acid. Nevertheless, in XRD-spectra of nanoclay, its uncured and cured compositions, a characteristic basic peak of nanoclay is fixed at 4.6° , 3.1° and 2.6° , respectively.

The results prepared by the methods of DTA and TGA analyses show that the initial temperatures of thermal-oxidative destruction (T_D) of the vulcanized resins are larger than T_D of the corresponding uncured samples. An increase of F/P leads to the decrease of thermal stability of uncured resins; in the cases of F/P = 1.2, 1.4 and 1.6 (mol) a parameter T_D is 383; 370 and $363^\circ C$, respectively. For cured resins a dependence of $T_D-f(F/P)$ is opposite, i.e. with growth of F/P an increase of T_D is observed. It has been shown that an increase of concentration of vulcanizing agent to ~20% leads to the decrease of loss mass of the sample at destruction, which is sharply appeared with growth of F/P. With increase of concentration of the vulcanizing agent to ~20% the depth and density of resins structuring are increased. A nature of the catalyst weakly influences on thermal stability of the cured resins, however with increase of quantity of the catalyst T_D is increased and w of the cured products is decreased.

The prepared results show that an introduction of 1.0-6.0 mass p. nanoparticle of clay into composition of resins synthesized and cured in the identical conditions leads to the noticeable improvement of indices of thermal stability of compositions, as T_D grows from ~ $420\div 470^\circ$ to ~ $520\div 585^\circ$, and w is decreased from ~ $55\div 47\%$ to ~ $15\div 10\%$. It is interesting that a sharp positive change of these indices occurs at content of ~ 1.0-3.0 mass p. filler.

Abstract

NEW COMPOSITES ON THE BASIS OF LIQUID GLASS AND STRAW

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Currently, more extended research on composite materials containing disperse wood products due to availability and low cost of these materials.

Our work is devoted to investigation of the properties of composites based on liquid glass and fine dried straw. We studied the structure and composition of obtained composites by FTIR. Composite microstructure of the samples was studied by optical microscope of type TRF, as well as by scanning electron microscope of type JSM-6510LV with high resolution of 3.0 nm at 30 kV, for fast characterization and imaging of fine structures.

Physical and mechanical (tensile, bending, compression, hardness HB), thermal (Vicat) and the water absorption have been studied. The studies were removed according to the noted above parameters on the relative content of ingredients, as well as environmental conditions (temperature, pressure) at obtaining materials. For example, it is shown experimentally that in the conditions of a pressure of 10 MPa and temperature 90°C a mixture containing 95% of dry straw (average filler particle size of about 50 microns) forms a composite, technical characteristics of which are as follows: Flexural Strength at elongation - 4 MPa, at break - 4.5 MPa, Vicat softening point 190° C, water absorption of 15%, 0.9 density g.cm³.

The experimental results are due to mainly on the character of interaction between the phases, which on its turn facilitates the distribution of filler particles in the composite.

Acknowledgments the financial support of Science & Technology center in Ukraine (Grant #5892 is acknowledged).

Abstract

OBTAINING OF NICKEL-TUNGSTEN COATING ON COPPER AND STUDY OF ITS PROPERTIES

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Up-to-date development of technology requires creation of new materials and coatings, which will have a number of previously defined properties.

Obtaining of nickel-tungsten alloy by electrochemical deposition on copper substrate and study of its electric and thermal properties is suggested in present work. As is known, copper is used almost in all industrial sectors, because of its high electroconductivity ($59.0 \text{ ohm}^{-1}\text{cm}^{-1}$). But in the presence of moisture copper is rapidly oxidized and it is unstable in corrosive medium. Electrodeposition of nickel-tungsten alloy on the surface of the copper is reasonable for increasing of its corrosive and thermal resistance. This alloy has high corrosive and thermal resistance, microhardness (which increases after heat treatment), durability [1].

Pyrophosphate electrolyte [2] was selected for deposition of nickel-tungsten alloy. The main advantage of this electrolyte is stability of composition and lack of complex former on the anode. This allows its use over a long period of time, without deterioration of the properties of coating. Content of nickel and tungsten in alloy was determined by roentgen-X-ray fluorescent analysis. Obtained deposits contain 23-28% (weight) tungsten, with current output 21-30%, coating thickness 12-15 micrometer. The deposits are fine-crystalline, dense, without visible cracks.

With the aim of study of electric and thermal properties of obtained coating the samples were annealed in vacuum at the temperature 600° during one hour. Specific resistance of copper substrate and samples, covered by nickel-tungsten, were measured at different temperatures after annealing. The same samples were placed in vacuum cell and heated during 30 sec. at the temperature $950-1000^{\circ}$. Their specific resistance was measured (four-point contact method) once more after heating.

The coatings keep good adhesion and their electric properties (which even improve after thermal treatment at definite temperatures).

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Abstract

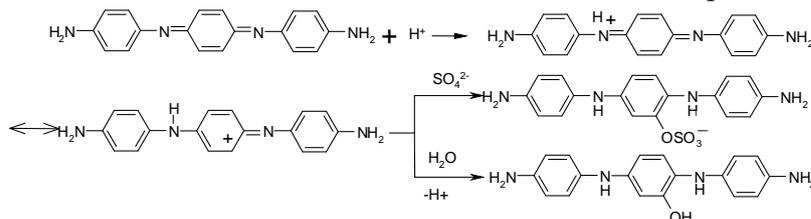
REACTION OF SULFURIC ACID WITH ANILINE TRIMER AND POLYMER

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Sulfonate group containing polyanilines may be of big interest because of their possible applications. [1-5].

It had been shown, that as a result of oxidative polymerization of p-phenylenediamine, polymer with analogous to pernigraniline structure was formed (PA) [1]. To obtain pure PA is complicated due to its high reactivity. As a side reaction in hydrochloric acid medium the reaction of 1,4-addition with subsequent aromatization of PA was proceeded with sulphuric acid or with potassium bisulphate. To obtain additional data, the reaction of sulfuric acid with model compound N,N-di(4-amino phenyl)-1,4-benzoquinone was investigated at the first time. The dependence of the quantity of sulfate groups on the concentration of sulfuric acid was determined. As 50 % 1,4-addition with 1 N hydrochloric acid was occurred during the doping of pernigraniline [1], the addition of sulphuric acid was started from the same normality and then the concentration 3 N and concentric acid were employed. According to spectral data, besides 1,4- addition of sulfuric acid, the addition of water was proceeded simultaneously.



And, as it would expected, unit weight of sulfuric acid increases with concentration of sulfuric acid. In the reaction carried out with concentric sulphuric acid water addition does not occur. When using 1 N and 0.5 N sulphuric acid water - sulphuric acid ratio in the product of the reaction is equal to 0.78 and 4.6, respectively. The reactions were carried out at room temperature and degree of conversion depends on the duration of the reaction.

This work was supported by State Committee Science MES RA, in frame of the research project SCS 13-1D298.

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Abstract

GREEN SYNTHESIS OF SILVER NANOPARTICLES USING PETROSELINUM CRISPUM WATER EXTRACT AND DETERMINATION OF ITS

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Green biological synthesis of metallic nanoparticles is an important method to improve properties and eco-friendly nanoparticle production method. The metal nanoparticles are finding applications in optoelectronics, nanodevices, nanoelectronics, nanosensors, information storage and catalysis. In this paper, Bio-synthesis of silver nanoparticles (Ag-NPs) from silver nitrate solution using water extract of *Petroselinum crispum* at room condition was successfully carried out. Visually observed on the change of the reaction solution from yellow to dark brown after the addition of *Petroselinum crispum* water extract indicated the formation of the Ag-NPs. The Ag-NPs obtained were characterized by UV–Vis, XRD and SEM.

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Abstract

EMISSION OF NANOCCLUSERS DURING N^+ , O^+ , N_2^+ , O_2^+ , Ar^+ IONS BOMBARDMENT OF AL AND SI SURFACES

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The bombardment of a solid with energetic atoms or ions leads to the release of a variety of secondary atomic particles from the surface. During ion sputtering of surface an abundant fraction of agglomerates of two or more atoms and the flux of sputtered particles (so-called "sputtered clusters") can be detected. The quantity to be determined experimentally is the mass distribution of sputtered particles, the size of which depends on the variation of the number of clusters sputtered per impinging primary ion. Two simple statistical models have been proposed describing the formation of clusters in sputtering [1]. In the model a pre-formed cluster is assumed to be removed from the surface by one single collision from the cascade initiated by the primary ion. In the atomic combination model, on the other hand, all constituent atoms of a sputtered cluster are assumed to be removed from the surface by independent collisions. Emission of large clusters ($n > 10$, n - the number of atoms in clusters), especially ionization of clusters at sputtering is a puzzling phenomenon and can not be described by simple statistical models. Therefore it is obvious that emission of clusters is hard to describe in a statistical approach. Besides that, they are automatically included in the model if the particle ejection process is treated by Molecular Dynamics computer simulations [1]. The volume of researches on studying the mechanism of formation of clusters is significant and continues to grow, but overview of the processes resulting in emission clusters at ion sputtering of surfaces is absent. Therefore, experimental investigation of cluster emission processes during ion bombardment of surfaces is very important.

In the presented work at UHV (1.10^{-9} torr) conditions A_n^+ ($n=1,2,3,\dots,7$) clusters emission during N^+ , N_2^+ , O^+ , O_2^+ , Ar^+ primary ions bombardment of the Al and Si surfaces has been investigated at different experimental conditions using SIMS method [2]. Mass and energy distribution measurements of emitted clusters at different primary ions initial energy ($E_0=5-50$ keV), intensities ($I_0= nA - \mu A$ on cm^2), angles of incident ($=0 - 45$) $^\circ$, counted from normal to researched surface and at various oxygen partial pressure ($p = 1.10^{-9} - 1.10^{-6}$ torr) in the chamber of interaction has been performed.

The observed decrease of the output of the cluster ions of Al_2^+ and Al_3^+ from aluminum upon transfer from the bombarding molecular ions (N_2^+ , O_2^+) to the atomic (N^+ , O^+) can be connected with the formation of the excited states of Al_2^+ and Al_3^+ . The fragmentation of clusters occurs during de-excitation and thus their number is decreased. The formation of the excited states, which leads to the fragmentation of the clusters Al_2^+ and Al_3^+ in the case of the bombardment with molecular ions, is improbable. According to the model of dual collision, the simultaneous collision of molecular ion (ion+atom), conducts to effective removal from the surface layer of the clusters (Al_2^+ , Al_3^+). On the basis of these considerations, the role of molecular ions predominates with respect to the atomic in the emission of Al_2^+ and Al_3^+ [2]. Interactions between the electron structure of surface and the electrons of the atoms, which form part of emitted poly atoms, are being determined with shaping of cluster.

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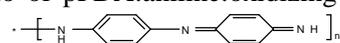
Abstract

OXIDATIVE POLYCONDENSATION OF P-PHENYLENEDIAMINE AND ANILINE IN ORGANIC MEDIUM AS A METHOD FOR POLYANILINE SYNTHESIS

N.A. Miraqyan, N. A. Durgaryan, R.H. Arakelyan, A.A. Durgaryan

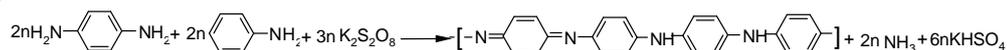
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The variety of electrical properties, easy processability and low cost make conducting polymers, particularly polyaniline (PANi), an attractive material for various applications[1]. This work has been focused on the syntheses of electroactive polymers with structures similar to PANi by oxidative polycondensation of anilines with p-phenylenediamine (pPDA). In the literature, the oxidative copolymerization of aniline with pPDA for the molar ratio of pPDA:aniline:oxidizing agent 1:1:1 had



been investigated, and following structure was proposed [2].

However, some discordances between the proposed mechanism and the used amount of oxidizing agent and the obtained and possible yields strengthen our opinion that reaction mechanism differs from that of described in literature and it proceeds with the mechanism similar to oxidative condensation of pPDA[3] according to the scheme .



The fact, that ammonia have been determined, is the evidence that support our conclusions. If the reaction proceeded according to scheme, polymer with analogous to emeraldine structure should be obtained. But the conductivity of obtained doped copolymer is only of 10^{-7} S/cm instead of 0.1 S/cm for PANi . It should be noted, that the copolymerization reaction have been carried out in the aqueous hydrochloric acid medium. Previously, the occurrence of side reactions during the oxidative condensation of p-phenylenediamine in aquatic acidic medium had been established and only usage of organic medium made it possible to synthesize N,N'-bis(4-aminophenyl)-1,4-benzoquinonediimine from pPDA[4]. Hence, to avoid side reactions we carry out the copolymerization reaction of pPDA and aniline in organic media. Obtained results indicated the similarity of the structure of obtained product and PANi - PMR and UV spectrum of obtained copolymer and emeraldine were similar. Moreover, the conductivity of obtained copolymer doped with 3 N hydrochloric acid is equal to 0.52 S/cm. It must be mentioned, that PANi, synthesized using the same reaction conditions, has conductivity equal to 0.06 S/cm. For our knowledge, it is at the first time that copolymer shows electrical conductivity higher that PANi. It is worthy to mention that the conductivity of the doped with hydrochloric acid copolymer obtained in aqueous medium is only equal to 2.9×10^{-7} S /cm. Influence of reaction conditions on polymers conductivity was considered.

This work was supported by State Committee Science MES RA, in frame of the research project SCS 13-1D298.

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Abstract

BRUSH TYPE METHYLSILOXANE POLYMERS: SYNTHESIS, PROPERTIES & APPLICATION

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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. Polysiloxanes are characterized by a number of interesting properties, e.g. excellent heat resistance, low toxicity, biocompatibility, high oxygen permeability, poor wet ability, extremely low surface tension, low melting point and glass transition temperature, resistance to radiation, special rheological properties, outstanding electrical isolating properties and others.

In this presented work we report the synthesis of new brush type polysiloxane.

Brush type polyorganosiloxanes may be synthesized by two ways:

1. Via hydrosilylation reaction of polymethylhydrosiloxane with allyl or vinyl containing compounds in the presence of platinum catalysts (Pt/C, platinum hydrochloric acid, Karstedt's Catalyst, Rhodium and Ruthenium complexes); or using dehydrocoupling reactions of polymethylhydrosiloxane with hydroxyl containing compounds in the presence of catalysts.
2. The second way for synthesis of brush-type oligomers is the hydride addition of methylhydrocyclosiloxanes to allyl or vinyl containing compounds with ether, ester and trialkoxysilyl fragments, in the presence of platinum catalysts; obtaining of cyclotri(tetra, penta)siloxanes with various attached fragments and polymerization of methylorganocyclosiloxanes with terminated agent and without it.

This two way of synthesis and application of polymers will be discuss in presented paper.

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Abstract

GRADED ZONE STRETCHING OF THE LINEAR POLYMERS

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Uniaxial oriented stretching is a widespread method of the structural modification of the linear polymers. As a result of stretching the isotropic polymer goes over into the **oriented state**. Polymer becomes structurally anisotropic, which results to appropriate anisotropy of physical and mechanical properties. The samples with different properties may be obtained by means of the variation of the orientation degree depending on: stretching temperature, stretching rate, cooling rate of the heated polymer and relative elongation. Throughout the volume of the sample oriented in **conventional mode**, anisotropy, and therefore the physical and mechanical properties, are practically identical. If in the stretching process a gradient of at least one of the four above mentioned parameters is provided, this should lead to the gradient of anisotropy (orientation degree) and hence to the gradient of physical and mechanical properties.

We have established the conception about **new structural state** of the thermoplastic polymers – about **gradually oriented (stretched) state (GOS)**. Transition of the isotropic polymers into **GOS** is realized by the action of inhomogeneous mechanical field on the sample or by **uniaxial managed graded zone stretching** which ensuring a predetermined change in **relative elongations** at predetermined areas of the samples.

Zone stretching can be carried out on a standard tensile-testing machine with using the graded zone stretching device (**GZSD**) elaborated by us. **GZSD** makes it possible to implement a very wide range of stretching modes. Preselected experiment mode is carried out via the control assembly. The device contains a heater which is disposed between the fixed and active clamps of the tensile-testing machine. Between the heater and an active clamp the cooler is placed in the form of a blower or sylphon bellows with liquid. A heater and air blower have preferably equidistant geometric shape with respect to the cross section of the test sample. The heater is done with the ability of heating the sample by the width of the selected area with the selected size and profile, and the cooler is done with the ability to direct on this area a stream of air or to cover liquid from sylphon on the surface of the test film. Zone stretching is carried out in the following way: we placed a heater and a cooler near the active clamp. When the selected temperature is achieved, the simultaneous movement of the active clamp, heater and cooler begins. The heater and cooler are moved in a direction opposite to the movement of the active clamp. In the heating zone, the value of the yield strength of the polymer is minimal. It is why only the heated section of the sample is stretched. As a result of stretching and displacement of the heater this area of the sample goes out of the heating zone and enters into the cooling zone. As a result of the simultaneous movement of three mobile units of the device, the stretching process is gradually spreading towards the movement of the heater and cooler. The stretch degree of the sample is determined by the speed ratio of the displacement of active clamp and a heater. The gradient stretching mode is achieved by varying this ratio in the sample stretching process. Preselected experiment mode is carried out via the control unit. Some illustrative materials are presented in the paper. The concept of the **GOS** and development of methods of graded orientation of polymers are of interest for the understanding of the processes of structural modification of polymers and to create new classes of materials particularly FGMs.

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Abstract

LIGHT-RESPONSIVE CHIRAL PHOTOCHROMIC POLYMERS

O. Nadtoka, V. Syromyatnikov

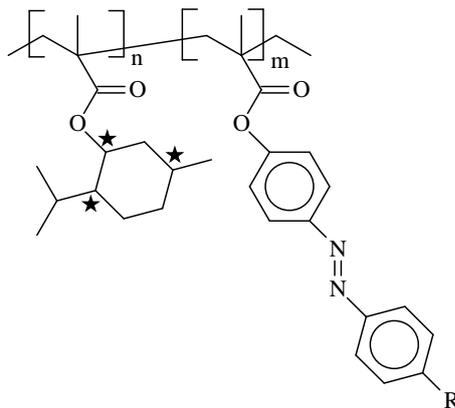
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Among the research directions in the field of photochromic materials the investigations aimed at creation and studying of photoactive polymers/polymers blends with chiral and photochromic dopants have an important role [1-3]. Azobenzene derivatives are known as the best photosensitive substances. Azochromochores are undergone a reversible and irreversible photochemical transformations such as trans-cis isomerization under actinic light. This leads to the configurational changes that caused the appearance of photoinduced anisotropy [4].

Combined chiral copolymers containing several different photosensitive groups in one and the same macromolecule could be of significant interest. Such polymers may be obtained, for instance, by radical copolymerization of monomers with different functionalities.

It was synthesized new menthyl-containing methacrylic monomers (MtMA). Further copolymerization of MtMA and methacrylic azomonomers AzoMA allowed us to obtain polymers with different content of chiral and photochromic fragments.

As chiral substituent at the synthesis of methacrylic derivatives was used menthol (5-methyl-2-(1-methyl)-cyclohexanol), which has three chiral centers.



Monomer reactivity was evaluated using data copolymerization. Q-e-scheme takes into account the internal thermodynamic stability and polar effects in transition state.

The development and design of such polymer systems allows the preparation of novel materials with fascination optical properties.

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Abstract

TOPOLOGY OF FORMATION OF LATEXEA IN HETEROGENEOUS STATIC MONOMER-WATER SYSTEM

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Dispersibility of the latex particles and their size distribution is of crucial importance for the further use in various areas, including as microspheres, with different immobilized nanoparticles (e.g. nanoparticles of silver and other precious metals, metal oxides, semiconductor compounds) [1, 2].

The first reports about the possibility of producing an aqueous surfactant free dispersion of polymers in the static polymerization system monomer-water have been published in [3-8]. Mechanism static dispersing monomer system – water in this case are still unclear. According to [5, 9, 10] dispersion (formation of new interfacial) occurs due to the increase of free energy of the system as a result of the exothermic effect of polymerization. It is assumed that the polymerization reaction occur in the vicinity of the interface water-monomer phase and particles dispersed therein are generated in the form of monomer microdroplets [5]. It is further assumed that during the polymerization the density of the particles increases, and they are “immersed” into the aqueous phase.

The report cites experimental results demonstrating the topological latex particle nucleation mechanism in polymerization process and methods for determining their density. The results of these experiments may be used as a confirmation of the mechanism of nucleation of the latex particles in monomer–water heterogeneous system.

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Abstract

POLY-L-LACTIDE COPOLYMER OF SIMVASTATIN FOR CARDIOVASCULAR ENGINEERING SYNTHESIS AND CHARACTERIZATION

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We have synthesized a group of novel biodegradable polyesters by the reactions between L-lactide and simvastatin (SIM) – a cholesterol lowering drug with additional anti-inflammatory and immunosuppressive properties [1-3].

Due to the presence of lactone ring in SIM and L-lactide, they both were used as monomers in ring-opening polymerization (ROP). We have carried out two types of polymerization, the direct one and the one preceded by the tetrahydropyranylation (THP) of the SIM secondary hydroxyl group.

Zirconium (IV) acetylacetonate was used to initiate ROP between SIM and L-lactide which resulted in obtaining a novel copolyesters mixtures in the bulk at 120°C. Obtained copolymers differed with regard to SIM content (from 2,8-7,5 mol%) and molecular weight (from 3,9-38,5 kDa) in the direct method. The two-step method with THP of the SIM secondary hydroxyl group resulted with obtaining a linear conjugate with high-molecular weight (15-40 kDa), but a lower SIM contribution (1 mol%) as compared to the direct copolymerization method.

Structural connection between poly-L-lactide and SIM was confirmed by ¹H NMR spectroscopy and COSY experiments.

In this study we have demonstrated the effectiveness of zirconium (IV) acetylacetonate in initiating the copolymerization process for advanced material design using high molecular bio-active substance in the form of monomer.

This work was supported by The National Centre for Research and Development: Contract No. PBS1/A7/2/2012 "Development of multifunctional polymer systems for long-term controlled release of risperidon in diseases of the nervous system".

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Abstract

STUDY OF EFFECT OF BIORAG ON FREQUENCY OF DEFECTS CAUSED BY PESTICIDES IN CROMOSOMES AND THE DNA

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Among the vicious factors of the environment the pesticides are especially dangerous compounds for human health. Due to the ease of their introduction in the human organism together with food, they harm chromosomes and the DNA, resulting in the provocation of not only cancerogenous malignant tumours and the genetic diseases, but also of such systemic diseases as the diseases of the heart, nervous diseases, diseases of the food processing system *et al.*

Therefore it is necessary to perform activities that will decrease or eliminate the evil effect of the pesticides on the organism. In this connection the appropriate choice and use of the anti-mutagenic compounds that will reduce to the minimum the frequency of the chromosomes and of the malignant activities of the DNA that are in chromosomes is crucial.

During the first series of the experiments we studied what the effect of the pesticides is: Bordo's liquid and chlorophos on the genetic apparatus of the laboratory mice/rats. During the second series of the experiments we performed the same activity and applied Biorag to reduce the evil effects on the organisms of the mice.

These investigations have revealed that during and after the use of the pesticides Bordo's liquid and chlorophos (the dose was 1/5 per le 50) the frequency of the structural deteriorations// malfunctions in chromosomes and in the DNA reached 8.8+- 1.24% and 7.3+-1.2% accordingly, while in case of the use of Biorag as an additional agent, the deteriorations caused by Bordo's liquid were decreased to 2.7+-0.2% and in case of chlorophos it decreased to 3.0+-0.3%. (control quantity being 1.2+-0.1%).

The aforementioned pesticides besides the malfunctions in chromosomes and in the DNA cause the increase of the frequency of pathological mitosis ($ro < 0.001$). In case of the use of Bordo's liquid the frequency of the pathological mitosis reaches 12.8+-1.6%, while in case of the use of chlorophos it reaches 11.5+-1.5%.(the dose being 1/5 ld50)

With the simultaneous use of Biorag the frequency of the pathological mitosis decreases accordingly to 3.8+-0.4% and to 2.1+-0.5%. (the control being 3.7+-0.6).

Thus, experiments performed in this case and in experiments performed previously at other times with other pesticides and other fertilizers have revealed again that the bioenergoactivator Biorag is characterized as being a substance that has universal antimutagenic features.

Abstract

MICROSCALE TEMPERATURE VISUALIZATION IN SILVER NANOPARTICLE DOPED POLYMER NANOCOMPOSITE

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The visualization and control of optical to thermal energy conversion in nano and microstructures is a key challenge in many fields of science with applications to areas as nanofluidics, nanocatalysis, photothermal cancer therapy, drug delivery, imaging and spectroscopy, information storage and processing, nanoscale patterning and solar energy harvesting [1-3]. In the presented work a polymer nanocomposite incorporated with silver nanoparticles and organic luminescence dye has been fabricated, which exhibits thermochromic properties. It was shown that this kind of composite dramatically change its color when changes an environmental temperature and acts as thermochromic material with such improved parameters as temperature controlled fine tuning of absorption. Moreover, prepared polymer nanocomposite is distinguished with intensive luminescence emission the spectral position and tuning rate of which depends on temperature. This combination of silver nanoparticles and organic luminescent dyes can find versatile application in the areas such as: fabrication thermo addressable luminescence displays and thermo optical printers, environmentally friendly thermo chromic clothes. In medicine: modelling, simulation and visualization of heat spreading to the surrounding biological medium, new possibilities for the measuring heat release at the nanoscale, fabrication nano sized storage media for quantum information devices, thermo controllable filters, windows and smart coatings, infrared image converters. A simple technology promises to fabricate thermo chromic material based cost-effective devices.

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Abstract

CREEPING, AS THE POLYMERIC MATERIALS ONE OF THE MOST IMPORTANT MAINTAIN FEATU

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It is nearly decennary that is done intensive and systematical researches in mechanical chemistry. The first hypothesize that the chemical unions abruption is possible with mechanical chemistry way was announced by Shtaudinger in 1930 [1].

In many different fields working reaserchers, engineers, and constructors say that destructive influence on polymers with mechanical intension happens by for a lot of chemical reagents, besides powder, sea water, fumes and others. That we can call aggressive environments.

The most deformation feature is creeping-the solid bodies feature to save deformation with permanent intension influence.

As it is known, the polymers have the average place in the viscous liqueds and among flexible solid bodies, so the creeping whole deformation (ε_{CR}) is flexible (ε_f), flexible- elastic (ε_{f-e}) and viscous fluid (ε_v) deformation summery:

$$\varepsilon_{CR} = \varepsilon_f + \varepsilon_{f-e} + \varepsilon_v \quad (1)$$

During the creeping theory long development was done by many different concepts, from them one of the most spreading is the heritage theory.

This theory is based on Bocman's decisions [2], with it the creeping depends on past deformations, and the embarks each step has thier independent contribution in the last deformation. So, the full deformation can be get by the all contribution's summery.

The polymers creeping is done by Bolcman-Volter's equation:

$$v(t) = \frac{\dagger(t)}{E} + \int_0^t \{ (t-\dagger)\dagger(t)d\dagger \quad (2)$$

The function $\{ (t-\dagger)$ is called the memory function, that takes into consideration the samples the whole prehistory or the past deformations influence.

We have studied on polypropylenes creeping the aggressive environments influence. The done experiments show that with the increase of the sulfuric acid concentration the creeping of the polypropylenes is decreased.

The polymer materials usage for a long time in such cases causes the products' shapes changing without losing integrity.

There is no doubt that, in the polymers chemistry and the physics fundamental fields such as the strengths theory, the long life problems, the polymer materials recycling and products production and exploitation questions analyses aren't possible without mechanical chemistry events.

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Abstract

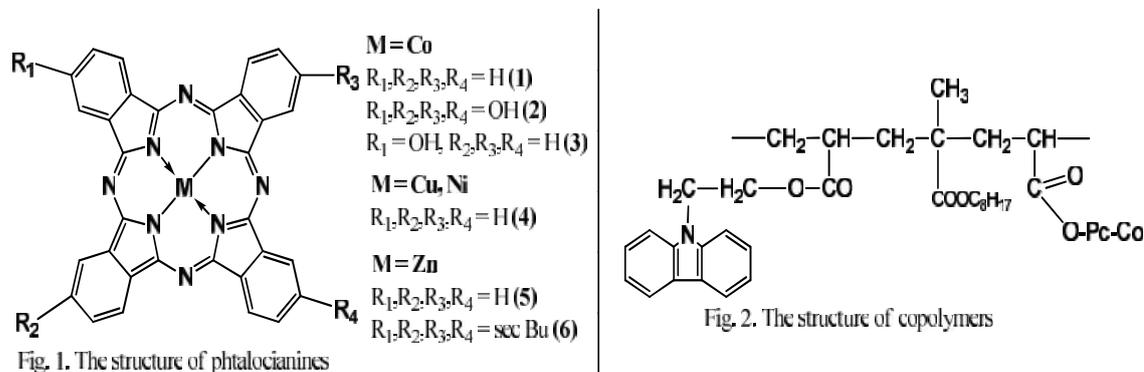
SYNTHESIS AND RESEARCH OF SOME PHTALOCIANINIC DYES WITH Cu, Zn, Co FOR TESTING IN THE SYSTEMS OF SOLAR CELLS TYPE

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Phtalocianines present interest as organic nanomaterials, due to the exceptional properties and their applications in areas such as: solar cells organic semiconductors, liquid crystal optical recording medium and information [1, 2]. For the purpose of developing new materials, photoconductive in the field of infrared and visible, are synthesized metalloptalocianines of transition metals Cu, Zn, Co, with the general formula described in Figure 1.



Synthesis of phtalocianines of copper, cobalt and zinc (fig. 1) was achieved in nitrobenzen solution at a temperature of 200 to 300°C. Preventively, salts-acetates of Cu, Zn and Co, were subject to dehydration. Phtalocianinic colors were purified by recrystallization from mixture of nitrobenzen and methanol.

Using the color of cobalt monohydroxiphtalocianine (Pc-Co (3)), through the polymer-analogical transformations on copolymer of 9-carbazolyethylmethacrylat (60 mol. %) , acrylic acid (5-15 mol %) and octylmethacrilat (25-35 mol. %), were obtained different polymers-analogues with the formula structure described in Figure 2.

Synthesized copolymers are soluble in some organic dissolvents (toluene, chloroform) and forming thin layers (0, 5-2, 0 mm) transparent.

Both phtalocianinic colors (1-4), and functionalized copolymers with Pc-Zn dyes (5-6) will be used in the fabrication of the solar cells.

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Abstract

METHYLENE DIOXOLANES: SYNTHESIS, PROPERTIES AND RING-OPENING POLYMERIZATION

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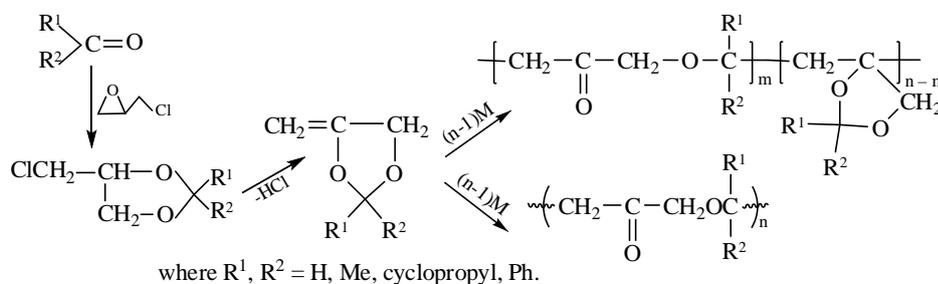
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The radical ring-opening polymerization of cyclic monomers recently attracts attention of the researchers, since as a result of this the inaccessible or practically inaccessible polymers with original structural units are prepared.

In this work the results of synthesis of methylene dioxolanes and investigation of their radical polymerization proceeding with opening of dioxolane cycle and formation of carbonyl containing linearly constructed polymers will be presented.

By interaction of various aliphatic and aromatic ketones or aldehydes with epichlorohydrin in the catalytic conditions the corresponding 4-chloromethyldioxolanes have been synthesized and with their subsequent dehydrochlorination 2-substituted -4-methylene-1,3-dioxolanes have been prepared.

With the aim of investigation of mechanism of the radical homopolymerization of the synthesized methylene dioxolanes it has at first been carried out the model addition reaction of various addends – thiophenol and trichlorobrommethane for these monomers. It has been revealed that as a result of addition of addends to methylene dioxolanes both cyclic adducts with keeping of dioxolane ring and linear adducts with its opening and formation of adducts with ketoether fragments are formed.



The free radical polymerization of the synthesized methylene dioxolanes has been carried out in the presence of peroxide initiators at 70-80° both in mass and in solution. It has been established that analogously to results of model reactions the forming elementary links have a cycloliner structure at homopolymerization of methylene dioxolanes. Moreover, the portion of cyclic and linear links depends on nature of the substituents located at 2 – carbon atom of dioxolane cycle, as well as on polymerization temperature. The prepared polymers have been characterized; their structure has been established on the basis of data of spectral (IR- and PMR-spectroscopy) and chemical analyses. The physical-mechanical and physical-chemical indices of made polymers have been determined by conventional methods.

Abstract

RADIATION CHEMISTRY AS A NEW WAY FOR THE SYNTHESIS OF NANOSTRUCTURED CONDUCTING POLYMERS

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Conducting polymers (CP) represent one of the most widely investigated class of functional - conjugated systems due to their potential technological applications. CP are usually prepared by two main routes: chemical and electrochemical syntheses, while CP formation is always initiated by the oxidation of monomers.

We recently succeeded in the development of a new γ -radiolysis-based alternative way for synthesizing nanostructured CP in aqueous solution. Starting from 3,4-ethylenedioxythiophene (EDOT) monomers or from pyrrole (Py) monomers dissolved in water, synthesis of conducting PEDOT [1] or PPy [2] was achieved using different oxidizing species: HO \cdot (hydroxyl), CO $_3^{\cdot-}$ (carbonate) or SO $_4^{\cdot-}$ (sulfate) radicals, generated in water by the high energy ionizing γ -rays.

All oxidative species lead after a recurrent step-by-step oxidation process to self-assembled CP polymers (Figure 1) which are characterized by good thermal stability and which are evidenced in solution by cryo-TEM and UV-Vis absorption spectroscopy and after lyophilisation and deposition by SEM and by an original technique developed in our laboratory: AFM-IR nano-spectroscopy. The simple choice of γ -rays-induced oxidizing species which determines the whole oxidation mechanism, has not only a clear influence on the chemical structure and the hydrophilic properties of synthesized polymers, but also plays a crucial role on the final morphology of polymers nanostructures [3]

Also, conducting properties of PEDOT and PPy-containing layers are evaluated by four point probe technique. Optical and conducting properties of radiosynthesized CP-containing layers, which are respectively evaluated by UV-visible absorption spectroscopy and by cyclic voltammetry, are found to be close to those of usually electrosynthesized CP layers.



Fig 1. PPy synthesized by radiolytic method and *in-situ* observation of its morphology

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Abstract

POLYMERIC RECORDING MEDIA BASED ON CARBAZOLE CONTAINING COPOLYMERS AND BENZOXYPHTHALOCYANINES OF TRANSITION METALS

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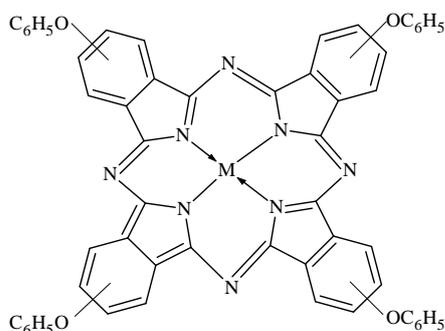
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The problem of creation of new photosensitive media based on carbazole containing polymers, especially for registration of holographic information, are actual and very necessary for solving of many technical (physics, photonics) and economical problems, e.g. protection of industrial and agrarian production from falsification.

For this purpose were synthesized a series of phthalocyanine dyes of zinc and cobalt benzoxyphthalocyanines with structure like that from the figure



Structure formula of metal benzoxyphthalocyanines.

All synthesized dyes are well soluble in organic solvents: toluene, chloroform and others, which is why they can be used to obtain nanocomposite and thin films (0,5-2,0 μm) from composite material with copolymers of N-vinylcarbazole and 1-octene and others.

From composite solutions were obtained thin layers $d \sim 1,0-1,5 \mu\text{m}$. Carbazole containing copolymers were sensitized with 2,4,7-trinitrofluorenone (TNF) and additional with 0-15,0 mass% of metal benzoxyphthalocyanines. Copolymer photoconductor layers (PL) sensitized with 15% TNF show electrophotosensitivity until wavelength - 650 nm, while PL additional sensitized with zinc benzoxyphthalocyanines show photosensitivity until 850 nm, i.e. up to near infrared region.

On the photothermoplastic carriers of information with photosensitized layers of prepared compositions were registered, in the red light of He-Ne laser at $\lambda = 633 \text{ nm}$, holographic gratings with diffraction efficiency up to 10%, with resolution up to 1000 mm^{-1} and with low noise.

Abstract

AZOPOLYMER RECORDING MEDIA FOR HOLOGRAPHIC RECORDING

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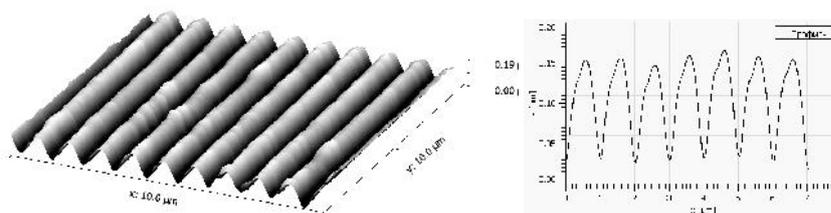
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Recently polymer materials with azo dyes become attractive materials for holographic recording due to possibility of surface relief grating fabrication with high diffraction efficiency and resolution. It has been reported that large surface modulations can be obtained on azo polymer films upon exposure to an interference pattern of laser beams [1].

In this study, novel type of carbazole-based azo polymer has been synthesized through a polymerization azo-coupling scheme [2]. As carbazole-based polymer the epoxypropylcarbazole (EPC) 90% and as azo dye the Disperse Orange 3 (DO) 10% were selected respectively. DO was purchased as a commercial product with dye content 90% from Sigma-Aldrich Company. FTIR characterization of synthesized copolymer EPK:DO has proved the introduction of azo group in polymer matrix confirmed by the peak at 1580 cm^{-1} in the IR spectrum corresponding to the N = N stretching frequency. Copolymer film was prepared as thin film spin-coated at glass substrate. The film thickness was measured with microinterferometer MII-4 and was 140 nm. The transmittance spectra for obtained films coated on glass substrates were measured over the range 200 – 900 nm. The broad absorption band in the range 420-580 nm with $\lambda_{\text{max}}=460\text{ nm}$ is assigned to strongly absorbing azobenzene groups. The surface-relief-grating (SRG) formation process was studied for obtained thin films. An interferometric holographic recording was used to expose linear grating. The interference pattern of DPSS laser beams was produced by two spatially symmetrical s-polarized beams ($\lambda=532\text{ nm}$ and power density 120 mW/cm^2). It was shown that s/s-polarization condition is not efficient for SRG formation process. While using two circularly polarized interfering beams (left-circularly polarized: right-circularly polarized LCP:RCP) good quality SRG were direct produced without any chemical treatment and with diffraction efficiency more than 20%. Fig. shows atomic force microscopy image of the recorded sinusoidal surface relief structures with spatial period $1\text{ }\mu\text{m}$. The depth of the grating was in the range from 80 nm to 130 nm.



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Abstract

STUDY OF STRUCTURE OF NANODROPLETS OF WATER IN REVERSE MICELLES: INFLUENCE OF KOSMOTROPES AND CHAOTROPES

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The unique structure of water is still a matter of discussion in biology, chemistry and physics. Complexity of water structure becomes enormous when it is confined to nanometer-scale cavities. Water confined into the nanometer-scale cavities behaves anomalously. e.g. enzymes entrapped in reverse micelles achieve their optimal efficiency when the reversed micelle reaches a particular size. This means, that the enzyme activity is dependent on the molecular ratio of water to surfactant. Water in the core of reversed micelle reveals at least two structures. Water that is close to the periphery of the micelle or in direct contact with the barrier molecules i.e. surfactants differs from water nearer the center of the reversed micelle. Both of these structures differ from free, chemically pure water. Introducing of kosmotropic and chaotropic additives into the water pockets of reverse micelles is especially important because of their influence on the structure of water.

The structure of reversed micelles is studied by several methods: UV-visible spectroscopy, IR-spectroscopy, small angle neutron scattering, nuclear magnetic resonance, differential scanning calorimetric method, dynamic light scattering, etc.

The goal of the proposed work was to review results obtained by our group in the sphere of reverse microemulsions, namely investigations by infrared, ultraviolet-visible and proton magnetic resonance spectroscopy, dynamic light scattering, viscosity measurements, etc. Study the influence of different ionic and nonionic kosmotropic and chaotropic additives introduced in the water nanocages of AOT and Brij30 reverse micelles on the ratio of the bound, free and trapped water fractions, binding process of optical probes with reverse micelles, sizes of the water droplets, density of the water core, etc [1-3].

Results may be useful in the investigations of the interface features of reverse micelles as models for biomembranes i.e. in the investigations of water structure, when it is confined to nanometer-scale cavities, viz. in biological systems. Results also may be informative in the investigations of reverse micelles since several features of reverse micelles remain to be solved, e.g. water structure close to the interface, water activity, internal pH in the water nanocage, etc.

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Abstract

SYNTHESIS OF SILVER-MONTMORILLONITE NANOCOMPOSITE USING LAWSONIA INERMIS EXTRACT AND DETERMINATION OF SUBSTRACT EFFECT ON MORPHOLOGY AND PARTICLES SIZE AS A GREEN ROUTE

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Green route synthesis of silver nanoparticles via a biological process using plant extract containing phytochemical agents have attracted considerable interest these days. In the present study, the synthesis and characterization of silver-montmorillonite nanocomposite by using water extract of *Lawsonia inermis* was carried out. For this purpose the water extract of *Lawsonia inermis* is used as reducing agent and stabilizer and also silver nitrate and montmorillonite as precursor and template respectively. By addition of silver nitrate to the extract at room temperature, the color of the extract was changed, which showed the formation of silver-montmorillonite nanocomposite. The characterisation of the obtained nanocomposite was studied using different methods, which including: ultraviolet-visible spectroscopy (UV-Vis), powder X-ray diffraction (XRD), scanning electron microscopy (SEM) and transmission electron microscopy (TEM).

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Abstract

NEW POLYMER METAL COMPLEXES BASED β -DIKETONES AND LANTHANIDES FOR OLEDs

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Organic light emitting diodes (OLEDs) are considered the next generation of technology for flexible flat panel displays and low cost solid state lighting. OLED has many advantages of low voltage operation, self-radiation, light weight, thin thickness, wide view angle and fast response time to overcome the weaknesses of existing liquid crystal display. There has been a large research activity on coordination compounds of the lanthanide ions with organic ligands including β -diketones, which can act as excellent light conversion molecular device, light-emitting diodes, polymer sol-gel derived glasses, electroluminescent devices [1-4]. The photoluminescence properties of rare-earth (lanthanide) compounds have been fascinating researchers for decades [5-7]. An attractive feature of luminescent lanthanide compounds is their line-like emission, which results in a high color purity of the emitted light. The emission color depends on the lanthanide ion but is largely independent of the environment of a given lanthanide ion [8-9].

The complex of samarium (III) with 2-methyl-5-phenylpenten-1-3,5-dion (mphpd) $\text{Sm}(\text{mphpd})_3 \cdot 2\text{H}_2\text{O}$ was synthesized. The polycomplex $[\text{Sm}(\text{mphpd})_3]_n$, and copolymer with styrene $\text{Sm}(\text{mphpd})_3$ -styrene in ratio 5:95 were obtained by free-radical polymerization and the kinetics of polymerization was studied by dilatometric method at the first time. The method of dynamic light scattering and the results of electronic microscopy showed that the obtained polymer systems are nanoscale. The luminescent spectra of obtained metal complexes in solid state are investigated.

The electroluminescent spectra of organic planar heterostructure ITO/PEDOT:PSS/ $[\text{Sm}(\text{mphpd})_3]_n/\text{Al}$ are examined and analyzed.

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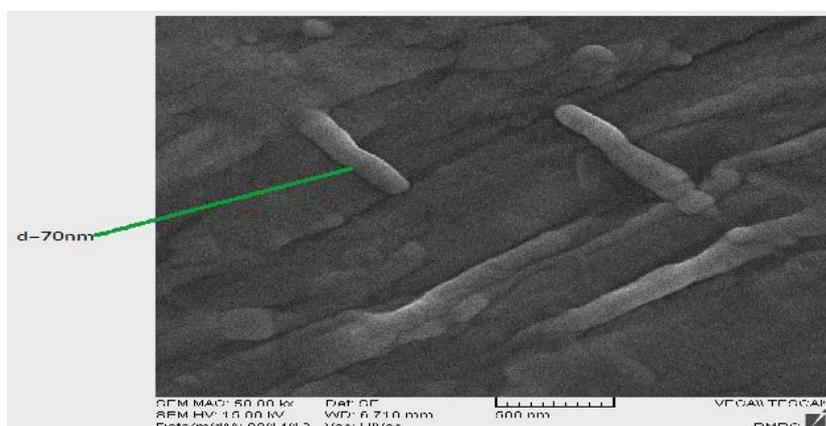
Abstract

POLYVINYL CHLORIDE /MMT NANOCOMPOSITE, SYNTHESIS AND EVALUATION OF THE MORPHOLOGICAL AND THERMAL PROPERTIES

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In this project, polyvinyl Chloride (PVC) /montmorillonite nanocomposite has been prepared by melt blending process. For this purpose montmorillonite (MMT) was modified by cetyltrimetyl ammonium bromide (CTAB) as a quaternary ammonium salt and called organo clay (OMMT). Then PVC/ OMMT nanocomposites were prepared by melt blending process in different ratios of components. The results showed enhanced properties of nanocomposites. The morphology of the PVC/ OMMT nanocomposites were studied by scanning electron microscopy (SEM), Infrared spectroscopy, X-ray diffraction (XRD) and thermal gravimetry (TGA) analysis.



SEM image of PVC/ OMMT

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Abstract

CYCLOPROPANE CONTAINING BIOACTIVE POLYMERS: SYNTHESIS, STRUCTURE AND PROPERTIES

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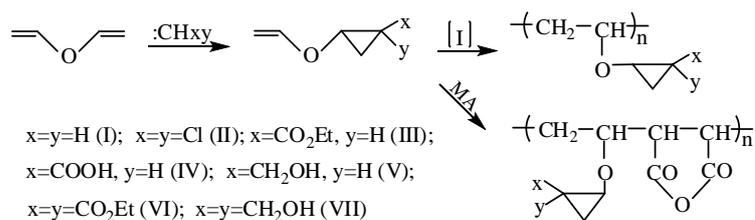
The polymers containing cyclopropane fragments and various reactive functional groups in macromolecules show the various specific properties, including biocide ones, which is of great scientific-practical interest.

The purpose of this work consisted in synthesis, homopolymerization of functionally substituted cyclopropyl vinyl ethers and their copolymerization with maleic anhydride and investigation of their bioactive properties. In this work the results of synthesis of cyclopropane containing monomers have been generalized, the polymerization involving kinetic, spectral, chromatographic methods of analysis and results of model reactions has been studied. The copolymers with maleic anhydride have been prepared and the anhydride-containing copolymers as the bearers of biologically-active substances have been investigated.

The main ways of preparation of bioactive macromolecules:

- (co)polymerization of biologically inactive monomers with formation of bioactive polymers;
- polymerization of biologically active monomers with formation of macromolecules possessing the same bioactive properties;
- copolymerization of bioactive monomer with vinyl monomers;
- application of polymer bearers;
- introduction of bioactive compounds in polymer matrix.

The cyclopropyl vinyl ethers synthesized by us are referred to the category of multifunctional monomers. Their targeted (co)polymerization and reaction with other compounds will lead to the preparation of bioactive materials.



Comparing changes of influence of polarity of monomers stipulated by p-conjugation (p-electrons of oxygen atom with π -electrons of double bond) and activity of π -double bond in the polymerization process in a series of the synthesized monomers it has been concluded: with increasing of polarity of π -bond (with growth of δ^- -charge on the end O -atom) a chemical reactivity of the considered compounds grows.

At copolymerization of the synthesized monomers with maleic anhydride there have been prepared the anhydride-containing copolymers, which then have been used as the polymer bearers of biocide compounds.

Abstract

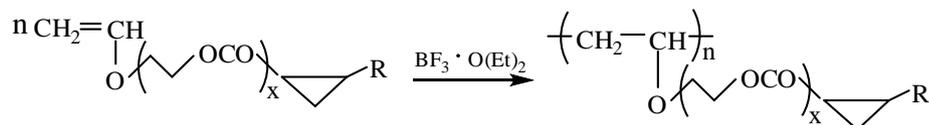
CATIONIC POLYMERIZATION OF CYCLOPROPANE-CONTAINING VINYL ETHERS

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In this work it is described the synthesis of new monomeric vinyl ethers with cyclopropane groups. The cationic polymerization and photochemical structuring of the prepared polymers has been investigated. The initial monomers have been prepared by divinyl ether reaction with the corresponding carbenes and by interaction of vinyl-2-chloroethyl ether with potassium salt of 2-substitutedcyclopropane carboxylic-1 acid in the presence of the catalyst of phase transfer. The polymerization of the synthesized monomers has been carried out in the presence of. $\text{BF}_3 \cdot \text{O}(\text{Et})_2$ and accompanied by quantitative conversion of monomer to polymer.



$x=0$, $\text{R}=\text{H}$ (I); Cl_2 (II); CH_2OCH_3 (III); $x=1$, $\text{R}=\text{Bu-}$ (IV); BuO- (V); Ph- (VI)

The structure of the synthesized monomers has been established on the basis of data of the IR- and PMR-spectroscopy. The cationic polymerization of monomers I–VI was carried out in the atmosphere of dry nitrogen in toluene solution in the temperature range $-70 \div -10^\circ$. The polymerization proceeded without induction period.

The consideration of data of the spectral analysis showed that the polymerization proceeds exclusively on vinyl-ether group, in this case the cyclopropane groups remain without changes. It has been established that with temperature rise from -70° to -10° a yield of polymers is slightly increased. In this case a changing of the concentration of initiator doesn't influence on yield of purposeful product.

It has been shown that a photochemical irradiation of thin film of the prepared polymers leads to the opening of cyclopropane ring and is accompanied by formation of cross-linked material.

The overall polymerization rate under action of the catalyst $\text{BF}_3 \cdot \text{O}(\text{Et})_2$ in a series of the compounds I–III grows with increase of electron-donor ability of substituent in monomer: $\text{Cl} < \text{H} < \text{CH}_2\text{OCH}_3$.

The polymers prepared during polymerization of monomers I–VI at -20° under action of $\text{BF}_3 \cdot \text{O}(\text{Et})_2$ possess high MW and are characterized by wide MWD ($M_w/M_n=2,8 \div 4,2$).

Abstract

NEW POLYMER-SILICATE COMPOSITES

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Polymer-silicate composites, as it is known, are based on different polymers and high dispersive silicate powders. They differ from other analogues with high physical-mechanical and other exploitation properties. The main goal of our work is the obtaining and investigation of new polymer-silicate composites with improved acid-resistant and physical-mechanical properties. The composites were obtained on the basis of epoxy glues and some minerals widespread in Georgia (andesite, diatomite, quartz sand) both in separate and combined form. By means of method of experiment's mathematical planning there are obtaining the polymer-silicate composites with optimal physical-mechanical and some other exploitation properties. Thus e.g. it was obtained the composites differed from existed ones by high mechanical strength (on 2-4 times) and low (on 2-times) water absorption. Besides of new composites are different with high acid resistant, namely the coefficients of diffusion and penetration are better than existed analogues on 2 orders. The density and shrinkage of new composites 1.5 times is lower in comparison with existed acid-resistant silicate materials. The obtained materials may be used as coatings of different building constructions from influence of aggressive media.

Abstract

STRUCTURE-PROPERTY RELATIONSHIPS FOR NANOPOROUS AND MICROPOROUS POLYAMIDOIMIDE/POLYURETHANE FILMS

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Porous polyimide-based film materials are widely used as thermostable membranes for separation of gases or liquids at high temperatures. Polyurethanes having excellent physical-chemical and mechanical characteristics can be used as effective modifier for polyimide membranes. Thus, obtaining film materials from PI/PU blends allows increasing elasticity and permeability, which are important in their application in separation techniques.

In this work the series of polyamidoimide/polyurethane (PAI/PU) film materials were prepared by *in situ* synthesis from polyamic acid (based on trimellitic anhydride chloride and 4,4'-methylenedianiline) in the presence of polyurethane (Mw = 40 000, based on 4,4'-diphenylmethane diisocyanate and oligobutylene glycol adipate) in *N*-methylpyrrolidone (NMP) solution (20%) through heating from 25 to 250 °C with heating rate of 0.5 °C/min followed by partial extraction of PU component in MEK and characterized. The polymer PAI/PU films with PU content $c = 5, 15, 20, 25$ and 30 wt. % were synthesized. The morphology of PAI/PU blends was investigated by SEM technique. The formation of heterogeneous materials was observed, and increasing amount of the PU component led to higher size of PU domains in the system. It was found that both the precursor and extracted PAI/PU blends possessed porous structure. Obviously, in the precursor PAI/PU films pores were formed due to removing of solvent, DMFA and reaction side product, water, during synthesis of PAI. It was established that the higher the PU amount removed from the PAI/PU precursor the higher porosity of the resulted films. At increasing the PU content from 5 to 20 wt. % the average pore diameter increased from $d_p \sim 20\text{--}60$ nm (mesopores) to $d_p \sim 200$ nm. It was found that porous PAI/PU films had higher thermal stability compared to the precursor non-porous samples.

Abstract

CURE KINETICS OF THERMOSETTING BISPHENOL E ESTER RESIN WITH IONIC LIQUIDS

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Cyanate Ester-based thermosetting polymers are commonly used in structural aerospace composites, in electronic insulating applications, adhesive and encapsulant formulations as a high temperature polymer matrix. Thermally curable Cyanate Ester Resins (CER), giving the rigid 3D polycyanurates, exhibit a unique combination of thermal, fire, radiation and chemical resistance, high mechanical moduli, excellent dielectric and adhesion properties as well as low water/moisture adsorption. In the present work the effect of ionic liquids (ILs) on the curing kinetics and network formation of thermostable CERs formed via polycyclotrimerization of Cyanate Ester of Bisphenol E (DCBE) was investigated by means of differential scanning calorimetry (DSC) and Fourier transform infrared spectroscopy (FTIR). The values of reaction enthalpy at time (H_t) and conversion of the DCBE monomer at time (r_t), the values of glass transition temperatures (T_g) at time (r_t) of the cured PCNs filled by different ionic liquids were determined. It was found that the final conversion of cyanate ester groups increased with increasing ILs content in the reactive mixtures while the corresponding T_g values of the cured CERs decreased. Some kinetic parameters were also calculated in dependence of content of ILs used. Both DSC and FTIR data have been shown that even a small amount of ILs accelerates the reaction of polycyclotrimerization of DCBE leading to formation of polycyanurate network. The FTIR data evidence an acceleration effect of ILs on kinetics of the early stages of CER formation.

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Abstract

PROPERTY MODULATION OF POLYMERS CONTAINING BENZODITIOPHENE AND PYRROLO[3,4-C]PYRROLE-1,3-DIONE UNITS VIA THE INCORPORATION OF THIENO[3,4-B]THIOPHENE UNITS FOR PSCS AND OFETS

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The solution processes polymer solar cells (PSCs) made from the conjugated polymer and fullerene derivative have been considered as a most promising solar to electrical energy conversion techniques due to their easy device fabrication to large area at low cost [1]. The maximum power conversion efficiency (*PCE*) achieved for PSCs exceed over 10% [2-4]. We prepared new low band random copolymer (RP) via the incorporation of relatively strong electron deficient thieno[3,4-b]thiophene (TT) unit on the backbone of highly efficient large band gap polymer, P(BDT-TDPPDT) [5]. containing electron rich 4,8-bis(2-ethylhexyloxy)benzo[1,2-b:4,5-b]dithiophene (BDT) and a weak electron accepting 2,5-dioctyl-4,6-di(thiophen-2-yl)pyrrolo[3,4-c]pyrrole-1,3(2H,5H)-dione (TDPPDT) units with the aim of tuning the properties of P(BDT-TDPPDT). The optical band gap of RP was 1.66 eV and the calculated highest occupied/lowest unoccupied molecular orbital (HOMO/LUMO) energy levels of RP were 5.29 eV/ 3.63 eV. The opto-electrical studies suggest that the incorporation of TT unit on P(BDT-TDPPDT) backbone significantly lowers the band gap and LUMO level of P(BDT-TDPPDT). However, RP displayed slightly higher hole mobility compared to that of P(BDT-TDPPDT) and the estimated hole mobility (μ) was $4.0 \times 10^{-4} \text{ cm}^2 \text{ V}^{-1} \text{ s}^{-1}$. The polymer solar cells (PSCs) prepared with a simple device configuration of ITO/PEDOT:PSS/RP:PC₇₀BM/Al offered a maximum power conversion efficiency (*PCE*) of 4.29%, with a open circuit voltage (V_{oc}) of 0.75 V, a current density (J_{sc}) of 10.57 mA/cm², and a fill factor (*FF*) of 54%. Currently, RP showed a comparable device performance with P(BDT-TDPPDT) and the PSC device optimization is still under progress for RP. We expect that RP might give higher *PCE* than P(BDT-TDPPDT) due to its enhanced opto-electrical and charge transport properties.

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Abstract

SOME AROMATIC AZIDES AND PENTAZENES IN MULTISTEP RADICAL POLYMERIZATION

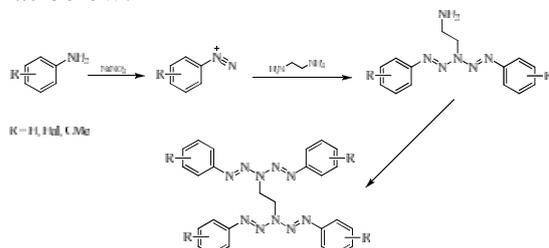
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Aromatic azides can be obtained by the action of sodium azide on corresponding diazonium salts. They are photosensitive and form biradicals –nitrenes (singlet or triplet). The last ones can transform in active free radicals, which can cause the radical polymerization. This fact we had found out firstly for carbonyl-contained azides, such as derivatives of acetophenone, xanthone, fluorane, anthraquinone, phenylphthalimides [1-3]. Diazides are more effective than monoazides as a rule. For some diazides (ex. 4-azido-N – 4'-azidophenylphthalimide [2]) we have recently found double-step mechanism of photoinitiation due to the direct energy supply (intramolecular transfer) for differently positioned azidogroups with different values of photolysis quantum yields. For MMA the polymerization degree is about 1000

Monopentazenes or pentazadienes are known to be obtained by action of monoalkylamines on diazonium salts [4]. We had firstly discovered that they can initiate the radical polymerization of vinyl monomers [5]. Mechanisms of corresponding processes were proposed and discussed [6]. Recently as prolongation of these investigations we have studied an interaction of diazonium salts with diaminoalkanes. Monopentazenes were found to be obtained as the first stage of the synthesis and after as the second stage we can obtain new compounds – bis-pentazadienes with the common structure as below:



As p-substituents –OCH₃, –CH₃ and –H were used, near double bonds N atoms are positioned. Structures of all products were proved by analytical and spectral methods. Photochemical studies and experiments on applications of obtained products as photocrosslinkers and photoinitiators have been carried out. In photolysis they can produce free radicals of several kinds, due to eruption of one (or both) pentazene moieties and radicals transformations. Therefore they can involve multistep polymerization processes. The perspectives of their applications in the industry were evaluated.

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Abstract

SILICON BASED SOLID POLYMER ELECTROLYTE MEMBRANES

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In the, fast growing development process of electrochemical devices (battery, solar cell, electrochromic devices, super capacitor etc), electrolyte has a very crucial and important place. It has to play many roles like mechanical separator, an electronic insulator, a good ionic conductor etc.

Polysiloxanes are promising components for comb polyelectrolytes because they possess a flexible backbone that enhances the transports of ions. Their amorphous and highly flexible [Si-O]_n backbone produces glass transition temperatures as low as -130°C and yields 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 work devoted to the alternative way of synthesis of comb-type polymers containing in the side chain propyl acetoacetate side groups obtaining via polymerization reaction of 2.4.6.8-tetramethyl-2.4.6.8-tetramethylcyclotetrasiloxane in the presence of nucleophilic catalysts in the 60-80°C temperature.

Via sol-gel processes of doped with lithium trifluoromethylsulfonate (triflate) or lithium bis-(trifluoromethylsulfonyl)imide oligomer systems solid polymer electrolyte membranes have been obtained. The electrical conductivity of these materials at room temperature belongs to the rather wide range of electrical conductivity magnitudes (10^{-10} x 10^{-4} S·cm⁻¹) and depends on the structures of grafted anion receptors and the polymer backbones.

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Abstract

FREE-RADICAL FRONTAL POLYMERIZATION OF ACRYLAMIDE IN THE PRESENCE OF NANO AND MICRO ADDITIVES

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The effect of different nanoparticles (bentonite, SiO₂) and finely disperse fillers (chalk, diatomite) on peculiarities of acrylamide frontal free-radical polymerization initiated by azoisobutyronitrile and benzoyl peroxide was studied. It was determined that the increase in an order with respect to initiator is conditioned by influence of nano and micro additives not only on the mechanism of initiator decomposition but also on the reaction of chains bimolecular termination. It has been known that according to the theory of heat waves propagation the velocity of vinyl monomers free-radical frontal polymerization depends on concentration of initiator as shown in the equation: $u = [I_0^n f(x_i)]^{1/2} = I_0^{n/2} [f(x_i)]^{1/2}$. Where u is front velocity, I_0 and n are initial concentration of initiator and power of initiator, $f(x_i)$ is function depending on monomer concentration, temperature and polymerization thermal mode, heat effect, ultimate conversion, temperature of adiabatic heating-up and other parameters.

Based on these results it could be assumed that such change of n value is conditioned by specific impact of high pressure on initiation efficiency and chains termination and etc. Later the frontal polymerization of methacrylic acid and triethylene glycol dimethacrylate without applying of high pressure has been studied. The observed data indicate that the power dependence of front velocity on initiator concentration substantially depends on the nature of the initiator. As a matter of course it is very important to ascertain the effect of different kind of finely disperse and nano-sized fillers on the order with respect to initiator and accordingly on the elementary reactions of chains initiation, propagation and termination. This problem becomes especially crucial if to consider the formation of the solid amorphous polymer fraction at interface of nanocomposites due to strong interaction of macromolecules with nanoparticles surface taking place in the course of synthesis of polymer nanocomposites by free-radical polymerization of vinyl monomers.

Thus in this study we focus on acrylamide frontal polymerization initiated by benzoyl peroxide and azoisobutyronitrile, in particular, on the effect of finely disperse fillers (diatomite, chalk) and nanoparticles (SiO₂, bentonite) on power dependence of front velocity on initiator concentration and mechanism of elementary reactions of chain initiation and termination.

Abstract

ELECTRODEPOSITION OF Mn-Cu AND Mn-Zn-Cu ALLOYS FROM CITRATE-SULFATE ELECTROLYTES AT HIGH CURRENT DENSITIES

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Galvanic coating of manganese and its alloys (Cu, Zn, Co, Ni, Fe), being relatively inexpensive, shows the highest corrosion resistance if compared to zinc alloys, and good corrosion – protective properties for coating of steel products [1]. Usage of pure manganese coatings in practice is restricted by its relatively highly chemical activity and phase transformation of unsustainable, plastic -Mn into sustainable, brittle -Mn form at room temperature in several weeks. Alloying Mn with a noble metal (Cu, Ni, Co, Fe, Zn) can however reduce its reactivity and also perform stabilization of -Mn [2, 3].

Electrodeposition of Mn-Cu and Mn-Zn-Cu alloys was carried out in a diaphragm bath from sulfate electrolytes, containing citrate as complexing agent: $0.3\text{MMnSO}_4 + 0.5\text{M}(\text{NH}_4)_2\text{SO}_4 + 0.005\text{MCuSO}_4 + 0.2\text{MNa}_3\text{C}_6\text{H}_5\text{O}_7$ and $0.3\text{MMnSO}_4 + 0.5\text{M}(\text{NH}_4)_2\text{SO}_4 + 0.005\text{MCuSO}_4 + 0.1\text{MZnSO}_4$; pH 6.5-7.5; 30°C ; $35\text{-}70\text{ A/dm}^2$; =15min; copper, steel and glass-carbon plates (4 cm^2) were used as a cathode, and Ti ($\text{TiO}_2\text{-RuO}_2$) as an anode (140 cm^2). The chemical composition of alloys was determined by the method of rentgeno-fluorescentic analysis on Delta-Analyzer device «INNOV-X SYSTEMS».

Semi bright, silver adherent deposits were obtained. Dependence of the chemical composition () and current efficiency of alloys on the condition of electrolysis are given in the table below:

Alloys	pH catholyte	I_k , A/dm ²	Mn, %	Cu, %	Zn, %	,%
Mn-Cu	6.5	45	92.69	7.31	-	21.43
		55	93.06	6.94	-	20.35
		70	91.05	8.95	-	17.97
Mn-Zn-Cu	6.5	35	82.33	6.17	11.5	35.01
		45	79.49	7.63	12.89	39.67
		65	78.66	7.99	13.35	34.82
	7.0	35	79.38	6.96	13.66	36.52
		45	83.38	5.16	11.46	36.71
		65	74.14	7.71	18.15	31.69
	7.5	35	64.96	10.75	24.29	33.33
		45	71.88	7.78	20.34	32.72
		65	58.86	11.15	29.99	25.43

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Abstract

ON THE POSSIBLE MOLECULAR MECHANISM OF THE MESOMERIC EFFECT IN IRREGULAR BIOPOLYMERS (PROTEINS)

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M-effect is a propagation of the electronic charge along a system accompanied by commuted (π -electron) links, while I-effect is observed in systems having σ - links. This investigation reveals the following:

- 1) Both effects have a quantum – mechanical nature.
- 2) The basis of the mechanism of these effects lies in the principle of the self organization of the field that is commonly known in quantum mechanics.

According to the quantum – mechanical attitude (in quasi classical approximation) it is possible to determine the electron density on atoms in the molecules by means of a formula presented in a book on quantum-mechanics of molecules written by Mac-Vinni and published in Moscow by Mir publishers in 1989, p. 270.

The functions depend on the configuration, on the number of atoms, on the composition of atoms in the system. At any change of the composition or of the configuration (e. g., during the isomerization) the wave function is changed. This results in the accompanying change of the electron density in the system.

Impact of the displacement – the direction of the charges depends on the type to which the displacement belongs. The type may be of the electron acceptor nature or that of the electron donor nature. The displacers cause the modification of the atoms' composition and this affects the wave function of the system and through it, it effects the distribution of the density of the electrons.

In this way, according to the self regulation principle of the field, the action of the displacement is evidenced by the reorganization of the electron density in the system, irrespective of the case whether the system is of sigma-links type or of the π - electronic links type. The difference is caused by the following fact: the σ - systems are generally characterized by branches and this causes the fast extinguishment (decrease of the I – effect, while π -electron systems have long none branched areas, hence the extinguishment) decrease along those lines is considerably weaker and the μ -effect spreads on larger distances.

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Abstract

EFFECT OF TEMPERATURE ON THE CUT OFF FREQUENCY OF ALGAN/GAN HIGH ELECTRON MOBILITY TRANSISTORS

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An analytical- numerical model for the cut off frequency of AlGa_N/Ga_N based high electron mobility transistors has been developed that is capable to predict accurately the effects of temperature on the electronic current of two dimensional quantum well, transconductance [1], depletion layer capacitances [2] and cut off frequency in different temperature. In addition taking into account the combined contributions from each of the individual electron scattering mechanisms. Salient features of the model are incorporated of fully and partially occupied sub-bands in the interface quantum well [3]. In addition current in the barrier of AlGa_N, traps density field in AlGa_N [4], gate leakage, interface trap in the device are also taken into account. Close agreement with the experimental data confirms the validity of the present model.

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Abstract

AN ANALYTICAL - NUMERICAL MODEL FOR THE MOBILITY OF INGAN/INN/INGAN HIGH ELECTRON MOBILITY TRANSISTOR (DHEMT)

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An analytical - numerical model for the mobility of InGaN/InN/InGaN high electron mobility transistor (DHEMT) development. Salient features of the model are incorporated of fully and partially occupied sub-bands in the interface quantum well [1]. In addition temperature dependent of band gap, quantum well electron density, threshold voltage, mobility of electron [2, 3], dielectric constant, polarization induced charge density in the device are also taken into account. To calculate the 2DEGs mobility in InN-based HEMTs, the different scattering mechanisms such as dislocations scattering due to the large lattice mismatch, impurity scattering by remote donors and due to interface charge, interface roughness in InGa(Al)N/InN heterointerfaces, alloy disorder scattering due to penetration of the 2DEG wave function into the barrier and phonon scattering are considered. The sheet carriers generated in InN-based double channel are found to be higher than the reported values for the conventional single channel HEMTs. The calculated model results are in very good agreement with existing experimental data for high electron mobility transistor device.

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Abstract

NUMERICAL PERFORMANCE FOR THE ALGaN/GaN/ALGaN/GaN DOUBLE-CHANNEL HIGH ELECTRON MOBILITY TRANSISTORS

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Numerical model for the AlGaN/GaN/AlGaN/GaN double-channel high electron mobility transistors on sapphire substrates is reported. Two carrier channels are formed in an AlGaN/GaN/-AlGaN/GaN multilayer structure. The DC performance of the resulting double-channel HEMT shows a wider high transconductance region compared with single-channel HEMT. Numerical model provide an explanation for the influence of the double-channel on the high transconductance region. In the self-consistent calculation, the nonlinear formulism of the polarization-induced field as a function of Al mole fraction in $\text{Al}_m\text{Ga}_{1-m}\text{N}/\text{GaN}$ heterostructures has been assumed, as well as taking in to account intersub-band coupling coefficients (H_{mn}) [1] and all fully and partially-occupied sub-bands within the interface 2DEG potential well [2, 3]. The buffer trap is suggested to be related to the wide region of high transconductance. The RF characteristics are also studied. The calculated model results are in very good agreement with existing experimental data for high electron mobility transistors device.

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Abstract

FULLEROPYRROLIDINES AS PROMISING ANTIOXIDANT MOIETIES IN POLYMER MATERIALS

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It is well known that the radical scavenging efficiency of fullerenes can be significantly activated by means of a connection with hydrogen donating groups of antioxidants such as phenolic, amine and sulfhydryl. The developed system of conjugated s-p bonds arranged in the fullerene molecule in a closed shape can promote a strong resonance effect on the grafted units and increase the hydrogen atom abstraction efficiency. In this case the known ability of fullerene to trap alkyl radicals might be combined with the strong chain breaking functionality to afford a new class of antioxidants with bimodal action. Explorations in the field of fullerene derivatives on their antioxidant performance provide novel information on the potential stabilization properties of this type of molecular structure.

This account describes an anti-oxidative influence of the fullerene-alkylpyrrolidines on the model oxidation environment. The antioxidant activity of the investigated derivatives was studied by measuring the inhibition rate constants for their reaction with alkyl and peroxy radicals in a model cumene initiated (2,2'-azobisisobutyronitrile, AIBN) oxidation experiments and compared to that recorded under identical experiments for buckminsterfullerene itself and commercial stabilizers.

The results indicate that linking the alkylpyrrolidine groups directly to the fullerene core gives rise to an additional antioxidative power to the buckminsterfullerene: - they heighten the inherent rate constant of buckminsterfullerene for scavenging alkyl radicals due to the additional antioxidant contribution promoted by the radical-quenching ability of the formed nitroxyl intermediates.

These novel C₆₀-amine conjugates may be considered as promising molecules for broad-spectrum radical scavenging antioxidants to use purposely in polymer materials.

Abstract

STUDY OF AGING EFFECT OF SILVER AND GOLD SOLS SYNTHESIZED IN BRANCHED AND LINEAR POLYACRYLAMIDES

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Silver and Gold (Ag and Au NPs) nanoparticles are emerging as promising agents for cancer therapy. They are being investigated as photothermal, antimicrobial agents or as a component of nanoconstruction for targeted delivery of anticancer drugs into tumor cells. Biocompatible water soluble polymers can be efficient for nanocarriers preparation. Moreover such nanosystems can decrease side effects on the healthy issues and intact cells. Nevertheless such systems undergo aggregation and sedimentation. Aging effect limits an application field of nanocarriers and should be studied in detail.

Current work is dedicated to the study of nanosystems with high content of Ag and Au NPs synthesized into branched copolymers with Polyacrylamide arms and Dextran core (D-g-PAA), linear PAA and its anionic derivatives.

Polymers were characterized by Size Exclusion Chromatography (SEC) and NMR spectroscopy. Potentiometric titration of polyelectrolytes was performed to measure hydrolysis degree of PAA chains. Synthesized Ag and Au NPs were studied by UV-vis spectroscopy, Zeta Sizer and Transmission Electron Microscopy (TEM). The aging effect was controlled during 2 months. Combination of these methods allowed to analyze of average size, concentration and shape changes during the storage and to evaluate the possibility of nanosystems to use them for drug carriers production.

It has been shown, that synthesized hydrosols of Ag and Au NPs undergo both aggregating and dispersion during the storage. Significant change of hydrodynamic size distribution was observed after two month. The maximum contributed to Au NPs has shifted from 4 nm to 10 nm. For Ag NPs maxima has shifted from 2 to 5 nm.

Moreover, it was determined that macromolecular parameters, namely compactness of macromolecule influenced greatly on the aggregation process in studied nanosystems. Anionic derivatives of D-g-PAA allows to synthesize nanocolloids with high content of small (2-4 nm) nanoparticles, but it was impossible to produce Au and Ag NPs into linear polyelectrolyte matrix.

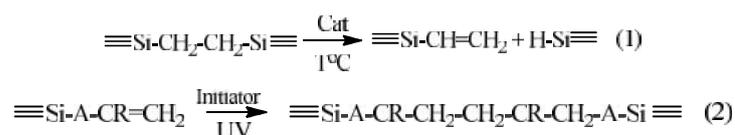
Abstract

SILICON COMPOUNDS AND THEIR APPLICATION IN VARIOUS INDUSTRIES

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Silicone polymers and materials based on them have found wide application in all spheres of human activity. Silicone compounds and sealants are used in electronics, microelectronics, optoelectronics, electrical engineering, automotive and aviation industries, electrical engineering, building industry. In recent years dramatically increased their consumption in medicine and as a household. To create new materials that meet the most complex demands, the use of modern methods of production involving nanotechnology. Thanks to directional synthesis and advanced methods of analysis of the obtained compounds and sealants with high optical and chemical purity, biologically inert, good mechanical and dielectric characteristics, high heat and frost resistance. Formulations of electrically conductive and thermally conductive materials produced in two- and one-component versions. Basic mechanisms of polymerization used in the development of formulations of silicone compounds and sealants are the polyaddition reaction (1) and radical polymerization under the influence UV irradiation (2) according to the schemes below:



As can be seen from the diagrams, the polymerization takes place without isolation of by-products, which allows the use of such compositions not just as a film or coating, but also as a filling for the enclosed volume of any configuration. Silicone materials can be vulcanized condition different physical state: gel and elastomer (compounds, sealants and adhesives - brand "SIEL") to glassy (compounds and adhesives trade mark "STYK"). Operating total resource materials developed from -90 to +350 ° C, they possess high radiation resistance (SIEL 159-275 withstands the dose of 10⁷ R without significant changes in physical mechanical and optical characteristics), good oil-gasoline (SIEL 159-305), adhesion to such surfaces as metal, glass, ceramics or other (cohesive separation). Compounds of a series of STYK subjected to polishing and grinding (Brinell hardness 100 ÷ 120). Compounds SIEL and STYK are available in both filled and unfilled condition. Unfilled compositions exhibit high light transmission (up to 92-98% in the visible range of temperatures) and variable refractive index (from 1.375 to 1,560), which is very important when using these materials, for example, as an intermediate layer in the triplexes of different composition, as well as antireflection films for glasses with different refractive index, etc.

High-purity silicon compounds of the specified type will be virtually free of ionic impurities compounds (Na, K, Ca, Cl, etc.), transition metals valence (Fe, Ni, Cd, etc.), and radioactive compounds (U, Th, etc). Depending on the type of device or devices you can find the materials, curable at moderate temperatures from ambient to 160 °C, respectively, in a period from one day up to 30 minutes; or under the influence of UV radiation of different intensity at room temperature with duration from several minutes to several seconds. Thermally curable materials are capable of polymerization in layers of different thickness, while the UV curable only in thin, not more than 0,1 - 0,2 cm. However, the UV-curable compositions allow the use of screen printing and selective method of vulcanization. At the moment there are a large series of materials type SIEL and STYK of more than 50 items.

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