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K.I. Satbayev Kazakh National Research
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BOOK OF ABSTRACTS

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Satbayev University (Kazakhstan)
&
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ПОЛИМЕРЫ, КОМПОЗИТЫ, НАНОКОМПОЗИТЫ И БИОКОМПОЗИТЫ-2023
(ICPCNB-2023)

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В тезисы докладов включены материалы Международной конференции по полимерам, композитам, нанокомпозитам и биокомпозитам-2023 (ICPCNB-2023), в которых заслушаны и обсуждены актуальные проблемы синтеза, исследования, и применения, а также достижения в области композитных, нанокомпозитных, биокомпозитных и полимерных материалов, а также создания конструкций из них.

Материалы могут быть полезны научным работникам, преподавателям, докторантам, магистрантам и студентам университетов, занимающимися вопросами исследования и применения композиционных, нанокомпозитных, биокомпозитных и полимер композитных материалов.

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Edited by Professor Sabu Thomas

Book of abstracts contains the presented and discussed materials of International conference in which the advanced problems of of synthesis, research, and application, as well as achievements in the field of composite, nanocomposite, biocomposite and polymer materials were heard and discussed, as well as creating structures from them.

The materials can be helpful for researchers, university professors, PhD and MSc students who are Interested in problems of of composite, nanocomposite, biocomposite and polymer composite materials.

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«By researching, I teach,
by teaching, I research»

Friedrich Humboldt

Dear friends and colleagues!

You are invited to participate in the upcoming International Conference on Polymers, Composites, Nano- and Biocomposites-2023 (ICPCNB-2023). The conference will provide a platform for the exchange of ideas and discussions on contemporary issues in the synthesis, research, and practical applications of nano-, biocomposite, and polymer materials. Distinguished scientists from around the globe will contribute to the discourse. The primary partner of ICPCNB-2023 is Mahatma Gandhi University (India), under the leadership of Professor Sabu Thomas. We look forward to your valuable presence at this significant event.

The conference encompasses a broad spectrum of topics. Emerging polymer nanocomposite materials are garnering attention for its distinctive mechanical, thermal, and electrical characteristics. In recent times, there has been a growing exploration of the potential applications of polymer materials, along with nano- and biocomposites, in the creation of materials tailored for specialized and multifunctional purposes. This includes applications in biological settings for in vitro and in vivo experiments, agriculture, catalytic systems, and the integration of "smart polymers" into our daily lives. The active research and implementation of these materials signify essential advancements in diverse fields. Simultaneously, there is an ongoing revisiting of concerns related to the environmental sustainability, disposal methods, and the mitigation of potential adverse impacts on both human health and the environment.

The focus of this International Conference is to commemorate the 90th birth anniversary of Academician Shaikhutdinov E.M. He was a rector of the Kazakh National Research Technical University named after K. I. Satbayev. Academician Shaikhutdinov E.M. made an exceptional contribution to the advancement of polymer chemistry, both in Kazakhstan and internationally.

Academician E.M. Shaikhutdinov is a prominent figure linked to the establishment and progress of a pioneering field of knowledge in Kazakhstan during that era-the science of macromolecular compounds. He established his own scientific lineage, and his successors carry forward the legacy of Academician E.M. Shaikhutdinov. These followers not only uphold the scientific principles of their mentor but also effectively apply his original ideas. They contribute to research, industry, and academia, both domestically and abroad.

We express our gratitude to all conference participants for their willingness to engage and contribute by delivering plenary lectures, oral presentations, and poster sessions. Additionally, we appreciate the submission of valuable and compelling abstracts, which significantly enhance the scientific merit of this event.

CHAIR

MATERIALS ENGINEERING PROBLEMS AT POLYOLEFIN COMPOSITIONS FOR THE PRODUCTION OF HEAT SHRINK TUBES

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This work presents the development of specialised polyolefin compositions for manufacturing heat-shrinkable products by Radpol S.A., which necessitated extensive experimentation to optimise flame-retardant blends while retaining the required mechanical strength. Heat-shrink tubing, which predominantly serves as cable protection, is critical in various applications and must fulfil mechanical, electrical, thermal, chemical, and environmental protection roles. A crucial aspect of heat-shrinkable products is their low flammability, achieved through various flame-retardancy mechanisms, such as heat absorption, radical reaction limitation, and barrier formation.

The experimental process involved compounding on a laboratory-scale extruder and granulator, followed by rigorous testing for oxygen index, smoke index, and toxicity index in an accredited laboratory. Although specific composition details remain proprietary, it is disclosed that the polyolefin blends were designed with a unique combination of flame retardants and other additives to meet stringent requirements.

Significantly, the work references literature where the oxygen index values for similar applications exceeded 34% and draws parallels to the current study's use of melaminotriazine (TRZ), aluminium hydroxide, and bentonite clay to reduce filler content while maintaining suitable properties for electrical cable applications. Balancing aluminium and magnesium hydroxide was crucial to achieving optimal oxygen index and processing parameters.

The resultant polyolefin composition boasted enhanced thermal resistance, resistance to ageing, halogen-free composition, and high flame resistance, fulfilling specific mechanical and flame retardancy benchmarks such as a minimum breaking strength of 7.0 MPa, elongation at break of at least 200%, an oxygen index of a minimum of 32%, and an oxidation induction time of at least 360 minutes.

Post-extrusion, the tubing underwent radiation cross-linking with an electron beam, inducing a three-dimensional network within the material, essential for its shape memory characteristics. The study elaborates on optimising the electron beam irradiation process, highlighting the need for precise energy levels to achieve uniform cross-linking, enhancing the material's shrinkage properties.

This research also delves into the recyclability of the cross-linked material, examining the incorporation of crumb rubber from used car tires into new rubber compounds through a thermomechanical process, showcasing the potential for sustainable end-of-life management of heat-shrinkable products.

In conclusion, this work successfully formulates a new generation of polyolefin-based, flame-retardant heat-shrinkable tubing with improved performance characteristics, and it sets the stage for future research in the recycling of cross-linked polyolefin materials.

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

CIRCULAR ECONOMY: NEW OPPORTUNITIES IN SUSTAINABLE NANO MATERIALS AND POLYMER BIO-NANOCOMPOSITES

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Green chemistry started for the search of benign methods for the development of nanoparticles from nature and their use in the field of antibacterial, antioxidant, and antitumor applications. Bio wastes are eco-friendly starting materials to produce typical nanoparticles with well-defined chemical composition, size, and morphology. Cellulose, starch, chitin and chitosan are the most abundant biopolymers around the world. All are under the polysaccharides family in which cellulose is one of the important structural components of the primary cell wall of green plants. Cellulose nanoparticles (*fibers, crystals and whiskers*) can be extracted from agrowaste resources such as jute, coir, bamboo, pineapple leafs, coir etc. Chitin is the second most abundant biopolymer after cellulose, it is a characteristic component of the cell walls of fungi, the exoskeletons of arthropods and nanoparticles of chitin (*fibers, whiskers*) can be extracted from shrimp and crab shells. Chitosan is the derivative of chitin, prepared by the removal of acetyl group from chitin (*Deacetylation*). Starch nano particles can be extracted from tapioca and potato wastes. These nanoparticles can be converted into smart and functional biomaterials by functionalization through chemical modifications (*esterification, etherification, TEMPO oxidation, carboxylation and hydroxylation etc*) due to presence of large amount of hydroxyl group on the surface. The preparation of these nanoparticles includes both series of chemical as well as mechanical treatments; crushing, grinding, alkali, bleaching and acid treatments. Transmission electron microscopy (*TEM*), scanning electron microscopy (*SEM*) and atomic force microscopy (*AFM*) are used to investigate the morphology of nanoscale biopolymers. Fourier transform infra-red spectroscopy (*FTIR*) and x ray diffraction (*XRD*) are being used to study the functional group changes, crystallographic texture of nanoscale biopolymers respectively. Since large quantities of bio wastes are produced annually, further utilization of cellulose, starch and chitins as functionalized materials is very much desired. The cellulose, starch and chitin nano particles are currently obtained as aqueous suspensions which are used as reinforcing additives for high performance environment-friendly biodegradable polymer materials. These nanocomposites are being used as biomedical composites for drug/gene delivery, nano scaffolds in tissue engineering and cosmetic orthodontics. The reinforcing effect of these nanoparticles results from the formation of a percolating network based on hydrogen bonding forces. The incorporation of these nano particles in several bio-based polymers have been discussed. The role of nano particle dispersion, distribution, interfacial adhesion and orientation on the properties of the ecofriendly bio nanocomposites have been carefully evaluated.

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POLYMERIC ASSISTED GROWTH OF METAL HALIDE PEROVSKITES FOR HIGHLY EFFICIENT LIGHT-EMITTING AND PHOTOVOLTAIC DEVICES

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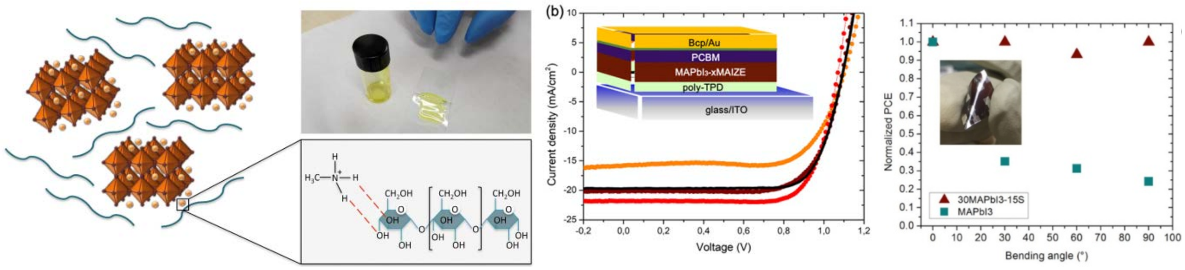
The control over Metal Halide Perovskites (MHPs) formation is a fundamental requirement foreseeing the exploitation of these outstanding, eclectic materials in optoelectronics. MHPs, extensively used in photovoltaics (PV) and light emitting diodes (PeLEDs) are deposited from solution on a target substrate and formed throughout a self-assembly process of their chemical precursors [1]. The resulting polycrystalline film shows often a far from ideal behaviour, due to unsuitable morphology and high defect density, direct consequences of a scarcely controllable assembly. We present here the exploitation of a tailored biopolymer, starch, as beneficial additional component of formamidinium (FA)- and methylammonium (MA)-based tri-iodide perovskite films. We prove how the macromolecule by establishing specific supramolecular interactions with MHPs precursors allows the deposition of an optimal film via single-step deposition method. Noticeably this is a fundamental technological advantage in comparison to standard multistep deposition approaches. Furthermore, it allows a fine tuning of i) solution viscosity (making it compatible with different large area deposition techniques), of ii) perovskite grain size and of iii) film thickness, parameters that all depends to the polymer:perovskite:solvent relative concentrations. Very importantly the presence of the biopolymer is also improving the stability of the polycrystalline film thanks to two fundamental properties. The polymer being an electronic insulator reduce the impact of the internal electric field over OHPs mobile ions; in addition the polymer is also permeable to ions (ionic conductor), thus by buffering those prevent ions migration/segregation across perovskite grains, one of the most important material degradation mechanism under device working conditions. Additionally the polymer confer improved mechanical properties to the final device, and this is a key requisite for flexible optoelectronics.



We validated our approach by embedding these composites in PV and light-emitting PeLED devices. As result we obtained an inverted, planar, low-temperature processed solar cell showing a remarkable 17% efficiency [2] and a highly efficient LED (EQE of ~5%) exhibiting outstanding radiance values above 200 W/sr•m^2 obtained at very high currents (about 1000 mA/cm^2) which are among the highest reported radiances for NIR PeLEDs [3]. We further exploit the possibility to tune the film thickness, so its overall transmittance, to manufacture semi-transparent PV devices, [4] and the superior mechanical properties of these composites to manufacture robust and flexible PV devices [5].

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IMPACT OF BIOBASED FILLERS ON THE PHYSICO-CHEMICAL PROPERTIES OF POLYVINYL ALCOHOL/CHITOSAN NANOCOMPOSITES FOR SUSTAINABLE FOOD PACKAGING

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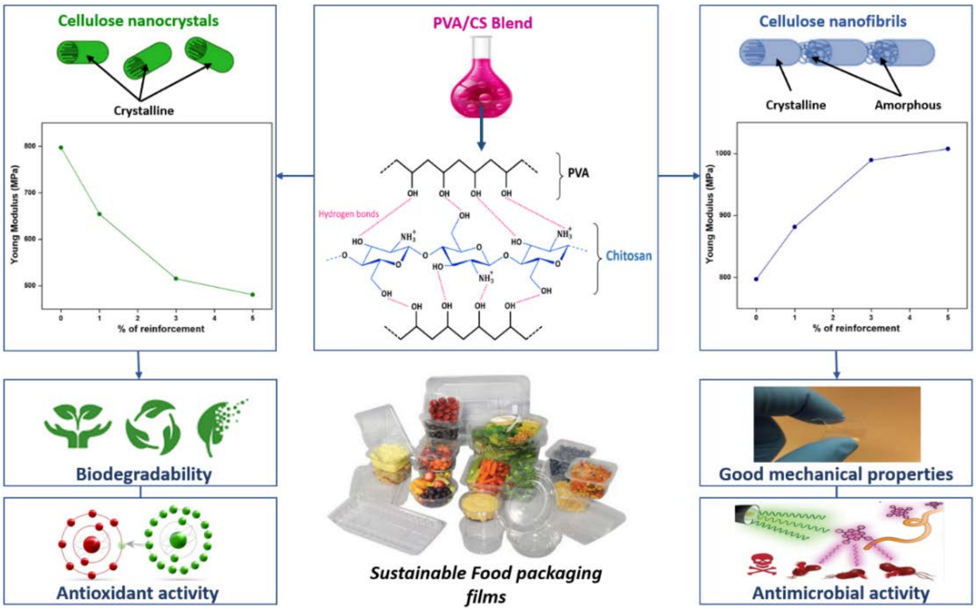
This study investigates the impact of incorporating CNC, CNF and lemon particles in PVA/Chitosan bio-nanocomposites for the development of novel sustainable food packaging materials.

The increasing demand in the food industry for alternatives to synthetic packaging materials has prompted the development of eco-friendly options with enhanced physical and mechanical properties. This study focuses on evaluating the influence of different weight fractions (1 wt%, 3 wt%, and 5 wt%) of Cellulose Nanocrystals (CNC), Cellulose Nanofibrils (CNF), and Lemon Peel (LP) on the morphological, thermal, structural, biodegradable, and mechanical properties of PVA/Chitosan (CS) biocomposites [1-2].

Results from Differential Scanning Calorimetry (DSC) and Fourier-Transform Infrared Spectroscopy (FTIR) reveal a compatibility between PVA and Chitosan, attributed to strong hydrogen bonding interactions, which is further supported by Tensile tests results. The addition of various reinforcements leads to an improvement in biodegradability. Notably, CNF and LP contribute significantly to enhancing the mechanical properties of PVA/CS, while CNC has a detrimental effect due to its aggregation within the PVA/CS matrix. Consequently, PVA/CS/LP composites show promise as effective bio-based packaging materials.



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FABRICATION OF CONTROLLED NANOSTRUCTURES OF CONDUCTING POLYMERS AND THEIR COMPOSITES TO IMPROVE HYDROGEN GAS SENSING

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Hydrogen gas is in high demand in many industries as raw materials and as fuel in transportation due to the clean source of energy. However, H_2 gas is very dangerous to store, transport, and use since it is of explosiveness. In addition, H_2 gas molecules are very light and can readily leak through all sorts of holes. Therefore, detection of H_2 gas at very low concentration is extremely crucial. As usual, Its hydrogen sensitivity is to a large degree determined by the conductivity or electron mobility of the polymers through the interaction between hydrogen gas and polymer molecules. The investigations on polymer structures and morphology are of the highest priority to improve the responsiveness of the materials to hydrogen gas and ensure their efficacy in different environments.

In this study, a novel, and facile assembly approach was developed to construct a relatively quick and sensitive conductive polymer sensor for detecting trace quantities of hydrogen gas in a nitrogen atmosphere. Through chemical polymerization, hybrid thin films of Vanadium pentoxide (V_2O_5) and polypyrrole (PPY) were fabricated to form ordered structure of the composites. Also, the effect of p-Toluenesulfonic acid, a dopant, on structure and property of conducting polymer and vanadium pentoxide composite was investigated through SEM, TEM, and Hall measurement. Dopant effect was proved to improve sensing performance via Hydrogen sensing experiment. These sensors are able to detect minor current changes induced by low-coordinated hydrogen exposure (5-250 ppm) interactions at room temperature and have quick response and recovery times of 42 s and 37 s, correspondingly.

NANOENCAPSULATION USING BIOPOLYMERS, NANO GUARD FOR FERTILIZERS: A NEW WINDOW FOR SAFE AND SUSTAINABLE AGRICULTURE

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Microbeads based on natural polysaccharides is drawing significant attention in various applications. However, its application in fertilizer is limited. In this study, crosslinked microbeads were employed to prepare an environment-responsive release natural fertilizer with sodium alginate and carboxymethyl cellulose. The morphology of the fertilizer encapsulated microbeads was evaluated by scanning electron microscopy. The composition and self-assembly process of the fertilizer were characterized by elemental analysis, Fourier transform infrared (FTIR) spectroscopy, UV-vis 20 absorption spectroscopy, zeta potential analysis, thermal analysis, X-ray photoelectron and XRD analysis. Excellent pH-responsive behaviour was observed by the nutrients release results. In an alkaline 23 medium at room temperature, the nutrient release rate can be clearly accelerated compared with 24 acidic and neutral media. Moreover, pot experiments showed that fertilizer can effectively promote plant growth. The pH-responsive environment-friendly fertilizer can control nutrient release and avoid excessive release of nutrient, showing promising applications in modern green and sustainable agriculture and horticulture.

Figure 1: Shows fertilizer encapsulated microbeads.

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COMPARATIVE ANALYSIS OF THE EFFECT OF POLYMER ADDITIVES ON THE PHYSICAL AND MECHANICAL PROPERTIES OF ASPHALT CONCRETE MIXTURES

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In light of the current problems in the road construction industry related to technological violations during the laying of asphalt concrete mixtures and their negative impact on the physical and mechanical properties of the coating, special attention is paid to the quality of organic binder in asphalt concrete mixtures. In this article we will focus on studying the effect of polymer additives on the compaction of asphalt concrete mixtures.

Problems associated with technological violations during the laying of asphalt concrete not only reduce the durability of the pavement, but can also lead to serious operational problems. Our research focuses on solving these problems through the use of polymer additives that have the potential to increase the compaction of mixtures, hence improve the characteristics of the road surface.

Within the framework of the work, not only the influence of polymer additives on the physical and mechanical properties of asphalt concrete was considered, but also their influence on the stability and durability of the pavement was analyzed. The results obtained can serve as a basis for the development of effective strategies for improving the technology of laying asphalt concrete mixtures and improving the quality of road surfaces in general.

Modern Kazakhstan is facing serious problems in the field of road construction related to the low quality of organic binder. The insufficient quality of bitumen and the limited volume of supplies create difficulties affecting the quality of the road surface and leading to disruptions in the construction of highways.

As part of laboratory studies conducted at «KazdorNII» JSC, a reference sample was prepared in accordance with the standards. This sample was manufactured under laboratory conditions using BND 100/130 bitumen at a load of 160 kN (40 Mpa) and a temperature of 160 °C and subjected to tests followed by determination of the initial density.

In the course of the research, the effect of the use of polymer in the composition of stone-mastic asphalt (SMA) concrete was analyzed, both with and without the addition of polymer. The experiment included a change in the density of the samples, a decrease in the load and a decrease in the temperature of the mixture. Particular attention was paid to the determination of the physical and mechanical properties of the samples, which allows us to draw conclusions about the effect of additives on the characteristics of asphalt concrete mixtures under various operating conditions.

The results obtained can have an important practical application, providing a basis for developing recommendations for improving the quality of road materials and optimizing construction processes under conditions of variable factors.

Keywords: polymer, organic binder, asphalt concrete mixture, physical and mechanical properties.

ENHANCING SOIL MOISTURE RETENTION AND PLANT GROWTH WITH COMPOSITE HYDROGELS

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Recent scientific inquiry has centered around composite hydrogels, amalgamating synthetic and natural polymers. This article delves into the investigation of composite hydrogels, with a specific focus on that incorporating bentonite clay, aiming to assess their efficacy in soil moisture retention. The primary objective of this study is to systematically evaluate the practical application of composite hydrogels, particularly those founded on synthetic and biopolymers, in the context of soil moisture retention. Additionally, the research seeks to quantify the impact of these hydrogels on soil structure, plant biomass, and the development of root systems. The study rigorously investigates interpenetrating networks (IPNs) derived from agar-agar, both individually and in conjunction with bentonite clay. A comprehensive analysis of the water retention capabilities of these hydrogels is conducted to ascertain their effectiveness in augmenting soil moisture content. Furthermore, the study systematically compares the performance of these hydrogels concerning the influence on plant biomass and root system development. Furthermore, the introduction of hydrogels into the soil positively influenced biomass increase and the development of plant root systems. The soil structure experienced tangible improvements, characterized by increased volume and porosity. This study underscores the considerable potential of composite hydrogels, especially those incorporating bentonite clay, as efficacious agents for enhancing water retention in soil. These findings contribute meaningfully to the ongoing exploration of innovative solutions for sustainable agriculture and environmental stewardship. Subsequent research and practical applications of these composite hydrogels hold promise for addressing water scarcity and optimizing crop productivity.

Keywords: polymer hydrogels, interpenetrating networks, water-holding capacity, soil, plants.

SYNTHESIS AND POTENTIAL USE OF CRYOGELS WITH METAL NANOPARTICLES

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Hospitals are extensively employing chloroderivatives (such as chlorohexidine, triclosan, and triclocarban) as effective antiseptic and disinfectant agents, resulting in the heavy contamination of hospital wastewater with antimicrobial agents. Additionally, silver nanoparticles (AgNPs), gold nanoparticles (AuNPs), quantum dots, and other metal and metal oxide nano- and microparticles may be utilized for diagnostic purposes in medicine. Unfortunately, these hazardous wastes often reach aquatic environments, causing serious damage.

On the other hand, it is well-known that various metal nanoparticles exhibit high catalytic activity. However, there are challenges related to aggregative stability and the purification process. Numerous examples exist of the usage of immobilized metal nanoparticles (MeNPs) for catalysis. We have developed an advanced two-step preparation method for cryogels containing well-distributed immobilized gold (Au), palladium (Pd), and silver (Ag) complexes, or Pd (or AgNPs, AuNPs). These cryogels can be utilized for catalytic dechlorination under mild conditions without the need for expensive and hazardous borohydride.

Moreover, the catalytic activity of immobilized noble metal particles for the reduction of nitrophenol was evaluated. Ionically cross-linked cryogels were prepared, and their physicochemical properties were investigated. For the effective degradation of chlorinated aromatic compounds catalyzed by PdNPs, a 50-fold excess of formic acid is required. The catalytic reaction was performed in a 20 mM solution of formic acid at pH 3, with 0.4 mM 2-chlorophenol dissolved in formic acid added to the cryogel CHI-GA-PdNPs (0.2 mM). HPLC analysis was applied to study the kinetics of the catalytic degradation process. The degradation of chlorophenol reached 50% within one hour, after which there was a slight decline in catalyst activity, possibly related to chloride ion accumulation.

Turnover number and turnover frequency parameters for cryogels containing four different concentrations of gold nanoparticles were calculated. The conversion degree of 4-nitrophenol for the cryogel containing the lowest concentration of gold nanoparticles reached 96.8% at room temperature. The catalytic activity of incorporated gold nanoparticles for 4-nitrophenol conversion did not decline over 14 consecutive testing cycles. From a practical standpoint, the current challenge involves optimizing the nitrogroup reduction parameters for the synthesis of novel benzyliden hydrazide derivatives in the presence of supported AgNPs in cryogels, which may result in novel drug discovery.

In conclusion, this ongoing research raises several fundamental questions regarding the mechanism of catalytic reduction reactions and the stability of the catalyst. Cryogels with MeNPs have the potential to address issues related to toxic chlorinated reagents, decomposition, and efficient water treatment for toxic contaminants, including MeNPs and heavy metal ions.

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Keywords: AgNPs, PdNPs, AuNPs, nitrophenol, novel drugs, chlorophenols.

RHEOLOGICAL FEATURES OF SOME PHYSICALLY AND IONICALLY CROSSLINKED POLYMER HYDROGELS LOADED WITH DOXYCYCLINE AND HOW THEY INFLUENCE DRUG-RELEASE BEHAVIOR

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Polymer hydrogels as temporary depot for a wide variety of active therapeutic compounds have received growing attention during last decade in investigating them as drug-delivery and drug-release systems. This study deals with three different polymer hydrogels loaded with a broad-spectrum antibiotic (Doxycycline Hyclate), namely Pluronic F127 (a symmetric triblock copolymer: poly(ethylene oxide)-*b*-poly(propylene oxide)-*b*-poly(ethylene oxide)) and PVA (poly(vinyl alcohol)) – based hydrogels (physically crosslinked) and calcium alginate – based hydrogels (ionically crosslinked). Based on and strongly related to their rheological characteristics revealed by oscillatory rheometry, Doxycycline release from these hydrogels into an aqueous PBS solution at 37^{0}C (to mimic both pH and ionic strength of extracellular fluids of mammalian and human body under physiological conditions) was assessed and rationally analyzed in terms of Fickian and non-Fickian diffusion.

Keywords: dynamic rheology, polymer hydrogels, drug-release

PRODUCTION OF POLYLACTIDE NANOPARTICLES IMMOBILISED WITH ISONIAZID AND VITAMIN C

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Nowadays, the method of directed transport of drugs is becoming increasingly important in medicine and pharmacology. It allows increasing the concentration of delivered substances in a certain place and blocking or severely limiting their accumulation in healthy organs and tissues. One of the promising drug carriers used in the development of controlled drug delivery systems is polylactic acid (PLA). We were interested in using biodegradable polymeric nanoparticles (NPs) for immobilization with isoniazid (INH) and vitamin C (VC). Which will have sustained action, targeted delivery, high efficacy and low toxicity. This will help to expand the use of these simple drugs for the rapid treatment of multidrug-resistant forms of tuberculosis. Thus, in this work, PLA-INH-VC NPs were prepared by double emulsion method where several factors affecting particle size were investigated: polymer to drug ratio, organic to aqueous phase ratio, surfactant concentration, and homogenization time. Stable nanoparticles were produced at drug/polymer ratio of 1/1, PVA concentration of 0.5%, organic to aqueous phase ratio of 1/5, homogenization time of 15 minutes with minimum average particle size of 445.3±5.3 nm, particle distribution of 0.208±0.02 and maximum percentage of drug and vitamin C encapsulation efficiency i.e. 72% and 83% respectively. TGA/DSC and IR spectroscopy studies identified molecularly dispersed drug (isoniazid and vitamin C) in polylactide nanoparticles. Vitamin C was found to reduce the degradation of the polymer and thus prolonged the release of the drug from the polymer matrix. PLA-INH-VC nanoparticles were analysed for mycobacterial activity and the nanoparticles were found to inhibit the growth of isoniazid-resistant mycobacteria.

Keywords: nanoparticles, polylactic acid, multidrug-resistant tuberculosis, antituberculosis drug

SUSTAINABLE AND FIRE-SAFE POLYMERS AND COMPOSITES

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The quest for sustainable and fire-safe polymers and composites has become increasingly pivotal in materials science. This keynote gives the background of flame retardant technologies and emerging opportunities and challenges in the field. As the demand for eco-friendly materials rises, a critical focus on flame retardancy properties has emerged as a key facor for innovation. This exploration traverses the evolution from conventional flame retardant methodologies to sustainable solution approaches. This keynote underscores the need for a paradigm shift in the design and synthesis of polymers and composites, emphasizing the importance of both efficacy in fire suppression and adherence to sustainable principles. The keynote aims to illuminate the ongoing research landscape, fostering a deeper understanding of the opportunities and challenges that shape the future of flame-retardant polymers and composites.

Keywords: Fire retardancy; Sustainable Flame Retardants; Fire; Flame Retardant Polymers and Composites

ADVANCED NANOCOMPOSITE COATING BASED ON FUNCTIONALIZED HEXAGONAL BORON NITRIDE

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Nanocomposite-based coatings provide excellent performance in many applications. In this presentation, we discuss the development of advanced coatings for i) coating high-voltage insulators and ii) corrosion protection of steel in seawater based on nanocomposites of silicon rubber and epoxy with hexagonal boron nitride (hBN), hBN nanosheets (hBNNS), and hBNNS functionalized with perfluorooctyl-triethoxysilane (hBNNS- FTS). Efficient coating of high voltage insulation, composites/nanocomposites of Silicon Rubber (SiR) with hBN, hBNNS, or hBNNS-FTS were synthesized by solution mixing of PDMS, PDMS crosslinker and the filler in chloroform. The composite/nanocomposites were coated on ceramic plate and cured at room temperature. The impact of filler type and loading on the coating hydrophobicity, mechanical properties and thermal stability were investigated. Moreover, the suitability of the developed coatings for high voltage insulation were examined using the standard inclined plane test (IPT) at 4.5 kV for 6 hours under continuous flow of contaminants and observing the resulted tracking and erosion. The results revealed that coatings based on hBNNS-FTS provide best surface hydrophobicity, mechanical properties, and thermal stability. Moreover, Sir/HBNNS-FTS coatings have passed the IPT test requirements at 0.5 wt.% loading, which is 10 times lower than that of SiR/hBN and SiR/HBNNS coatings.

On the other hand, nanocomposites of epoxy (EP) and hBN, hBNNS, and hBNNS-FTS were fabricated, applied on the surface of steel sheets, and cured at 70° C. The coatings were characterized and electrochemically tested in seawater environment. The coating hydrophobicity has significantly improved by incorporation of the hBN fillers, as indicated by the increase in the water contact angle from 76 to 98.7° for the EP/hBNNS-FTS nanocomposite coating. Moreover, after 90 days of immersion in 3.5% NaCl, the impedance modulus of the EP/hBNNS-FTS nanocomposite coatings containing 0.25 wt.% hBNNS-FTS was 7.96 GΩ.cm^2. Moreover, failure of the of pure epoxy was observed after 28 days of immersion of the coated steel substrate in 3.5% NaCl, while no sign of failure was observed after 90 days of immersion of the steel substrate coated with EP/hBNNS-FTS nanocomposite coating.

Our results indicate that proper functionalization of 2-D nanomaterials is efficient route to develop high performance coatings for various applications.

HYBRID SUPERCAPACITORS IN AQUEOUS ELECTROLYTES: A SUSTAINABLE *GREEN* TECHNOLOGY

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Supercapacitors also widely known as electrochemical capacitors are the perfect solution for peak power shaving as they deliver heavy bursts of energy and quickly store energy that is otherwise lost such as in grid-scale storage devices, stop/start systems, tramways and electric buses.1 Water-based supercapacitors can serve this purpose at low cost per kWh while being environment-friendly. In industrial supercapacitors, nanoporous carbon is a most common electrode material, which store charge at a layer of nanometric thickness, also called electric double layer (EDL). According to the formula for energy, E = ½ CU2, where C is capacitance and U is voltage, organic electrolytes (e.g., tetraethylammonium tetrafluoroborate in acetonitrile are generally preferred, as they enable to reach voltage values as high as 2.7 – 2.85 V.2 However, due to moisture sensitive and extensive drying of carbon electrodes, cost of these devices is very high.

By contrast, aqueous electrolyte are eco-friendly, low cost and device assembling is very easy (devices can be assembled in open air). Recently, we introduced a hybrid supercapacitor concept in aqueous electrolyte where relatively low voltage values are compensated by enhancing capacitance, in order to reach the energy performance of supercapacitors in organic electrolytes. Thanks to the hybridization of battery-like and capacitor-like electrodes in a single device, hybrid supercapacitors that use carbon electrodes and aqueous iodide-based electrolyte offer higher capacitance than their symmetric counterparts. Moreover, their electrical characteristics are similar to an EDLC (e.g., linear galvanostatic charge/discharge, rectangular cyclic voltammogram, low time constant).

The hybrid supercapacitor in aqueous sodium iodide electrolyte exhibits charge/discharge signature of a true supercapacitor with 100% coulombic efficiency, 92.5% energy efficiency, and a discharge capacity of 83.5 mAh g-1 at a charge capacity of 84.3 mAh g-1. At a power of 3.0 kW kg-1, the energy of the hybrid capacitor reaches 11.6 Wh kg-1 as compared to 12.1 Wh kg-1 for the symmetric cell with the same activated carbon in organic electrolyte. Hence, hybrid supercapacitors implementing “green” aqueous electrolytes perform comparably to classical supercapacitors in organic electrolyte, while being environmentally friendly, more secure and cost effective.3-4

This presentation will include results from fundamental investigations of carbon/iodine interface by using in-situ Raman spectroscopy5 and electrochemical quartz-crystal microbalance measurements. Further, mitigation strategies will be presented to suppress polyiodides evolution and enhance the cycle-life of these supercapacitors by using water-in-salt electrolytes.

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FABRICATION OF NANOFILTRATION MEMBRANE THROUGH THIN FILM NANOFIBER COMPOSITES FOR ION SEPARATION

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Nanofiltration is one of the newest separation processes that has been noticed due to its lower energy consumption and higher flux. In the conducted research, a membrane was synthesized that showed an acceptable value in terms of ion separation. Considering that the use of smart water is one of the methods of enhancing oil recovery from oil reservoirs, therefore, this research can be used in the discussion of smart water production by membrane method.

In this research, a three-layer thin film nanofiber composite membrane (TFNC) was made by electrospinning method. The first layer was a mesh-shaped polyester and the middle layer was a 2-layer electrospun substrate consisting of hydrophobic polysulfone with two concentrations of 25 and 20% by weight. The third layer is a polyamide layer that was made by interfacial polymerization between piperazine monomers with a concentration of 2% by weight and trimesoyl chloride monomers with a concentration of 0.2% by weight. Characterization of polyamide layer and polysulfone fibers was investigated by infrared spectroscopy (FTIR), scanning electron microscope (SEM), surface roughness (AFM), contact angle, and separation of $MgSO_4$ and NaCl ions. Based on the FTIR test, peaks of 1618 and 2990 cm^{-1} were observed, which indicate the presence of polyamide layer and polysulfone substrate, respectively. FTIR results showed that the polyamide layer was well coated on the membrane surface. The diameter of fibers in 25% and 20% polymer was measured using SEM images, which are 0.90 ± 0.45 and 0.31 ± 0.12 micrometers, respectively. Regarding the AFM test, the formation of a thin polyamide layer on the surface of the nanofibers can reduce the average surface roughness from 592.80 to 102,60 nm. The contact angle test was performed on the surface of the synthesized membrane and based on this test the contact angle was calculated to be 125°. The salt separation test was performed by passing two brines through the membrane. During this test, 68.66 ± 16.85% separation for the $MgSO_4$ bivalent salt and 39.34 ± 2.05% separation for the monovalent NaCl salt was obtained.

Keywords: Membrane, Nanofiltration, Electrospinning, Nanofibers, Interfacial polymerization, Divalent ion separation

FINDING WAYS TO OBTAIN PESTICIDES FROM NATURAL OBJECTS: FROM PLANTS AND MICROFLORA

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Nowadays, due to the depletion of agricultural land resources, it becomes necessary to develop organic farming. Organic farming is a method of farming that excludes the use of pesticides, herbicides, chemical fertilizers, synthetic plant growth regulators, and genetically modified seed material. Organic agriculture has a positive impact on natural resources and helps maintain interaction processes within the agro-ecosystem, which is vital for both agricultural production and nature conservation. To fertilize the soil and protect plants from diseases and pests, only organic biofertilizers and biological products are used. In our laboratory, work is carried out related to the production of biological products based on I) plant raw materials and II) microflora isolated from natural objects of the Kyrgyz Republic. I) To solve this problem, plants are studied from two positions: A) the use of plant extracts for the synthesis of metal nanoparticles, in particular, silver nanoparticles (SNPs). It is well known that plant extracts containing SNPs exhibit antibacterial, fungicidal and a number of other biological activities that are currently in demand. We have carried out the syntheses of SNPs in extracts of *Artemisia absinthium*, *Artemisia absinthium*, *Taraxacum*, *Arctium*, *Plantágo*, *Armoráciarusticána*, *Brassicanápus*, *Tanacétum vulgáre*, *Chenopódium album*. As a result of a comparative test of pure extracts and extracts containing SNPs, the latter showed more pronounced fungistatic and bacteriostatic properties. The most effective among them was found to be *Taraxacum*+SNP extract, which showed aninhibition area of 30 mm against *Candida albicans*. The synthesis of SNPs in plant extracts has a number of advantages compared to chemical and physical methods: 1) environmental friendliness - do not contain toxic substances used in chemical reduction; 2) cost-effectiveness - there is no need to create special installations; plants are annually renewable raw materials; waste can be used; 3) there is no need for reducing agents and stabilizers of nanoparticles - these roles areper formed by primary and secondary plant metabolites; 4) it is possible to obtain a wide range of NPs, depending on the plant; 5) it is possible to obtain NPs on an industrial scale. B) Extracts obtained from plant waste – leaves and stems of Solanum tuberosum, leaves and stems of Solánum lycopérsicum have also been studied. An aqueous extract ZH-2 has been obtained, which exhibits a growth-stimulating effect that is superior in its effect of the well-known commercial biological products *Fitosporin* and *Trichoderma veride* on seed germination, growth and development of tomato seedlings. II) Isolates of the genus *Trichoderma* that are most active against pathogens of fusarium blight in vegetables (potatoes, etc.) have been isolated from natural objects. Work is underway to determine the ability of the obtained *Trichoderma* isolates to destroy cellulose and grow on natural substrates. Exploratory research is being conducted to obtain bacterial preparations (based on antagonisticbacteria) with a wide spectrum of action (fungicides, bactericides, etc.). A microflora isolate (M1) has been isolated, which may become the basis for a new biopesticide. The development of effective biological products based on natural objects is environmentally friendly and economically profitable. Their introduction into practice will make a significant contribution to the development of organic farming in the Kyrgyz Republic.

Keywords: *silver nanoparticles, plant extracts, biopesticides, effective microflora, green synthesis, organic farming*

UNSATURATED POLYESTER RESIN MODIFIED WITH CASEIN

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Casein is the most important protein component of milk. It is available as a white to yellowish, slightly hygroscopic powder, soluble in water and alkali. It is one of the oldest natural biodegradable polymers.

About 83% of milk protein is casein, it is not a uniform substance according to recent studies, but a mixture of αS1 and αS2-casein (forms insoluble calcium salts), β-casein (insoluble in Ca salt), γ-casein (insoluble in Ca salt), κ-casein and 5% soluble Ca salt. About 3% of casein is present in a colloidal, milky, opalescent solution. A small part of the population is allergic to casein. Casein intolerance, also known as "milk protein intolerance".

The study examined the chemical resistance of biocomposites containing various amounts of casein. The motivation to undertake this research was to learn about the functional properties of composites exposed to unfavourable environmental conditions, such as water, acids or bases, acetone and toluene. The influence of solvents on the structure, thermal and thermomechanical properties and texture of pure resin and its materials with the addition of casein was investigated. In order to test their degradation, the biocomposites were exposed to solar radiation (accelerated aging chamber), various types of solvents (immersion test), microwaves (microwave reactor) and high temperature (thermogravimetric analysis).

The influence of biopolymer modification on the mechanical, thermomechanical and thermal properties of the obtained materials, as well as changes in their structure, properties and appearance (morphology) was observed. After immersion in solvents, a significant increase in weight and deterioration of gloss and (thermo)mechanical properties were noticed.

Keywords: casein, unsaturated polyester resin, biopolymer, biocomposite

MORPHOLOGICAL, MECHANICAL, AND BARRIER PROPERTIES OF POLYMER COMPOSITES AND NANOCOMPOSITES FOR DIVERSE APPLICATIONS

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The synergistic combination of materials with distinct properties paves the way for the creation of novel materials with exceptional characteristics. These materials exhibit heightened strength and unique attributes while maintaining reduced density, illustrating the extensive potential of employing cutting-edge technologies in composite synthesis. The art of crafting intelligent and profitable materials through the manipulation of diverse parameters and material blends underscores the immense scope for advancement in this field. The advent of nanotechnology has further catalyzed a tenfold increase in research and development.This presentation focuses on the properties and applications of diverse polymer-based composites. Specifically, it encompasses natural rubber/nitrile rubber blend nanocomposites, date palm fiber-reinforced foam composites, and bio-composites derived from natural fibers, including nanocellulose-based composites. Various characterization techniques, such as transmission electron microscopy (TEM), scanning electron microscopy (SEM), X-ray diffraction analysis, and the assessment of mechanical properties, stress relaxation, thermo-mechanical characteristics through dynamic mechanical analysis, thermal conductivity, and barrier properties, are employed to elucidate the distinctive attributes of these composites and nanocomposites.Our findings highlight the significant role of various fillers in acting as compatibilizers and reinforcing agents, contributing to the enhancement of long-term mechanical performance and barrier capabilities in these composite materials.

Key words: polymer, composites, nanocomposites, blends, nanocellulose

STUDY OF A COMPOSITE POLYMER MATERIAL BASED ON SPECIAL-PURPOSE RUBBER FOR THE PRODUCTION OF PRODUCTS USED IN AN AGRESSIVE MEDIUM

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The modern market demonstrates a wide variety and an ever-growing range of polymer materials and products made from them. In a number of the most innovative industries, primarily in the automotive industry, composite materials based on large-tonnage polymers have come to the fore, due to their high competitiveness in the world market. Polymers occupy one of the leading places among structural materials for mechanical engineering. The expediency of using thermoplastics based on composite polymers in mechanical engineering is determined, first of all, by the possibility of recycling while preserving the original properties. In world practice, the most common universal composite materials are currently thermoplastics based on high-molecular rubbers and thermoplastics. This class of polymer mixtures is capable of simultaneously exhibiting the properties of both thermoplastics and elastomers. The best way to obtain composites containing vulcanized elastomer particles in the melt of a thermoplastic matrix is the method of dynamic vulcanization, and vulcanizates obtained in this way are called dynamically vulcanized thermoplastics (TDV) or thermoplastic vulcanizates (TPV).

Today TPVs based on polypropylene or polyethylene with olefin rubber are most distributed, however such combination is not able to solve the problem of resistance to aggressive environments. One of the main ways to reduce the degree of swelling in the presence of solvents and other aggressive media is the combination of polar elastomers with thermoplastics. When using only nitrile-butadiene rubber (as an elastomeric phase) in combination with ABS plastic, it is impossible to achieve a satisfactory level of oil and gas resistance. When developing the formulation of the TPV mixture, it was decided to use a more polar rubber, such as chloroprene. Due to the high polarity, mixtures of chloroprene and butadiene-nitrile rubber have a good. A sulfur-resin system was used as a vulcanizing agent for dynamic vulcanization in a high–speed batch mixer of the Brabender company. The process of dynamic vulcanization was observed by changing the torque on the mixer shaft. Changing the content of polychloroprene and butadiene-nitrile rubber to 50/50 ratios gives the compositions high elastic-strength properties, such as: conditional tensile strength, relative and residual elongation. The test of the developed TPV based on a mixture of two polar rubbers using thermoplastics (copolymer of acrylonitrile with butadiene and styrene), using 3 mass parts of a sulfur-resin vulcanizing group for resistance to swelling was carried out in such aggressive environments as: motor and hydraulic oil, SGR-1 at room temperature. Exposure of samples in the above media for 14 days showed a satisfactory level of resistance to these media. Thus, the developed TPV based on mixtures of nitrile-butadiene NBR-28AMN and chloroprene rubbers SN23 in combination with thermoplastics such as ABS-plastic 0646 can be recommended for use in the manufacture of rubber products in direct contact with automotive lubricants.

CROSS-LINKED POLYETHYLENE BASED BINARY AND TERNARY NANOCOMPOSITES: MICROSTRUCTURE, MECHANICAL & WATER RESISTANCE CHARACTERISTICS

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In the present study cross-lined polyethylene nanocomposites were synthesized, encompassing binary systems such as XLPE-Al_2O_3, XLPE-clay, and XLPE-TiO_2, as well as ternary compositions of XLPE-Al_2O_3-clay and XLPE-Al_2O_3-TiO_2, all in a 1:1 ratio. The investigation sought to characterize these composites with a particular emphasis on mechanical properties and contact angle studies. The addition of nanofillers significantly enhanced the mechanical properties of the binary system compared to neat XLPE. Moreover, a noteworthy finding was the substantial increase in tensile strength (100%) and Young's modulus (208%) in the ternary hybrid composite of Al_2O_3 and clay, indicating synergistic effect and filler networks associated with self-assembly in ternary system. The study also delved into the contact angle behaviour, revealing improved hydrophobicity in nanocomposites as opposed to neat XLPE. The research not only contributes to the understanding of nanocomposite optimization but also sheds light on the microstructure development in ternary system of nanocomposite.

Key words: Polymer nanocomposites, Cross-linked polyethylene, Ternary nanocomposites

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USE OF VARIOUS SYNTHETIC POLYMERS IN THE TEXTILE INDUSTRY AND THEIR ADVANCEMENTS

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A large variety of synthetic fibres are used in textile production use namely polyester, polyamide or nylons, polyacrylic, polypropylene, polyurethane etc. The advantage of the synthetic fibre is that they can be widely modified to match the specific requirements of the end-uses. The three most important synthetic fibers are polyester (55%), nylon (5%), and acrylic (2%), the percentages are being in respect of total fibre production. Polyester microfibers provide soft feel like natural silk. Polyester can also be made hydrophilic and comfortable by suitable modifications e.g. incorporation of third or fourth components during polymerisation, addition of certain additives in polymer melt before extrusion, making hollow or of varied profile (e.g.trilobal) cross-section during melt spinning, surface modification by laser etc. Normal polyester fibres are difficult to dye. A number of modified polyesters are now available. Deep dyeable polyester (DD-PET) can be made by using 5-10 mol %, aliphatic dicarboxylic acid such as glutaric or adipic acid. Poly (ester-ether) fibres: polyester copolymer fibers made form a mixture of ethylene glycol, diethylene glycol and dimethyl terephthalate showed improved dyeability. Physical Modification of polyester can also be made by air texturising and draw texturing of partially oriented yarn (POY). Carrier-free dyeable polyester (CFDP) is produced by adding certain additives such as polyethylene glycol (PEG), adipic acid azillic acid which form block copolymers with polyester. Cationic dyeable polyester (CD-PET) is prepared by copolymerization with an isophthalic acid component containing a sulfonic acid group.

Nylon 6 and nylon 6,6 are two commonly used types of polyamide fibres. They have a compact molecular structure exhibiting excellent abrasion resistance. Nylon is popular for its strength, lustre, elasticity and resistance to damage by oil and chemicals. Aramid or aromatic polyamide fibres such as meta and para-substituted benzene dicarboxylic acid chlorides (Nomex and Kevlar respectively) are extremely strong and stiff. They possess very high thermal stability and flame resistance. The acrylic fibres include acrylic, modacrylic and other vinyl fibres containing cyanide groups as side chains. The fibres containing more than 85% and less than 85% acrylonitrile are known as acrylic, and modacrylic fibres, respectively. The remaining components or the comonomers used in the polymerisation are methyl methacrylate, vinyl acetate or vinyl pyridine. Acrylic fibres have found a wide spectrum of use where soft, wool-like characteristics are desired. Polypropylene is one of the most versatile polymers produced commercially, with applications both as a plastic and fibre. It is a thermoplastic polymer which is translucent and possesses good chemical and heat resistance. Spandex (e.g. Lycra®) is a synthetic fabric made of polyurethane with high elasticity (400% stretchable); This fabric is the most popular choice for clothing of high flexibility like sports apparel, swimwear, etc. Smart polymeric materials respond with a considerable change in their properties to small changes in their environment. Environmental stimuli include temperature, pH, chemicals, and light. Smart textiles can be made by grafting the copolymerization of environment-responsive polymers (ERP) (e.g. poly (N-isopropyl acrylamide) onto the surface of fabrics. Polymer based textile composites have gained much attention in recent years and gradually transformed the growth of industries especially automobiles, construction, aerospace and composites. Biopolymers have gained significant attention in the textile industry due to their potential to contribute to sustainability and to reduce environmental impact. The biopolymers, on the other hand, offers the advantage of being derived from renewable resources such as corn, sugar, starch, and other bio-based materials. Biodegradable polymers have also gained interest for biomedical applications. An aliphatic polyester is a long-chain polymer that consists of repeating ester groups. It is considered a biodegradable molecule because bacteria and other living organisms can decompose its structure. Aliphatic polyesters such as Polylactic acid (PLA) are biodegradable polymers.

Keywords: Textile fibres, polyester and other synthetic fibres, easy dyeable polyesters, biopolymers. flame retardant polymers

INULIN – BIOPOLYMER

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Currently, 30% of medicinal plants are produced. In the countries of the world, due to the deterioration of the ecological situation, the growth of oncological diseases, various optimal conditions methods for the separation and production of promising medicinal preparations from natural plants are being sought. Such a natural compound can be obtained as a biopolymer - inulin. Inulin is the primary product of fructose synthesis, which is needed daily in agriculture and medicine. Inulin is isolated from plants of the complex flower family (artichoke, dahlia, spratsy, andyz, camellia, etc.). There is little data on the distribution, composition, and structure of inulin in the scientific literature. This determines the relevance of further development of research in the field of organic chemistry and chemistry of natural compounds. However, it can be said with confidence that the possibilities of these carbohydrates, which play an important role in human life, are not fully revealed.

Inulin obtained from the above-ground and underground parts of plants of the family Asteraceae was isolated by extraction methods. Chloroform was used as an extractant to purify the mixture. Inulin yield: the inulin content of the stem was high, about 3.8%, the inulin content of the leaf was about 6.8%, the inulin content of the fruit was 17%, and the inulin content of the flower was 15%. As a result of the research, the optimal conditions for the isolation of inulin were determined, and the composition, structure, and molecular mass of the obtained inulin were studied by modern physico-chemical methods (IR-, UV-spectroscopy, electron microscope, NMR 1H, 13C).

Keywords: asteraceae, inudin, natural polymer, carbohydrate.

OBTAINING TECHNOLOGY, PROPERTIES OF HIGH-VOLTAGE PORCELAIN CERAMICS BASED ON LOCAL RAW MATERIALS AND FORMATION OF GLAZES

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In recent years, the Kyrgyz Republic (KR) has witnessed a rapid surge in the construction of hydroelectric power stations (HPSs), small hydroelectric power stations, renewable energy sources, and power lines. This robust development of the energy infrastructure in the Kyrgyz Republic is anticipated to result in an increased demand for various electrical products in the near future. Presently, the entirety of electrical insulators used in the Kyrgyz Republic's energy sector, including high-voltage porcelain ceramics (HPC), is imported from overseas. The energy sector of the Kyrgyz Republic annually invests substantial sums in procuring dielectric products. The creation of domestic electrical products using local mineral raw materials from Kyrgyz deposits holds significant relevance and timeliness.

The presentation will cover and analyze several aspects related to the formulation of ceramic compositions and the technology for manufacturing high-voltage porcelain ceramics (HPC) using specific local raw materials. Specifically, the following key points will be addressed: identification of optimal component compositions for ceramic masses derived from mineral resources within the deposits of the Kyrgyz Republic; determination of quantitative relationships among components in the HPC ceramic mass; detailed exploration of grinding, molding, and firing temperature regimes for the formulated HPC ceramic masses; investigation into the nuances of microstructure formation and operational properties (such as mechanical strength and electrical breakdown strength) of HPC derived from local raw materials, in accordance with state standard regulatory standards; development of various glaze compositions and a study on the glaze formation on the surface of HPC shards based on local raw materials post-firing.

Experiments with glazes, comprising a blend of components sourced from local materials and imports (Russia, Ukraine), revealed that incorporating imported zirconium concentrate results in well-formed glazes on the surface of a HPC shard after firing at 1300°C. These glazes exhibit excellent adhesion to the HPC shard while presenting a smooth and glossy surface, making them the most optimal choice for HPC based on mineral raw materials from deposits in the Kyrgyz Republic.

Key words: high - voltage porcelain ceramics, glaze, firing, microstructure.

NANO REVOLUTION IN DRILLING FLUIDS: A COMPREHENSIVE REVIEW OF NANOPARTICLE APPLICATIONS FOR ENHANCED PERFORMANCE

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Enhanced technologies for drilling and extracting hydrocarbons from unconventional sources, such as shale gas, shale oil, deepwater, and arctic reservoirs, are essential in today's oil and gas industry. Additionally, the imperative need to reduce the environmental impact of oil recovery processes cannot be overstated. Nanotechnology has emerged as a promising solution to address these challenges, offering potential benefits to various aspects of the industry.Numerous research studies have been undertaken to explore the possibilities of improving drilling fluids through the integration of nanotechnology. These investigations have focused on modifying the rheological, filtration, heat transfer properties, and reducing friction in drilling fluids. They have demonstrated that nanoparticles can enhance the thermal stability of fluids, provide superior lubricity, improve hole cleaning, ensure wellbore stability, and effectively manage hydrate formation within the fluid circulation system.

This article aims to comprehensively analyze the results of these studies and the advancements observed in the application of nanoparticles in drilling fluids. By offering a detailed overview and comparison of recent developments in the intersection of drilling fluids and nanotechnology, this review equips researchers with valuable insights into this evolving field.

Keywords: Drilling fluids, Nanoparticles, Filtration, Friction reduction, Rheological properties

ENHANCING FILTRATION EFFICIENCY AND HEAVY METAL REMOVAL THROUGH SLOW FILTRATION USING ZEOLITE-BASED MATERIALS

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Rural regions, frequently situated far from centralized water distribution systems, are encountering growing challenges in obtaining clean water. This is primarily attributed to inadequate regulation of agricultural waste and overall contamination, the absence or deterioration of water supply infrastructure, improper use of water resources, the impact of climate change, and the prevalence of diseases.

Chemical alternatives such as natural zeolite or clinoptilolite can be selected depending on their suitability for a specific purpose. As the test begins, effects such as inlet and outlet quality, flow rate, pressure difference, and filtration efficiency must be carefully controlled and, in addition, that zeolite is compared to sand filters, a parallel test using sand as the filter medium for analysis should be carried out.

The collected data will help monitor the performance of the zeolite filtration system can find out how effective it is at removing pollutions as ions from water through rigorous research. If necessary, adjust improve system performance based on your findings. Safety and regulatory compliance should be paramount during use, especially when working with water treatment systems. During the investigative study pertaining to the filtration properties of zeolite, both natural and modified zeolite materials were employed. The research encompassed an examination of filtration characteristics with respect to parameters such as turbidity, variations in pH (hydrogen ion concentration), and the presence of various metal ions and macronutrients. The findings revealed that the filtration efficiency of the system exceeded 95% when employing modified zeolite and exceeded 90% when utilizing untreated natural zeolite. Additionally, a notable reduction in the concentration of heavy metal ions, including copper (Cu^{2+}), iron (Fe^{2+}), nickel (Ni^{2+}), and cobalt (Co^{2+}), was observed.

Keywords: slow filtration, water treatment, zeolite.

DEVELOPMENT OF CONCENTRATION TECHNIQUE DURING ATOMIC-ABSORPTION DETERMINATION OF Cu (II) IN NATURAL AND INDUSTRIAL WASTE WATERS

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In Uzbekistan’s metallurgical enterprises that extract metals from polymetallic ores, the problem of wastewater treatment is associated with the presence of toxic elements ions, such as cadmium, lead, copper, zinc, nickel, iron, etc. In recent years, along with traditional sorbents, environmentally friendly solid-phase extraction (TVEKS) has been widely used to isolate and determine heavy metals. The effectiveness of such sorbents in the concentration of elements most depends on the nature of the group fixed on the surface. Styrene-divinylbenzene copolymer, activated carbon, crosslinked chitosan, carbon nanofibers, chelating resin, etc. are often used as the solid phase.

In this work, we developed a method for determining copper on an artificial mixture containing Cu^{2+}, Ni^{2+}, Zn^{2+}, $Cd^{2+\cdot}$ ions. The mixture was obtained by mixing the initial solutions, so that the concentration of each of the metal ions was 2.5, 4.5, 4.45, 3.25 mmol/L, respectively. The concentration of metals in the solution before and after sorption was determined by analysis of the aqueous phase by atomic absorption method. In order to select a sorbent, studies were conducted on the sorption extraction of copper, zinc, cadmium, nickel with impregnated composite sorbents PAD400-DiPDTF, PAD400-MAB, PAD600-DiPDTF and PAD600-MAB. Sorption was carried out in a static mode at pH 5-6.

The data show that the presence of an extraneous ion in the solution leads to a decrease in sorption capacity relative to the main component. During multisorption, the best sorption ability is exhibited by Cu^{2+} ions for TVEKS - PAD600-DiPDTF and PAD600-MAB. With multisorption, competition is observed by ions for binding sites. However, a preferred sorption of copper ions is observed, which indicates a greater affinity of the functional groups of TWEX to copper ions. The total molar sorption capacity for Cu^{2+} upon multisorption (Q_e = 0.75 mmol/g) is close to or slightly higher (but within the framework of the static error <5%) of the maximum capacitance of an individual metal ion (Q_e = 0.74 mmol/g) due to preferred sorption. The simultaneous presence of copper, nickel and zinc ions inhibits the absorption of cadmium ions to a greater extent than for nickel and zinc ions. The sorbent PAD600-DiPDTF exhibits a very high selectivity of copper sorption with respect to cadmium ions, with a selectivity coefficient above $\alpha > 12000$, and can be proposed as a sorbent for concentration in the atomic absorption determination of Cu(II) in natural and industrial wastewater.

The synthesized composite sorbents PAD600-DiPDTP and PAD-MAB based on polymer matrices can be used for selective concentration of Cu(II) from solutions containing Ni^{2+}, Zn^{2+}, Cd^{2+}, and PAD600-DiPDTP showed better results, since it is characterized by a higher capacity relative to Cu^{2+} ions.

Keywords: single, paragraph, summarizes, words indentation (maximum 6 key words) composite sorbent, impregnation, organic ligands, sorption, metal ions,

OPTIMIZATION OF EYE DROP RECEIPT FOR APPLICATION OF GELLAN GUM IN OPHTHALMOLOGY

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One significant challenge facing contemporary medicine involves delivering drugs to precise locations within the body in carefully regulated quantities. The pharmaceutical industry prioritizes the development and application of advanced drug delivery systems to address this issue. Presently, approximately 25% of worldwide drug sales involve medications featuring enhanced delivery systems. Typically, medications formulated, introduced, or developed by major pharmaceutical companies incorporate a transportation mechanism as part of their design.

At present, advancements in methods and technologies that emerge at the crossroads of organic chemistry, pharmaceutical chemistry, and macromolecular compound chemistry (polymers) enable the effective resolution of a majority of scientific and technological challenges linked to the formulation of efficient drug dosage forms.

Gellan gum (GG) has been utilized in the formulation of polymeric carriers designed for prolonged retention on the ocular surface, facilitating topical delivery of ocular drugs. The purification of commercial GG was accomplished through the fractional dissolution method in this study. The resulting aqueous solution of purified commercial GG displayed polyelectrolyte characteristics due to its elevated molar mass and carboxylic groups in glucuronic acid fragments. Two methods, fractional deposition, and ultrasonic treatment were employed to fractionate commercial GG. The GG fractions underwent characterization through 1H and 13C NMR spectroscopy, FTIR spectroscopy, and thermogravimetric analysis. The reduced viscosity of the GG sample was measured in a 0.025 M tetramethylammonium chloride (TMACl) solution. The average-viscosity molecular weights of the GG fractions were determined using the Mark-Kuhn-Houwink method. The selection of synthetic procedures, solvents, and reagents was guided by the biocompatibility of the materials and their potential application in drug delivery.

The impact of a simulated tear fluid model on the reduced viscosity of GG has been investigated. The research reveals that the most effective thickening of an aqueous GG solution occurs at an ionic strength of 0.015 mol/L or higher, achieved through the use of a simulated tear fluid. The optimization of the formulation for creating eye drops involving GG has been focused on the "sol-gel" transition triggered by the influence of tear fluid. Subsequent plans involve the immobilization of ofloxacin and pilocarpine within the GG matrix, aiming to develop sustained-release eye drops for ophthalmological use.

Keywords: commercial low acyl gellan gum, purification, ultrasound treatment, reduced viscosity, intrinsic viscosity, Mark-Kuhn-Houwink equation, viscosity average molecular weights

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DESIGN AND FABRICATION OF SUPERHYDROPHOBIC MEMBRANES FOR SEPARATION PROCESS.

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Superhydrophobic membranes have emerged as a promising solution for oil-water separation due to their ability to repel water while selectively absorbing oil. These membranes can effectively separate both immiscible oil-water mixtures and oil-in-water emulsions, driven solely by gravity. The separation efficiency of these membranes is extremely high, with residual oil in the filtrate lower than 30 p.p.m. This meets the stringent standards for wastewater discharge [1]. One example of a superhydrophobic membrane is the electrospun polystyrene (PS) nanofiber membrane. This membrane exhibits superhydrophobicity and superoleophilicity, making it highly efficient at oil-water separation. It selectively absorbs oil, making it a promising material for oil spill remediation [2]. Another approach to superhydrophobic membranes is the use of superhydrophobic/superoleophilic surfaces that can repel hot water and strong corrosive liquids. These membranes have been shown to have high separation efficiency for the filtration of light oils from oil-water mixtures. However, there are limited studies on superhydrophobic surfaces that can repel hot water [3]. Antifouling cellulose hybrid membranes have also been developed for effective oil-water separation. These membranes are eco-friendly and economical, making them suitable for various applications such as waste particle filtration and blocking thiol-based odor materials [4]. To effectively separate oil-water emulsions, superhydrophobic membranes with smaller pore sizes are required. Methods such as phase inversion, electrospinning, coating, and self-assembly have been proposed to fabricate these membranes. These membranes have shown excellent oil flux and efficiency for oil-water separation [5]. Electrospun nanofibrous membranes made of polyvinylidene fluoride-co-hexafluoropropylene have also been developed for oil-water separation [6]. These membranes have achieved high oil filtration flux and oil recovery rates, making them suitable for practical applications [6]. Superhydrophobic porous ceramic/metallic tubular membranes have been studied for oil-water emulsion separations. These membranes offer a crossflow pressure-driven separation method, which is suitable for modular applications and process integration with biodiesel production reactions [7]. In conclusion, superhydrophobic membranes have shown great potential for oil-water separation. They can effectively separate oil-water mixtures and emulsions, with high separation efficiency and low residual oil content. Various materials and fabrication methods have been explored to develop these membranes, including electrospinning, nanofiber membranes, and hybrid membranes. These membranes offer a promising solution for addressing the environmental challenges posed by oil-water pollution.

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BIOWASTE DERIVATED ACTIVATED CARBON FOR RADIOACTIVE IODINE SORPTION

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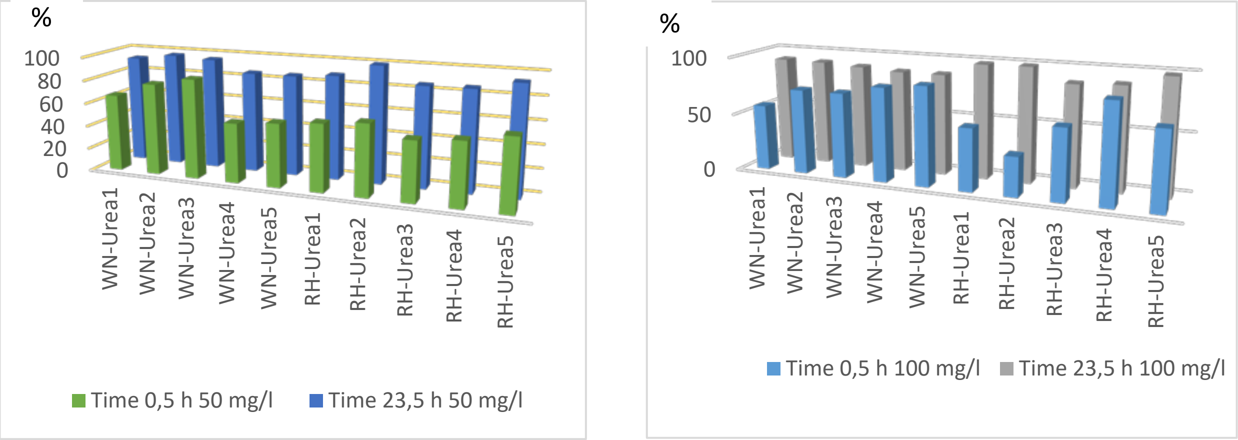
Nowadays due to expanding population and constant energy demand the nuclear energy is essential for every country. Kazakhstan now understand that and taking first steps toward to build a first Nuclear plant. Radioactive waste monitoring and management have to be on place before this time. In this work we aim to create new effective sorbent for radioactive iodine sorption, because iodine is one of the most harmful substance which can be released in case of severe nuclear incidents. Proposed solution involves the creation of a filter media capable of capturing radionuclides from contaminated wastewater. The sorbents made from agricultural waste, including walnut shells, rice hulls and buckwheat hulls, which are rich in lignocellulose. These materials converted into carbonaceous substances and subsequently modified with elements such as sulfur, nitrogen, silver and ferrocyanide to include active sites for trapping radionuclides. Sorption of a solution of potassium iodide with a concentration of 50 and 100 mg/l was carried out, the sorption results are shown in diagram 1.

Diagram 1. Results of sorption of potassium iodide with a concentration of 50 mg/l and 100 mg/l on activated carbon



Thus, it has been experimentally proven that the sorption of iodide ions from aqueous solutions occurs with an efficiency of up to 60% in the first 30 minutes and up to 90% in the first day, which makes it possible to use these sorbents for the sorption of iodine-containing solutions.

Keywords: activated carbon, radioactive iodine, sorption, rice husk, walnut shell, buckwheat husk

X-RAY DIFFRACTOMETRIC ANALYSIS OF COMPOSITE MATERIALS

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X-ray diffraction analysis of the T-1 composite material was carried out on an automated diffractometer DRON-3 with $Cu_{K\alpha}$ radiation, β-filter. Conditions for taking diffraction patterns: U=35 kV; I=20 mA; shooting θ-2θ; detector 2 deg/min. X-ray phase analysis on a semi-quantitative basis was carried out using diffraction patterns of powder samples using the method of equal portions and artificial mixtures. Quantitative ratios of crystalline phases were determined. Interpretation of diffraction patterns was carried out using data from the ICDD card index: database of powder diffractometric data PDF2 (Powder Diffraction File) and diffraction patterns free of mineral impurities. Contents were calculated for the main phases. The interplanar distances and phase composition of the samples were determined. The results of semi-quantitative X-ray phase analysis were obtained and diffraction patterns of samples were studied: albite (Feldspar) $Na(AlSi_3O_8)$ 2.2%, PF (potassium feldspar) $KAlSi_3O_8$ 8.4%.

Table- Results of semi-quantitative X-ray phase analysis of crystalline phases of the sample. № T-1

Name of the phase	Formula	Concentration, %
quartz	SiO_2	89.4
albite (PS)	$Na(AlSi_3O_8)$	2.2
KPS	$KAlSi_3O_8$	8.4

Conclusions:

As a result of semi-quantitative X-ray phase analysis of the crystalline phases of the sample. №. T-1 shows the presence of quartz 89.4%, albite (Feldspar) $Na(AlSi_3O_8)$ 2.2%, PF $KAlSi_3O_8$ 8.4%.

THERMAL ANALYSIS OF PETROLEUM BITUMINOSINES ROCKS OF THE BEKE DEPOSIT

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Thermal analysis of oil bituminous rock samples (OBR) was carried out on a derivatograph Q-1000/D system F.Paulik, J.Paulik and L.Erdey from <MOM>, (Budapest). The method is based on recording by a device changes in the thermochemical and physical parameters of a substance that can be caused when it is heated. The thermochemical state of the sample is described by the curves: T (temperature), DTA (differential thermoanalytical), TG (thermogravimetric) and DTG (differential thermogravimetric). The last of the presented curves is a derivative of the TG function. The shooting was carried out in air, in the temperature range of 20-1000ºC. Heating mode – dynamic (dT/dt = 10 $\frac{\text{degree}}{\text{min}}$), reference substance – calcined Al_2O_3, sample weight – 200 mg.

The mineral composition of powder samples was determined from the morphologies of thermal curves and numerical values of the intensities of endo- and exothermic effects using associated thermogravimetric readings of TG lines. The results of the analysis were compared with data from atlases of thermal curves of minerals and rocks and compared with descriptions of the thermal behavior of minerals presented in other reference sources and accumulated in the data bank of the laboratory that conducted these studies. The thermal behavior of the removed samples allowed, within the capabilities of the hardware used, determine the mineral and material composition of the presented complexes and establish the dynamics of changes in the content of thermally active components in the samples.

Conclusions.

1. It was discovered that at temperatures of 20-200 ^{0}C, adsorbed water is removed from the pore spaces of silicon inclusions; its amount is 4%.
2. It was found that at temperatures of 200-505 ^{0}C, an exothermic effect occurs, caused by the oxidation of organic matter (OM) by atmospheric oxygen, with the release of three pulses of thermal energy, leaving three peaks on the DTA curve at 285, 385 and 445 ^{0}C.
3. Combustion of the complex is carried out in the temperature ranges of 200-310, 310-390 and 390-505^{0}C, in which the thermogravimetric (TG) curve registers the weight loss of the sample corresponding to 4.0, 4.75 and 6.25%.
4. It has been established that the oil-bituminous rock contains: mineral and material composition, in%: Quartz - 70.6, Albite (feldspar) - 7.1, PF (potassium feldspar) - 3.2, Organic matter CO_{org} - 16.0, H_2O -3.0.

SEAMLESS INSULATING SHELLS BASED ON POLYETHYLENE FOAM

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Maintaining a comfortable indoor climate requires effective insulation systems that protect buildings from the active sun and high ambient temperatures. The advantages of Tepofol polyethylene foam: low thermal conductivity and density, low vapor and water permeability and the ability to form seamless joints along the surface of insulated surfaces. The aim of the research is to improve insulation systems based on foamed polyethylene and to develop modified polyethylene with lower flammability. An active experiment carried out on the basis of mathematical design methods made it possible to establish an analytical connection between the consumption of flame retardant and modifier as well as the pressure in the extruder and the reaction functions: the average density of the polyethylene foam and the flammability criterion. The oxygen flammability index of modified polyethylene foam was taken as the flammability criterion. Foaming agent masterbatch and mineral filler were used as flame retardants. Analytical optimization of mathematical models obtained as a result of an active experiment made it possible to determine the optimal consumption of flame retardant, which was 3.7...3.8% by weight of the polymer. Modified polyethylene foam can be used to form insulating shells in extreme climatic zones; also important is the possibility of using it for cold preservation: in ice sports facilities, storage rooms, as well as for snow preservation in summer.

Keywords: polyethylene foam, seamless shell, oxygen index, insulation systems

STUDY OF ATOMS, MOLECULES AND AEROSOL PARTICLES USING LASER SPECTROSCOPY METHODS AND APPLICATION IN ECOLOGY

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The physical mechanism of formation of the useful signals (selective ionization signal and cavity ring-down signal) were identified that allow registration of parameters of atomic and aersols systems in the intensive pulsed laser field. High-sensitivity laser methods that as laser resonans-ioninazation spectroscopy in vacuum, atom-ionization in flame, cavity-ringdown laser absorption spectroscopy for identification of ultra small concentration of atoms in various phase states of substance were used. Subjects of the research were water standard solutions and solid metals s(Li, K, Na, Ca, Cs), p(Al, In), d(Cr, Mn, Fe, Co, Ni, Cu, Ag, Au, Pt, Zn, Hg), f(Yb) elements, aluminum alloys, especially pure solvents, crystals (NH_4F, NaF), semiconductor materials (GaAs, Si) and various aerosols of salts of metals (NaCl, CsCl, NaI, NaF, KCl $AgNO_3$) chemicals, organic dyes, alloys, soils and rocks. As a result the first time new mechanisms of reception of free particles are revealed and new methods of increase of efficiency atomization, selective ionization and excitation of atoms in systems "flame", "rod-flame", in atomizer "graphite-furnace" are offered. For the first time new parameters of aerosols on physical and chemical properties of aerosol plumes from solid surfaces and aerosols of salt of metals and organic aerosols are revealed. The methods of addition and calibration curve were used to examine the effects of the matrix on the analytical signal of the studied atoms.

Keywords: atom, molecule, aerosol particles, non-absorbing aerosols, optical resonator

SEDIMENTATION ANALYSIS OF OIL-BITUMEN ROCKS OF KAZAKHSTAN

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Limited oil reserves, high rates of its consumption and rising prices for petroleum products make it necessary to search for alternative sources of hydrocarbon raw materials. One of such sources is oil-bituminous rocks (OBR), the organic part of which approaches the properties of petroleum bitumen. Reserves of oil-bitumen rocks are available in Canada, the USA, the Middle East, China, Russia, Kazakhstan and other countries. Proven and promising geological reserves of bitumen in industrially developed capitalist and developing countries are estimated at 580 billion. t, of which 71% are in Canada and 27% in Venezuela. As a result of comprehensive studies, according to preliminary estimates, in Western Kazakhstan, the estimated reserves of natural bitumen and high-viscosity oils are 950-1000 million tons. World experience shows that bituminous rocks can be used to produce a wide range of valuable products: "synthetic" oil, liquefied gas, in the paint and electrical industry, in road construction.

Extraction methods are used to separate the oil-containing part of the NBP from the mineral part. In this work, methods of water-alkaline extraction and extraction of the organic part of oil-bituminous rocks with an organic solvent in the Soxlet apparatus were used. An alcohol-benzene mixture was used as a solvent.

Petrobituminous rocks of Western Kazakhstan from the Tyub-Karagan and Munaily-Mola deposits were used for the study. The results of solvent extraction in the Soxlet apparatus are shown in the table. It was found that the petrobituminous rock of M. Munaily-Mol is more enriched with the organic part (16.71%), and the mineral part is 83.29%, whereas the rock of M. Tube-Karagan (14.6% and 85.4%, respectively).

The dispersed composition of the systems was studied by sedimentation analysis. Its principle is based on the determination of the settling rate of particles of the dispersed phase on the cup of torsion scales and the subsequent determination of the nature of the particle size distribution and the degree of dispersion.

Table Composition of oil-bituminous rocks determined by the extraction method in the Soxlet apparatus.

OBR	OBR weight, g	The content of the organic part		The content of the mineral part	
		G	%	g	%
Munaily-Mola	50	8,35	16,71	41,65	83,29
Tube-Karagan	50	7,3	14,6	42,7	85,4

THE INFLUENCE OF BIOCHEMICAL MODIFICATION OF WOOD FILLER ON THE PHYSICAL-MECHANICAL PROPERTIES OF POLYPROPYLENE-BASED COMPOSITE

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The main task in the development of polymer composite materials at present is to enhance their characteristics, aiming for high physical and mechanical properties, reduced energy consumption, and lower production costs. Various approaches can be employed to address these challenges, such as the biochemical modification of wood fillers. In this regard, this study conducted research focused on the biochemical modification of wood filler.

Polypropylene grade PP 4215M from PJSC "SIBUR Holding" was used as the polymer binder for composite material production. Wood flour from deciduous trees with a particle size of 0.18 mm served as the plant filler. The biochemical modifier used was Ronozim VP from "DSM Nutritional Products Ltd," Switzerland. The binder-to-filler ratio was 1:1. Filler modification was carried out in an aqueous environment at 55 °C under high-shear forces, with the modifier added at a dosage of 0.5%. Composite materials were produced using a twin-screw mixer of the closed type, "Measuring Mixer 350E," in the laboratory station "Lab-Station" at a rotor speed of 60 rpm.

To assess the impact of wood flour modification, the physical and mechanical properties of wood-polymer composites were investigated. The tensile strength increased from 33.8 MPa to 36.2 MPa (by 7%) compared to the control sample without modification. The bending modulus increased by 10% in the composite with wood flour and sunflower husk compared to the control sample, owing to the high cellulose and hemicellulose content in the filler's chemical composition. The impact viscosity according to the Sharpy test increased from 8131 MPa to 9138 MPa (by 12%) at room temperature. The presence of a biochemical modifier in the wood flour led to the hydrolysis of the filler's proteins, reducing the intermolecular interaction of the plant filler between individual fibers, thereby improving the interaction between the polymer matrix and the plant filler. This likely contributes to the increased tensile strength and Sharpy impact viscosity of the compositions.

The melt flow rate increased from 1.2 g/10 min to 1.7 g/10 min (by 41%). Presumably, the increase in melt flow rate is associated with a reduction in the specific surface area of the filler particles interacting with polypropylene. Density and hardness studies revealed that the biochemical modification of the filler did not alter the density parameter and had a negligible effect on the hardness of the polymer composites. Water absorption studies at 23 °C over 14 days indicated a 21% reduction in water absorption for compositions with modified wood flour compared to unmodified samples.

MODIFICATION OF ROAD BITUMEN WITH MIXED THERMOPLASTIC ELASTOMERS

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Modern road construction imposes increased requirements on road construction materials, especially binders, in particular bitumen for asphalt concrete.

Usually asphalt concrete coatings based on petroleum bitumen are not able to provide the required physical and mechanical properties of coatings and their durability in the conditions of modern heavy-duty and intensive traffic. Low elasticity, insufficient indicators of crack resistance and temperature range of operability limit the use of products made of them in the hot summer period and in winter. One of the main ways to increase the service life of asphalt concrete coatings due to the physical nature and structural features of asphalt concrete is to change the structure and properties of organic binders used for its preparation. The most common technique is modification with polymer additives or waste products of their production.

In the work for this purpose, mixed thermoplastic elastomers based on various rubbers and polyolefins were used With this modification, a number of valuable properties inherent in polymers are transferred to bitumen: plasticity and elasticity in a wide temperature range, strength and heat resistance at positive temperatures, resistance to aging and aggressive environments.

Mixed TPE were obtained by high-speed mixing of rubbers with polyolefins. The peculiarity of the work is the scientifically based selection of rubbers and polyolefins that are part of the TPE, which allows selectively eliminating the disadvantages of bitumen. Each of the components is responsible for a certain set of properties of the bitumen-polymer binder.

It has been established that bitumen-polymer binders based on TEP ethylene propylene rubber and polyethylene have the optimal complex of physico-mechanical and operational properties.

The possibility of using secondary polyethylene in granular form in the composition of a mixed TPE is shown, which reduces the cost of the composition.

The developed compositions satisfy all the technical characteristics of bitumen and significantly exceed the values of GOST 22245-90.

MODIFICATION OF NATURAL BITUMEN WITH POLYMER WASTE AND POLYESTER RESINS

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IR spectra were recorded and processed using a VERTEX 70 IR Fourier spectrometer in the frequency range from 4000 to 500 cm^{-1} and using the PIKE MIRacle ATR single disrupted internal total reflection prefix with a germanium crystal. The mathematical processing of the results was performed using the OPUS 7.2.139.1294 software, as well as their libraries with an indication of the quality of the match.

A sample, pre-degreased with alcohol, is placed on an IR spectrometer attachment. The sample is positioned horizontally on the surface of the optical material. To register the spectrum, it is sufficient to ensure contact between the test sample and the prefix crystal. They are watching the process of removing the spectrum. The sample is identified using a library of spectra. The resulting spectrum is printed out. The spectra of the MNPVO practically do not differ from the absorption spectra obtained by the classical method, and are easily identified by spectral libraries. Minor changes in the band intensities in the NIP spectrum compared to the absorption spectra are corrected by a special function “Correction of NIP“.

IR spectra of sample No. 1 - M1. Absorption bands characteristic of PPP and bitumen are observed in the region of 2800-3200 cm^{-1}: absorption bands 3028.93 cm^{-1}, 2924.72 cm $^{-1}$, 2854.73 cm $^{-1}$, characteristic of valence vibrations of the CH and CH2 groups, 1493.07 cm^{-1}, 1452.81 cm^{-1} (deformation vibrations (CH2)) and 1376.84 cm $^{-1}$ (deformation vibrations (CH3)). The vibrations of the aromatic ring are represented in the spectrum by frequencies of 1601.59 and 1493.07 cm^{-1}, which indicates the presence of styrene groups. In the region of 1300-1700 cm^{-1}, sample No. 1 – M1 has absorption bands of 1601.59 cm^{-1} and 1702.92 cm^{-1}, 1376.84 cm^{-1} with some offset from the spectra of bitumen, which is in the spectrum with the addition of expanded polystyrene. Bitumen has a lower intensity than in the spectrum of the initial bitumen, and there are also additional absorption bands: 756.44 cm^{-1}, 697.84cm^{-1}, characteristic of PPP. The absorption bands in the region of 1000-1200 cm $^{-1}$, characteristic of PPP, overlap with the band 1031.14 cm $^{-1}$, associated with fluctuations in the S=O, R-SO-R group of sulfoxides of the initial bitumen, and a wide intense absorption band is recorded in the region 1031.38 cm^{-1}. An increase in peak intensity in the region of 101.3 cm^{-1} indicates the possibility of formation of organosulfur compounds. Absorption bands of 697.84 cm^{-1}, 756.44 cm^{-1} associated with PPP are observed. A band of about 1601.59 cm^{-1} characterizes the valence vibrations of unsaturated C=C bonds, mainly the benzene ring, and a set of absorption bands related to aromatic structures is also recorded, – 874,02; 798,14; 672,05; 664,14; 652,42; 644,58; 615,94 cm^{-1}, which indicates the presence of benzene compounds (monocyclic aromatic compounds) of varying degrees of substitution. Sample №. 2 – M2 is characterized by the presence of intense bands in the region of 2850-2930 cm^{-1}, corresponding to valence fluctuations of CH in the CH$_2$ groups (2923.88 and 2856.28 cm^{-1}), indicating a significant amount of marginal hydrocarbons, bitumen. and deformation (1456.58, 1376.44 and 721.94 cm^{-1}) vibrations of CH$_2$ and CH$_3$ groups. In the IR spectra, the presence of absorption bands characteristic of oxygen-containing (1706.24;1582.64 cm^{-1}) structures indicate the appearance of carbonyl groups of ester acids in bitumen

PVA- CELLULOSE BASED BIO NANOCOMPOSITES A POTENTIAL DUO: SYNTHESIS, CHARACTERIZATION AND APPLICATIONS

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PVA-based nanocellulose composites are a new class of materials that show great potential for use in a range of applications. The synthesis, characterization, and numerous applications of these composites are briefly highlighted in this abstract. Through a variety of techniques, nanocellulose is incorporated into a PVA matrix as part of the synthesis methods, improving the material's properties. AFM, FTIR, XRD, SEM, DSC and other characterization techniques are used to evaluate the structural and functional properties of the composites. Because of their exceptional barrier qualities, biocompatibility, and potential for sustainable solutions, these composites find use in packaging, biomedicine, and environmental remediation. The study emphasizes how crucial PVA-based nanocellulose composites are becoming to the advancement of materials science and the solution of urgent global issues.

Keywords: Nanocellulose, Poly vinylalcohol, Bio nanocomposites

JANUS STRUCTURE INSPIRED MULTILAYER COMPOSITES FOR EMI SHIELDING

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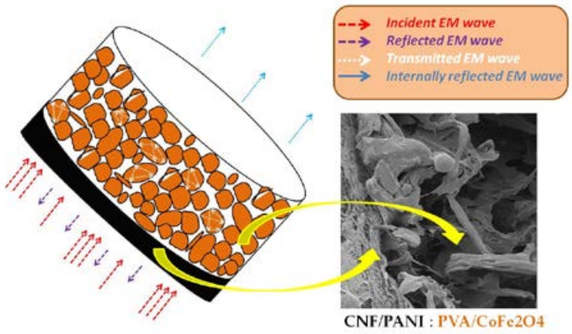
This work introduces a novel approach to achielving superior EMI shielding through the development of multilayer composite using Cellulose nanifiber (CNF/PANI) as bottom layer, Polyvinyl alcohol (PVA/ CoFe$_2$O$_4$) as top layer. These multilayer composites leverages the unique properties of PANI and CoFe$_2$O$_4$ along with the matrices enabling the development of lightweight, flexible, and highly effective EMI shield. Preliminary results shows exceptional EMI shielding property, positioning this maultilayer composutes as a promising candidate for applications in aerospace, telecommunications, and electronics. CNF/PANI and PVA/ CoFe$_2$O$_4$ alone showed a shielding of 10 and 15 dB respectively. Whereas, the multilayer showed a shielding of 29dB inferring that this potential composite has enhanced the shielding property.This study contributes to the advancements of materials science for EMI shielding, offereing a potential solution to the growing challenges of EMI in modern technology.



Keywords: EMI shielding, Absorption, Multiple internal reflection, Cellulose nanofiber, Polyvinyl alcohol

FIELD CONTROL OF MAGNETOELECTRIC MULTIFERROIC COMPOSITES AND ITS POLARIZATION

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Magnetic control of polarization and electrical control of magnetization offers an extra degree of freedom in materials possessing both magnetic and electric dipole moments magnetoelectric multiferroics [1, 2]. Microstructure with polycrystalline configurations that enhances the overall polarization/magnetization are identified in magnetoelectric multiferroic composites. The characterization of local fields corresponding to the polycrystal configuration underlines nontrivial role played by randomness in better cross-coupling mediated by anisotropic and asymmetric strains. A generic homogenization modeling framework which incorporates crystallographic domain features is introduced and computationally implemented for magnetoelectric multiferroics [3]. The homogenization, mathematically applicable to heterogeneous media with contrasts in physical properties, replaces the heterogeneity of the multiferroics by an equivalent effective medium with uniform physical characteristics. A statistically representative unit-cell is proposed to encompass all forms of multiferroics and its composites in bulk. The variational formulation of the coupled magneto-electromechanical problem reveals the nature of interaction between mechanical, electrical and magnetic fields of a multiferroic at a microscopic scale with high resolution. Locations of magnetic domains (due to electric field) and electric domains (due to magnetic field)-that are critical for information storage-in the microstructure are identified in this system.

Keywords: multiferroics, magnetoelectric composites, modeling, homogenization, polarization.

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FABRICATION AND CHARACTERISATION OF ECO-FRIENDLY SMART PACKAGING MATERIALS DERIVED FROM ETHYL CELLULOSE COMPOSITES

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Abstract

Biopolymer-based packaging materials have not been widely used in the packaging industry, mainly because of their poor mechanical, barrier, and processing properties as well as higher production cost compared with commodity plastic films. In addition, bacterial contamination in packaging industry is a common and serious problem, especially in food packaging, which threatens human life and health. Biodegradable and antibacterial films are of great significance for the application associated with food packaging meanwhile minimizing the negative impact on environments. As ethyl cellulose is biodegradable in nature, the resulted films are also biodegradable and environment friendly. These qualitatively responsive ethyl cellulose films can be utilized as conventional food wrappings or as a small patch within the conventional transparent packaging. Motivated by the outstanding properties of ethyl cellulose, the polymer nanocomposites of ethyl cellulose (EC) as a polymer matrix and the zinc oxide nanoparticles as a nano-filler have been prepared with the different zinc oxide wt.% concentrations using ultrasonication treatment and characterized by using various advanced techniques. The prepared films were characterized by FTIR, SEM, XRD techniques. The field emission scanning electron microscopy (FESEM) was used to study the surface morphology and to identify the presence of zinc oxide in the nanocomposites. Also, antibacterial activity of the prepared films were evaluated. The mechanical properties and thermal stability of the films were analyzed. To evaluate the hydrophilicity of films, were analysed and results showed improved hydrophobicity by the addition of zno nano particles.

SYNERGISTIC EFFECT OF DIVERSE BIOACTIVE AGENTS IN CARRAGEENAN BASED MATRICES: A COMPREHENSIVE REVIEW

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Marine polysaccharide carrageenan has gained wide attention owing to its compatibility with various bioactive agents, as the hydroxyl and sulphate functional groups present in carrageenan chains cause its blending with chemically susceptible compounds. Carrageenan, a natural sulphated polysaccharide with gelling properties have been in extensive use for the preparation of composites in the form of films, membranes, scaffolds, electrospun composites and so on. Apart from this, carrageenan-based composites can also be made in various forms including aerogels, hydrogels, cryogels and xerogels. Incorporation of fillers such as metal oxides, plant extracts, essential oils, enzymes, etc. enhances the properties of the resultant composites, as well as their combination exhibits synergistic effect. Addition of more than one bioactive agent as filler into the carrageenan matrix has shown to induce augmented properties such as antioxidant, antibacterial, antimicrobial and anti-inflammatory activities that can be beneficial in the field of wound healing, tissue engineering, biomedical, pharmaceutical, agriculture, packaging and food industries. Combination of fillers provide excellent properties such as mechanical properties and adjustable degradation rates in addition to their biological properties. Hence, this all-inclusive review focuses on the cumulative effect of bioactive agents as fillers in carrageenan matrices and their resultant properties, with the objective of better understanding the tunability of the resultant composites for diverse end-use applications.

Keywords: carrageenan, composites, bioactive agents, synergistic effects

COACTIVE MODIFICATION OF CARRAGEENAN FILMS WITH PLASTICIZERS AND CROSSLINKER: A PROMISING APPROACH TO TUNABLE FUNCTIONALITIES

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Multifunctional biobased films with improved physico-mechanical properties were prepared by incorporating glycerol (G), sorbitol (S) and potassium chloride (KCl) in a cost-effective kappa-carrageenan matrix. Both the plasticisers and the crosslinking agent were mixed with the polymer matrix to form uniform, smooth and transparent films of high quality. All properties under study were observed to be influenced by varying concentrations of glycerol and sorbitol, and were further enhanced by the addition of KCl. Glycerol containing films, with and without added KCl exhibited optimum mechanical and water interactive properties for biomedical applications, especially for wound healing. Meanwhile, films incorporated with sorbitol and KCl exhibited the highest tensile properties and lowest hydrophilic nature, an ideal combination for food packaging applications. Optimally plasticised and crosslinked carrageenan films are thus expected to help envisage tunable formulations for appropriate applications in real life scenarios thereby reducing the use of non-ecofriendly options.

Keywords: kappa-carrageenan, crosslinking agent, glycerol, sorbitol

SORPTION-SPECTROPHOTOMETRIC DETERMINATION OF COBALT IONS USING AN IMOBILIZED REAGENT

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In the study, a sorption-spectrophotometric detection method was developed for the determination of Co(II) ion from wastewater by immobilizing an organic reagent containing a nitrous group on natural modified silk fibroin fiber. The procedure was carried out in a strongly acidic environment (pH=3).

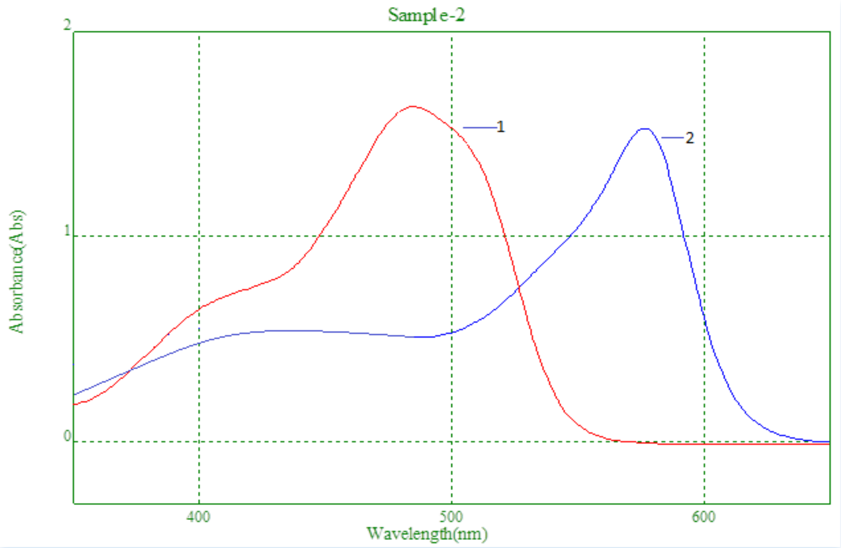
Keywords: organic reagent, modified silk fibroin, immobilized, sorption-spectrophotometric

Goal: to develop a rapid and sensitive method for the determination of cobolt(II) using an organic-based material immobilized on a fibrous carrier.

Methods: sorption-spectrophotometric, reflectance spectroscopy. Fibrous sorbents modified with various anion exchange groups were used as immobilization carriers.

Electronic absorption spectra of reagents and complexes were measured on an EMC-30PC-UV-1800 Spectrophotometer, and the pH of solutions was controlled on an I-130 potentiometer. The diffuse reflectance spectra of the disks were measured on an X-Rite One Pro spectrocolorimeter. IR spectra of reagents, carriers and immobilized organic reagents were recorded on an Avatar sustem 360 FT-IR spectrometer from Nicolet Justrument Corporation (USA).

Results: our proposed mechanism for the immobilization of organic reagents on solid supports was confirmed by IR spectroscopy data. Of the known fibers, the most suitable sorbent was chosen, modified natural silk fibroin fiber (SF), while the color of the fiber immobilized with an organic reagent changes from white to orange. Optimal conditions for the reaction of complexation of cobalt with immobilized cobalt were selected, the possibility of spectrophotometric determination of cobalt was shown, and the dependence of the obtained data on various factors (reagent concentration, immobilization time, pH of the environment, etc.) was established, at the same time, some physicochemical characteristics of the obtained data were determined and calculated. complexes. The conditions for the selective spectrophotometric determination of cobalt(II) in the presence of foreign cations and interfering ions have been optimized.



Picture-1. 4-((2-hydroxy-3- nitroso-1- naphthyl)azo) benzo sulfo absorption spectra of acid and its complex with Co(II) ion

The maximum absorption of the reagent is observed at λ=480 nm, and the maximum absorption of the complex is 575 nm, formed at pH 2.0-5.0. The intensity of coloring does not depend on changes in temperature over a wide range. Using the methods of molar ratios and isomolar series, the composition of the complex was found to be 1:1. Analyzing the connections between the organic reagent and the carrier, it was established that the functional analytical groups of the reagents responsible for complex formation do not participate in the formation of a covalent bond with the polymer carrier; they only form complexes with cobalt ions.

Conclusions: Sorption-spectrophotometric methods for determining cobalt in wastewater have been developed. These methods for determining cobalt(II) in terms of sensitivity meet the requirements of sanitary control and can be applied to various objects containing cobalt.

PREPARATION OF A NEW POLYCOMPLEXON BASED ON POLYACRYLONITRILE

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In this work, the kinetic aspects of obtaining a new polycomplexon based on an anion exchange sorbent obtained from polyacrylonitrile fiber were considered. The physico-chemical properties of the obtained polycomplex were studied and it was proved that it has a polyampholytic property. Various methods such as chemical precipitation, ion exchange, membrane separation, electrochemical treatment, adsorption are used to extract heavy metals from aqueous solutions. Among them, adsorption is the simplest and most common method. Adsorption of metal ions can be carried out by using polymer materials that form strong complexes with metal ions and retain functional groups such as amino, carboxyl, phosphorus and amidoxime. Adsorption of metals in these materials depends on the functional groups on the surface of the adsorbent. Polymeric sorbents containing ion-exchange and complex-forming groups show selectivity for some metals. Treatment of polyacrylonitrile with polyfunctional amines provides an opportunity to obtain anions with strong basic properties. Therefore, in order to synthesize sorbents containing a chelating functional group, polyacrylonitrile containing a polyfunctional group was subjected to successive chemical changes with polyethylpolyamine (PEPA) oligomer and monochloroacetic acid (MCA). As a result, a polycomplexon (PPM-1) with a strong and weak anion exchange group and a cation exchange group was synthesized. Optimum conditions for synthesizing PPM-1 polycomplexon were determined. The static exchange capacity (SEC) determination method was used to characterize the degree of exchange of new functional groups in the obtained polymer. Effects of reaction time, temperature, concentration of MCA on SEC of modified fiber were studied. The SEC of the modified fiber increased with increasing reaction time and MCA concentration, indicating MCA incorporation into the fiber. An increase in temperature also had a positive effect on the chemical modification process. In order to study the nature of ionogenic groups in the synthesized polycomplexons, the static exchange capacity with HCI and NaOH was determined. In order to characterize the chemical structure of the synthesized polymer, IR spectra were studied and valence vibrations of =NH, $-NH_2$, >NH, -C=N- groups and new absorption lines corresponding to the carboxyl group were observed. Therefore, new polyampholytes containing >NH and $-NH_2$ groups and –COOH groups were synthesized by successive chemical modification of PAN with polyethylene polyamine and monochloroacetic acid.

Keywords: polycomplexone, anionite, cationite, sorption, polyacrylonitrile, polyethylenepolyamine, monochloroacetic acid

EPOXY RESIN INDUSTRY: MODIFICATION AND APPLICATION

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Epoxy resins are synthetic resins with different applications including coating, adhesive and concrete. Modification of epoxy is very interesting to all researchers to find new applications and improve the physical and mechanical properties of the existing products. One method of modification epoxy resins is mixing epoxy resin with reactive dilute to reduce viscosity, increase equivalent epoxy weights as well as mechanical properties. The reactive dilute was based on styrene and glycidyl methacrylate was successfully synthesized via free radical solution polymerization technique using benzoyl peroxide (BPO) as an initiator with various feed ratios of styrene (St) and glycidyl methacrylate (GMA). The prepared reactive dilutes were used to improve the physical and mechanical properties of epoxy resin in the presence of an amine-based hardener at a ratio of 1: 1, 1: 0.5, and 1: 0.3. The results showed that the reactive dilutes affected the physical and mechanical properties. However, reactive dilute with a ratio of (30:70) gave the highest mechanical properties compared to others, as well as a hardener ratio of (1:0.3).

Keywords: Reactive dilute, Styrene, Glycidyl methacrylate, Epoxy, Hardener, Mechanical properties.

SORPTION OF NON-FERROUS METAL IONS FROM AQUEOUS SOLUTIONS BY POLYMER COMPOSITIONS BASED ON POLYACRYLIC ACID AND BENTONITE CLAY

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Polymer gels (PG) based on acrylic monomers, due to their high sorption characteristics, have found application in various areas of human activity, such as agriculture, ecology, pharmacology and others. However, in practice, a high degree of swelling of PG leads to a significant deterioration in their mechanical properties, such as strength and elasticity in the hydrated state. They also have a relatively low sorption capacity in relation to various organic and inorganic substances, which limits their practical use. The production of polymer compositions based on PG by introducing bentonite clays (BG) into their composition is one of the possible ways to eliminate these shortcomings. The choice of BG as a component for obtaining a polymer composition is due to the fact that they have high hydrophilicity, low toxicity, good adsorption capacity and are a relatively cheap, accessible and environmentally friendly material. Therefore, the authors of the work synthesized polymer composite gels (PCG) based on polyacrylic acid (PAA) and BG brand “Navbahor” produced in Uzbekistan. The sorption of some non-ferrous metal ions from aqueous solutions by the synthesized composites was studied. The synthesis of PCG was carried out by intercalation polymerization of monomers in the presence of BG particles using the in situ method. To do this, appropriate amounts of acrylic acid and a cross-linking agent were added to the aqueous suspension of BG, and then polymerization of the monomers was carried out. Redox systems served as initiators of polymerization. In this case, samples of PCG were obtained containing from 10 to 50 wt.% BG in their composition. The structure of the resulting composites was studied using IR and Raman spectroscopy, as well as scanning electron microscopy. The study of the sorption of non-ferrous metal ions by the obtained PCG samples was carried out from aqueous solutions of $CuSO_4$, $Ni(NO_3)_2$ and $CrCI_3$ under static conditions using the spectrophotometric method. The concentration of Cu^{2+} ions in the solution was determined at a wavelength of 615 nm (in the form of an ammonia complex), Ni^{2+} ions at 460 nm (in the form of a complex with dimethylglyoxime in the presence of an oxidizing agent), and Cr^{3+} ions at 560 nm (in the form of a complex with EDTA). The study showed that the introduction of BG particles into hydrogels leads to an increase in their sorption capacity. For example, when the composition contains 50% BG by weight of PG, its sorption capacity for Cu^{2+} increases by almost two in comparison with unmodified PG. The sorption capacity of this composite increases five times in comparison with BG. It was revealed that the synthesized PCGs also sorb Ni^{2+} and Cr^{3+} ions from aqueous solutions. At the same time, the sorption capacity of PCG with respect to these ions is noticeably lower compared to Cu^{2+}. To characterize the mechanism of sorption of metal ions from aqueous solutions by compositions, their elemental compositions were determined by X-ray fluorescence analysis before and after the sorption process of metal ions. At the same time, a decrease in the proportion of exchangeable ions (K, Ca, Mg, Fe) included in the composition of the BG in the sorbent was established, which is associated with ion exchange processes. Thus, based on the data obtained, we can conclude that PCG based on PAA and BG are promising sorbents, which in the future can be successfully used for the extraction of cations and anions from solutions. Moreover, these compositions are cheaper and technologically simpler compared to granular ion exchange resins.

Keywords: hydrogels, polymer composition, sorption, metal ions

OBTAINING A SURFACE-MODIFIED BIRCH ACTIVATED CARBON MEMBRANE, SIMILAR TO GRAPHENE OXIDE, AS A SENSING ELEMENT FOR A HUMIDITY SENSOR

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Currently, it is relevant to develop an ultrasensitive humidity sensor using relatively inexpensive materials and affordable manufacturing technology, which makes it possible to determine a wide range of environmental humidity. In this regard, one of the important tasks is to seek more affordable materials. Due to the peculiarities of electrical, physical-mechanical, and other properties, sensors must possess a broad measurement range, respond promptly to changes in humidity, operate stably under various environmental factors, and exhibit low cost and simple manufacturing technology. In this work, we developed an ultra-sensitive, simple, and low-cost humidity sensor using a graphene oxide (GO) membrane, GO/CMC (carboxymethylcellulose). The sensor operates in a wide range of relative humidity (5-95%) with a symmetric signal response time and demonstrates a high degree of stability (+/- 2%).

Therefore, we chose a GO membrane from birch activated carbon (BAC) with CMC as the initial material, which is among the potential materials to meet the aforementioned characteristics. The selection of suitable material is considered the most important factor in creating a sensitive sensor. GO was synthesized using the Hummers method. Instead of graphite, we opted for BAC as the initial material. We chose BAC as the foundation for its cost-effectiveness compared to graphite. Additionally, BAC shares similar structural, physical, and chemical properties with other carbon and graphite materials. Its larger specific surface area and high adsorption properties make it the most suitable material for creating sensitive humidity sensors.

The primary reason for developing a humidity sensor based on GO/CMC is that the composite membrane exhibits a smooth surface and compact lamellar structure compared to the initial GO membrane. The abundance of functional oxygen-containing groups further enhances sensitivity to moisture. Furthermore, a humidity sensor based on GO/CMC boasts enhanced mechanical properties. The synthesis of GO from BAC yields a higher output than synthetic graphite, contributing to the creation of an economically efficient, profitable, and high-quality composite membrane for humidity sensor production. To achieve a membrane with a specific thickness, uniform dispersibility, and a relatively flat surface, we selected appropriate concentrations of the GO solution from activated BAC. GO membrane from BAC with CMC were prepared using varying concentrations of BAC-GO liquid solution, with CMC employed as a coupling agent. As GO from BAC lacks the inherent capability to form a membrane independently, CMC was utilized in the process. All obtained GO membranes from BAC with CMC were prepared according to the following volume ratios: 50:50; 75:25; 25:75 (V/V, ml/ml). Among the concentrations tested (0.2%, 0.5%, and 1% liquid solution of GO from BAC), the most suitable concentration for forming a GO membrane from BAC with CMC was found to be 0.5%, with a volume ratio of 50:50 (V/V, ml/ml). The GO membranes obtained from BAC with CMC were examined using SEM, UV, and IR spectroscopy. The results of UV and IR spectroscopy for the synthesized GO membranes from BAC with CMC confirm that the selected concentrations of GO liquid solutions from BAC and CMC are suitable for membrane formation.

A humidity sensor was constructed using a GO membrane made from BAC and CMC. To create the humidity sensor, a suitable concentration of GO (0.5%) and CMC (0.5%) was utilized as the

sensitive material, with a volume ratio of 50:50 (V/V, ml/ml) to form the GO membrane from BAC with CMC.

The electrophysical parameters of a humidity sensor based on GO membrane from BAC with CMC were studied as a function of humidity to determine the performance characteristics of the device. The study results demonstrated that, with an increase in relative humidity (20-95%), the electrical resistance of the humidity sensor decreases by nearly four orders of magnitude, from 1.4x109 to 5x105 Ohms. This confirms the sensitivity of the GO membrane made from BAC and CMC to relative humidity.

Keywords: carboxymethylcellulose, graphene oxide, birch activated carbon, humidity sensor, membrane.

INVESTIGATION OF CARBON-IODINE INTERFACIAL PROCESSES FOR HYBRID SUPERCAPACITORS

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Hybrid supercapacitors combine battery-like and purely capacitive electrodes to offer significantly higher capacitance and energy than traditional supercapacitors (EDLCs and pseudocapacitors).[1-2] Investigation of iodine/carbon interface is crucial for the development of aqueous hybrid supercapacitors and iodine-based batteries.[3] In this study we use electrochemical quartz crystal microbalance (EQCM) to understand the carbon electrode charging mechanisms. EQCM studies show (i) the iodide electrooxidizes to iodine in the pores; (ii) water is pushed out of the pore due to hydrophobic nature of iodine (iii) number of water molecules desorbed with cation at the negative electrode are determined by the charge compensation at the cathode; (iv) the interactions of iodine with carbon generate the polyiodides and lead to the changes in the carbon structural parameters. Furthermore, the chemical interactions (charge transfer) when iodine is electrodeposited in the pore, how it affects the structural parameters of carbon electrode, have been studied by Raman spectroscopy. The presence of polyiodides, and shifts in D- and G-band is confirmed. However, when using templated carbon as electrode, the structural changes are less prominent.

Keywords: Carbon electrode, Iodine electrodeposition, hybrid supercapacitors, EQCM, Raman spectroscopy

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OBTAINING OF CELLULOSE FROM AGRICULTURE WASTES

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In recent years, there has been a growing interest in the processing of renewable plant materials in various fields of science and technology. Until later years, the use of biomass waste as an energy source, currently more than 75 million tons of cellulose fibers are produced from it annually [1-2]. In this regard, the main attention is paid to the replacement of some synthetic fibers with cellulose-based composites. This opens the way to the production of biocompatible, environmentally friendly, affordable natural multifunctional materials with unlimited reserves of raw materials and low cost [3, 4].

In this study, using the method of organosolvent oxidation, agricultural waste was studied as potential sources of raw materials for the production of cellulose from sunflower seed husks (SFH), soy husks (SH) and rice husks (RH). The study showed that the raw materials and the solvent (m/V, g/ml) are different 1/8, 1/10, 1/12, 1/14, 1/16, 1/18, 1/20, 1/22 an effective hydraulic module was obtained from the inside. The indicators of yield and quality of the obtained pulp are determined. The chemical structure of the obtained cellulose was also studied using a Fourier infrared spectrometer (Simex FT-801), the crystal structure on an X-ray diffractometer (XPertPRO Netherlands), the morphology of the SEM surface (Quanta 200i 3D FEITM), thermal stability (LabSys evo Setaram, France), particle sizes (Winner-2005a, China). According to the obtained result, the pulp yield was equal to SFH - 47.8%, SH – 38% and RH - 48.8%. This suggests that agricultural waste is a potential source of raw materials for the production of cellulose.

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THE UTILIZATION OF LOW-RANK COAL WITH CATTLE MANURE IN COMPOSTING IS ATTRIBUTED TO ITS BIOAVAILABILITY

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Coal is a natural raw material widely mined and plays an important part in the country's economy. However, coal also generates a significant amount of lignite classified as low-rank coal. The issue with low-grade fuels lies in their high moisture and ash content, rendering them unsuitable for energy and industrial applications. . Integrating low-rank coal into the composting process of cattle manure is a realistic option for utilizing this coal, leveraging its bioavailability to limit adverse effects and produce a novel type of compost.The bioavailability of low-rank coal is primarily related to how quickly microbes can access and break down its complex organic matter. When deciding whether to utelize coal, especially low-rank coal, as an energy source, its bioavailability can be said to be the decisive and only factor.Coal bioavailability, which depends on several variables, including microbial species, temperature, pH, and nutrient availability, is critical in determining how well microbes can degrade coal. One of the major factors affecting the coal bioavailability is its chemical composition. It composes various organic and inorganic compounds, such as carbon, hydrogen, oxygen, nitrogen, sulfur and minerals. In addition the chemical composition of low-rank coal can vary greatly depending on its origin, age, and geologic conditions. Considering this quality when dealing with low-rank coal is particularly important because it determines its potential as a source of energy, carbon, and other valuable materials.Porosity in low-grade coal is vital in adsorbing harmful or undesirable chemical compounds and facilitating bacterial penetration, expediting decomposition.Cattle manure is one of the most common types of organic fertilizers and feeds in the digestive tracts of domestic cattle, including bulls, cows, and calves.Cattle manure is rich in minerals like NPK and trace elements (copper, zinc, manganese, etc.) in readily absorbable forms and natural growth stimulants. However, its large-scale accumulation poses significant environmental challenges, making composting with low-rank coal a viable solution.The characteristics mentioned above of low-rank coal and cattle manure make them excellent sources for composting with substantial potential. Composting cattle manure with lignite can serve as a means of soil remediation. Scientific research has demonstrated that compost derived from low-rank coal and cattle manure is not phytotoxic to plants and can enhance plant yields.

Keywords: low-rank coal, bioavailability, cattle manure, compost

DEVELOPMENT OF MECHANO-ACTIVATED ADDITIVES BASED ON ALUMINUM AND ITS ALLOYS

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Aluminum is one of the available elements. It is the first metal used as a structural material in aviation. However, the softness of aluminum does not allow it to be used cleanly to create various structures. The addition of some chemical elements can significantly improve the mechanical properties of aluminum products. Silicon is one of the main alloying components. The use of Al-Si alloy as structural materials and hard fasteners in the aviation and space industry is due to the following characteristics: increased wear resistance, strength, corrosion resistance, low melting point compared to technically pure aluminum. The use of aluminum alloys is diverse. The use of structural alloys in engineering, shipbuilding, transportation, construction and other industries is steadily expanding.

The purpose of our research work is to obtain composite aluminum powders by mechanochemical processing and to study the laws of their influence on the combustion of condensed systems. As mentioned above, aluminum is an energy-intensive material when evaluating fuel efficiency relative to its mass. Its ability to oxidize in a variety of atmospheric environments, including oxygen, water vapor, monoxide, and carbon dioxide, makes it attractive for applications in areas such as solid-state rocket engines and explosives. Adding aluminum to these systems increases energy density at a lower cost.

The following reagents were selected as the main starting components: aluminum (Al) grade PA-4, fine powder of silver-white color (Al content 99.1%). Also AK-12 alloy, stearic acid, polyvinyl. Mechanochemical processing of the components was carried out in a three-drum with planetary-centrifugal motion of grinding media (PCM), the volume of the working chamber is 450 cm^3, the number of revolutions of the working chambers is 1200 per minute and the rotation speed of the platform with grinding chambers is 700 revolutions per minute, the number of cameras is - 2.

Various modern methods have been used to study the structure and properties of the raw materials obtained by mechanical processing, intermediates and target products. The phase composition of materials, specific surface area, particle size, and surface condition are investigated. Electron probe microanalysis was carried out on a desktop scanning electron microscope. The device normally has a low vacuum mode, which allows you to examine non-conductive samples without preliminary spraying of metal. The determination of the active aluminum content was carried out by the release of active hydrogen in interaction with a 20% NaOH solution.

The most widespread among silumins is the AK-12 alloy, which contains 10-13% silicon and has high corrosion resistance. However, its mechanical properties are not high enough. The microstructure at the eutectic point is a conglomerate of finely ground phases. This microstructure leads to low strength properties. It should be expected that during machining, it is possible to destroy the alloy to obtain a powder material consisting of a solid solution of silicon in aluminum and pure silicon. The fundamental difference between silumin and aluminum is the possibility of obtaining a powder material by mechanical action, unlike pure aluminum, the powder material from which is obtained only by spraying.

Aluminum powder is represented by phases of 97.81% aluminum and 2.2% aluminum oxide, while the initial silumin consists of phases of 87.3% aluminum and 12.1% silicon. The aluminum oxide phase is not fixed. It is known that during the preparation of thermite mixtures, aluminum powder agglomeration occurs, which during gorenje leads to a two-phase flow, reducing the energy characteristics of the fuel. To reduce the influence of agglomeration, powders are modified with organic compounds.

Keywords: aluminum alloys, mechanochemistry, combustion.

THE UTILIZATION OF A BIOCOMPOSITE DERIVED FROM LOW-RANK COAL AND SALT-TOLERANT BACTERIA AS A NOVEL SOLUTION FOR SALINIZATION OF AGRICULTURAL SOILS

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Soil salinization is a serious problem that threatens the sustainable development of global agriculture. It is estimated that about 62 million hectares, or 20 percent of the world's irrigated land, are currently subject to salinization. The excess of soluble salt on cultivated lands negatively affects crop yields and soil health. In the energy sector, natural fossil fuel coal even though widely used, releases a large amount of greenhouse gases. Additionally, the utilization process concentrates a large amount of low-rank coal (lignite, sub-bituminous coal), which has low energy value. However, low-rank coal is rich in humic substances that increase the structure of the soil, stimulate plant growth, and are used as a biofertilizer in agriculture. Resident coal bacteria can break down low-rank coal into humic substances through the processes of biodegradation and biosolubilization. In this regard, one of the new promising areas is the reclamation of economically significant crops, such as wheat and potatoes, on saline soils with low-rank coal. It has been proved by the positive results of several international scientific studies that a heterogeneous biocomposite consisting of salt-tolerant and coal-solubilizing bacteria not only reduces salt concentration in the soil but also releases active components for plant growth. Considering that soil salinization is a significant environmental issue, it is plausible to explore the potential of low-rank coals as a viable option.

Keywords: soil salinization, low-rank coal, humic substances, bacteria

DEVELOPMENT OF A THERMOREGULATED TRANSDERMAL PATCH WITH DANDELION EXTRACT(TARAXACUM OFFICINALE)

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One of the urgent and science-intensive problems in the creation of new dosage forms remains the search for biocompatible components of transdermal therapeutic systems (TTS). Such systems are very interesting due to the ability to deliver medicinal substances, bypassing the gastrointestinal tract and other organs to the target or the focus of pain, thereby avoiding the difficulties and harm of oral delivery, as well as the study of various mechanisms of the transfer of medicine through the skin. This contributes not only to a significant increase in the efficiency and volume of drugs used, but also significantly improve their consumer characteristics. Despite the complexity of creating transdermal forms, the number of medicinal substances delivered by skin diffusion is gradually increasing [1-2]. The aim of the work is the development and experimental study of a transdermal therapeutic thermoregulated system in the form of patches based on dandelion extract (Taraxacum officinale), growing on the territory of the Republic of Kazakhstan. The choice of polymer as a carrier is determined by the required rate of release of the medicine, depending on the physical properties of the polymer. Biodegradable and biocompatible polymers are used for medical purposes. In this study, a transdermal patch with a thermoregulated substance poly 2-ethyl-2-oxazaline was synthesized. Its ability to release the active phase was investigated by impregnation of colored vitamin B_{12} and dandelion extract. The thermoregulated transdermal patch was soaked with a napkin at temperatures of 25 and 37°C. The analysis of these samples was carried out by spectrometry. A significant increase in the release of active components with an increase in temperature, located in the structure of the transdermal patch, was revealed.

Keywords:dandelion Taraxacum, transdermal therapeutic system, thermoregulated, patch, polymer

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SYNTHESIS AND INVESTIGATION OF POLYMER CLAY COMPOSITE BASED ON NONIONIC MONOMERS AND BENTONITE CLAYS

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Functionalization of various adsorbents for the removal of heavy metal ions and ionic surfactants from water or waste water has attracted great research interest in the recent years due to the advantages of achieving high efficiency and good selectivity. Environmental pollution caused by toxic heavy metals is one of the most hazardous problems in many densely populated cities worldwide. Another very important worldwide pollution problem in our days is related to the increasing amounts of surfactants in waste water. Montmorillonite (MMT) is abundant in nature and well known for its lamellar structure, high surface area, and anionic charges. Due to its excellent surface properties, MMT has been used as support for hybrid nanomaterials. The combination of polymers containing functional groups and an inorganic matter like porous silica and zeolites affords to obtain a highly efficient material. It is well known that cationic surfactants can be separated from water in a similar way like heavy metal ions due to the adsorption on MMT clays.

Hence, in this study, chemically cross-linked composite gels based on bentonite clay from OrtaTentek and Tagan deposit (Kazakhstan Republic) and nonionic polymers, i.e., poly(hydroxyethylacrylate) and poly(acrylamide), were polymerized in situ after preliminary intercalation of monomers in an aqueous suspension of bentonite clays.

By means of cryo-scanning electron microscopy, it was shown that bentonite clay is well incorporated into the gel network structure with pore sizes up to 2μm. The intercalated bentonite clay can adsorb cationic surfactants as well as heavy metal ions due to electrostatic interactions. Conductometric and surface tension measurements indicate not only the adsorption of surfactants and heavy metals inside the hydrogel, but also the displacement of the critical micellization concentration (CMC) of the surfactants.

Keywords:nonionic polymers, polymer clay composite, bentonite clay, pollutants.

USE OF QUANTUM CALCULATIONS TO PREDICT CARBON NANOFILTERS BEHAVIOUR AT IODINE FILTERING

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This work is connected to the work creation of the radioactive iodine filter. The aim of this research is to assess the reactions of the products of lignin and glucose decomposition with iodine in aqueous solutions using quantum computations to understand the absorption processes on filter. All calculations were performed on the Gaussian 16 C.01 programme using semi-empirical parametric methods (PM3). The results of these calculations were obtained from thermodynamic data sets, enthalpy, and Gibbs free energy. These data were calculated by assessing the thermodynamic data of the reactants, transition states, and products of the reactions. The mechanism of the reactions was iodine–nitrogen bond formation with four different compound groups formed by lignin and glucose decomposition in the nanofiber. These compounds had functional groups of graphite and tetrahydropyran with additional NH_2 groups, pyridine, and pyridone. The results show that only the pyridine-type groups have a negative Gibbs free energy, -33.267 $kJmol^{-1}$ at 25 degrees Celsius and 1 atm, and the enthalpy and Gibbs free energy for graphite and tetrahydropyran-type groups have similar values. These data are preliminary and require further investigation with consideration of the reactions' mechanism and serve as supplementary information. The calculations were performed at supercomputer of the Satbayev University.

Keywords: quantum calculations, lignin, glucose, thermodynamic data, iodine, carbon nanofiilters

DEVELOPMENT OF SORPTION SPECTROSCOPIC METHODS FOR THE DETERMINATION OF HEAVY METALS

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Annotation. Sorption-spectroscopic determination of soil samples of the Tashkent region was carried out. It was found that the content of Cu, Cr, Pb, As, Mo, Sb among heavy metals in the soil exceeded the permissible norms, since the main source is enterprises located in the industrial zone of Akhangaran. The data of the method were compared with the results of mass spectroscopy.

Keywords: sorption spectroscopy, immobilized organic reagents, heavy metals, soil, inductively coupled plasma mass spectrometry (MS).

Modern tasks of monitoring the environment, sources of its pollution, as well as problems of ecological analytical chemistry of small concentrations of heavy and toxic elements determine the development and improvement of methods of physico-chemical analysis. [1-3].

The authors carried out monitoring of heavy metals in environmental objects as well as sorption-spectroscopic determination of them. The analysis of the soil of the Industrial zone where the factories are located in the Akhangaran district of the Tashkent region is carried out. The content of heavy metals in the soil taken from the industrial zone at a distance of 1 km, 5 km and 10 km was monitored.

Research methods

The process of sampling and sample preparation of soil samples was carried out according to GOST[17]. Sorbents synthesized at the Department of Polymer Chemistry of NUUz were used. In order to improve the properties of sorbents, the immobilization of organic reagents was carried out, such as derivatives of nitrosonaphthols, sulfosarsen, thoron I, sulfosalicylic acid, amido black, etc. Standard and working solutions of reagents were prepared according to the method specified in the literature [4].

Methods of immobilization and sorption. Before the sorption of metals, the sorbents were activated with HCl solution. After that, solutions of organic reagents were prepared for each metal, a certain concentration for each of them. Sorbents were lowered into reagent solutions and mixed on a magnetic stirrer. After immobilization, the sorbents were washed with bidistilled water, and metals were sorbed from sample solutions. After that, sorbents were desorbed and metals were extracted. The concentration of metals was determined by atomic absorption spectroscopy. The results are shown in Table.1.

To verify the accuracy and correctness of the data, heavy metals in the soil were also determined by mass spectrometry (ISP-MS) - 0677:2015 (MVI No. 499-AEM/MS). Among the metals analyzed by the ICP-MS method, the elements vanadium, chromium, manganese, arsenic, strontium, molybdenum, cadmium, tin, antimony, lead, bismuth were selected for study, and the content in the soil (million, mcg/g, g/t).

Table 1
The content of elements in soil samples

№	Name of the metal	From the zone 1 km	From the zone 5 km	From the zone 10 km
1	**V**	150	110	100
2	**Cr**	120	79,0	81,0
3	**Mn**	1300	1100	910
4	**Cu**	56,0	52,0	33,0
5	**Sr**	250	220	190
6	**Mo**	4,40	4,00	3,50
7	**Cd**	0,170	0,280	0,094
8	**Sn**	3,90	2,90	3,40
9	**Sb**	2,00	2,70	2,70
10	**Pb**	41,0	46,0	37,0
11	**Bi**	0,510	0,510	0,460

Conclusion

The soil taken from the industrial zone was analyzed by sorption spectroscopic and mass spectrometry (ISP-MS). As can be seen from Fig. 1, metallic manganese in the largest amount, 1300 mcg / g in soil taken at a distance of 1 km from the zone, 1100 mcg /g at a distance of 5 km from the zone, 910 mcg/g at a distance of 10 km from the zone. Also, the smallest metal is cadmium metal, the amount of Cd in the soil taken at a distance of 1 km from the zone is 0.170 mcg/g, at a distance of 5 km the amount of Cd is higher than the amount in the soil taken at a distance of 1 km from the zone. at a distance of 1 km, i.e. 0.280 mcg/g, at a distance of 10 km — 0.094 mcg/g. During soil migration, the amount of heavy metals in the soil mainly decreased with distance from the industrial zone. When approaching the zone, the amount of heavy metals increases, because the main source is considered to be factories located in the industrial zone of Akhangaron. Sorption spectroscopic analysis with immobilized organic reagents for the determination of heavy metals was carried out. This method allows the determination of heavy metals with low concentrations and contributes to solving environmental problems.

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DETERMINATION OF MICROELEMENTS AND ORGANOCHLORINE COMPOUNDS IN ENVIRONMENTAL OBJECTS TO OBTAIN NANOPARTICLES

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This work is devoted to the development of methods for the analysis of the levels of polychlorinated biphenyls (PCBs) in soil samples using a gas chromatographic method with electron capture. The optimal condition for the analysis of a gas chromatograph has been experimentally confirmed. In this case, capillary columns with a diameter of 0.1 mm and a length of 10 m were used. The inert gas He was chosen as the carrier gas in gas chromatography and the flow rate was 0.5 ml/min. As a result of the research, the following temperature modes of heating were chosen: a furnace at T=300°C for 2 min, an injector temperature at T=320°C for 2 min, and an ECD (electron capture detector) temperature T=320°C. It has been established that solutions of polychlorinated biphenyls evaporate at T=250°C. In these cases, the separation is carried out at T=250÷300°C. In the analysis of PCBs in the studied samples, methods of extraction, addition and calibration were used. Addition methods and a calibration curve were used to study the effect of the matrix on the PCB signal. It was found that the addition of PCB at a concentration of 200 μg/ml to the matrix did not affect the values of the observed signal. The objects of study were aqueous soil samples, extraction solutions, and standard solutions of polychlorinated biphenyls. Calibration plots and identifications of 7 related PCB isomers were obtained under optimal conditions. Soil samples were extracted with a mixture of chloroform (1:1 by volume) for 4 hours. The final 2.0 ml extract was analyzed for the presence of PCBs using a gas chromatograph equipped with a 10 mCi 63Ni GC-ECD model 86/30 electron capture detector. The average concentration of ∑PCB (1.143±0.06 μg/kg) was well below the recommended level of 0.1 mg/kg. In this work, studies were carried out on the quantitative content of trace elements in the studied soil samples. The variations of the microelements in soil samples were analyzed by the method of atomic absorption spectrometer “Saturn”. The mean concentration (in mg/kg) of the metals were Ca (416± 19,1) >Na (222 ± 13,6)>Cu(100±3,9)>Ni (87±5,1)>Pb(57,1±2,9)>Zn (40.0 ±2.5) >Co (29.0±1,9) > Cd(21.3±1,5) > Fe (18.0±1,3)> Mn (10.0±1,2)>Cl-(0,32±0,02). The variations in the levels of the microelements were in the order Ca >Na >Cu>Ni >Pb>Zn >Co > Cd > Fe> Mn >Cl-. Very few sites were found to be contaminated with metals, but the level of metal contamination was very low. There was no significant correlation between the PCBs and any of the metals. The sources of the PCBs and metal were anthropogenic. The mean concentration of the PCB (1.143±0.06 μg/kg) was much lower than the 0,1 mg/kg recommended level.

Keywords: organochlorine compound, extraction, microelements, retention time, solvent, nanoparticles

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IMPACT OF THIAZOLE YELLOW G DYE ON THE STRUCTURAL, LINEAR, AND THIRD-ORDER NONLINEAR OPTICAL PROPERTIES OF PMMA/CDS POLYMER NANOCOMPOSITES FOR OPTOELECTRONIC AND PHOTONIC APPLICATION

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Thiazole yellow (TY) dye-doped poly (methyl methacrylate)/CdS polymer nanocomposites (PNCs) thin films were developed by the spin coating technique. The structural, surface morphology, linear, third-order nonlinear optical (NLO) properties have been investigated. The structural properties of prepared samples were investigated using ATR-FTIR and X-ray diffraction (XRD).The surface morphology photographs were recorded using atomic force microscope (AFM). The TY/PMMA/CdS PNCs shows strong linear absorption spectra at range 320nm and 414nm nm in the visible region and also observed direct and indirect optical band gap decreases with increasing in the dye concentration for CdS/PMMA PNCs calculated by using Tauc's plots. In addition, the NLO properties of nonlinear refractive index (n_2), two-photon absorption (β), and third-order nonlinear susceptibility ($\chi^{(3)}$) were studied using the Z-scan technique with a DPSS continuous wave (CW) laser operating at 532 nm wavelength. The influence of dye doping has switched the nonlinear absorption reverse saturable absorption behavior (i.e. RSA). The obtained β, n_2, and $\chi^{(3)}$ are found to be in the order ~10^{-4} cmW^{-1}, 10^{-8} cm^{2}W^{-1}, and 10^{-7}esu, respectively for all the samples. Further, they exhibited strong optical limiting behavior with lower limiting thresholds (~kW/cm^2). The prepared PNCs exhibits strong linear and extreme changes in NLO properties showing that the PNCs could be suitable for optoelectronic and photonic applications.

Keywords: Polymer nanocomposites, optical bandgap, nonlinear absorption, two-photon absorption, optical limiting.

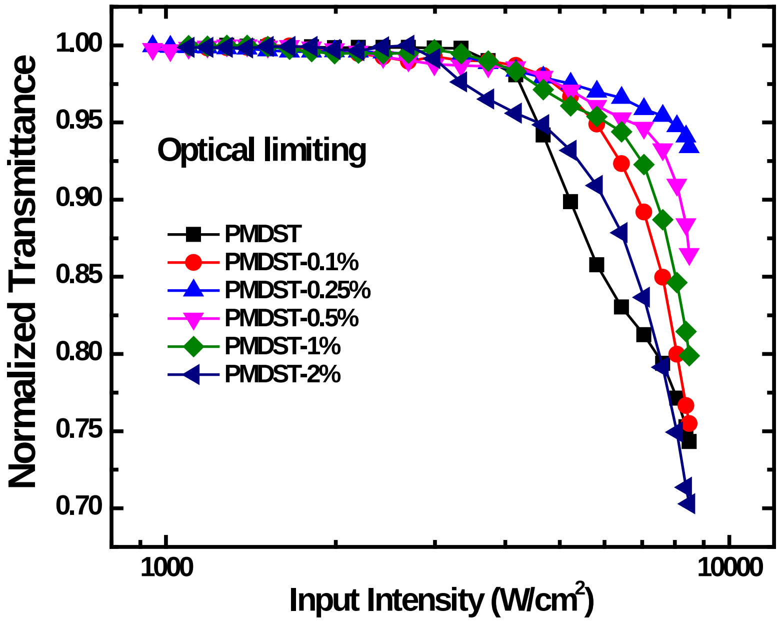

Figure 1: Optical limiting curves of PMDST NCs

POLY(LACTIC ACID)/NANOCELLULOSE BIOCOMPOSITES FOR SUSTAINABLE FOOD PACKAGING

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Considerable interest in food packaging research has been prompted by the rising environmental impact of waste, customer awareness for readily accessible foods with extended shelf life, and ecological consciousness about the scarcity of natural resources. The utilization of plastic-based food packaging has resulted in a significant environmental concern due to the accumulation of substantial quantities of plastic in the surrounding areas. Research efforts are being motivated by ecological and health considerations in the pursuit of developing biodegradable films. Besides, poly(lactic acid) (PLA) has been suggested as a possible substitute for petroleum-based polymers because of its sustainability, simple accessibility, and biodegradability. PLA is a biodegradable plastic made from sugar beet or maize starch that may be fermented by bacteria to generate material with desirable qualities like transparency and rigidity. However, there is a need for further improvement in certain properties of PLA, such as flexibility, toughness, permeability, and thermal properties. One potential approach for enhancing these attributes involves the integration of nano reinforcement. The utilization of nanocellulose derived from biomass has garnered significant interest in recent times owing to its renewable nature, ability to biodegrade, impressive mechanical strength, as well as its low density, and considerable economic worth. In this study, we present a comprehensive overview of the most up-to-date methods for synthesizing nanocellulose and its use as a filler material in the manufacture of PLA nanocomposites for food packaging. In addition, this study examines the emerging challenges and potential advantages associated with the utilization of PLA biocomposites incorporated with nanocellulose in the food packaging sector.

Keywords: Poly(lactic acid); Nanocellulose; Bionanocomposites; Food Packaging

MACHINE LEARNING ASSISTED PREPARATION OF CELLULOSE NANOCRYSTALS: A CASE STUDY

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The production of nanocomposites using the extraction of cellulose nanocrystals (CNCs) from various cellulose sources is a viable and sustainable method. Traditional batch experiments, however, take a lot of effort and time. Therefore, three machine learning (ML) algorithms were used to create ML models: decision regression tree, random forest, and artificial neural networks. The dataset gathered from the literature that has already been published was utilised for training the ML models that may be employed with a variety of cellulose sources and reactions. The choice regression tree had the maximum accuracy for the crystallinity prediction, while the random forest approach had the lowest accuracy for yield prediction. The most important parameters that determine the yield and crystallinity prediction are cellulose source and concentration of reagent. This study provides new perspectives and opportunities to understand and improve the preparation of CNCs.

Keywords: cellulose nanocrystals, machine learning, decision regression tree, random forest, artificial neural networks

INVESTIGATION OF EFFECT OF NANO KAOLINITE AS A FILLER IN THE COARSE WOOL - VINYL ESTER COMPOSITE

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In the reported work, wool fabric was coated with vinyl ester resin and subsequently composites were developed. To increase the mechanical properties of the composite, nano kaolinite was used as a filler. The effect of nano kaolinite in the physico- mechanical properties, surface morphology, moisture content, water contact angle, water diffusion and aging characteristics of the wool-vinyl ester resin composite was analyzed using various analytical methods. The inclusion of nano kaolinite significantly improved the tensile and impact strength of wool-vinyl ester resin composite. The SEM images depict a good adhesion between the wool fibre and the vinyl ester resin. The presence of nano kaolinite in the composite caused marginal reduction in the water contact angle and increase in the water diffusion properties. The FTIR spectra showed absence of chemical interaction between the nano kaolinite, wool fibre and vinyl ester resin. The thermal and UV aging properties of the wool-vinyl ester composites were improved with the addition of nano kaolinite, however the developed composites showed poor biodegradation.

CARBON BLACK/CHITIN NANOFIBER FOR GREEN TYRES: PREPARATION AND PROPERTY EVALUATION

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A green future prompted the innovation of tyres which is completely from sustainable material. This research highlights the synergistic use of carbon black (CB) and chitin nanofibers (CHNFs) for developing green tyres for the first time and characterized using FTIR, SEM, TEM, TG and BET surface area analysis. The FTIR analysis confirmed the presence of α chitin in the prepared CHNFs. The SEM and TEM images displayed the fiber like morphology and the diameter ranges from 18-32 nm. The Thermogravimetric analysis presented the degradation was single staged and the decomposition falls in the range 250-370 °C. The study focusses on the synergic effect of chitin nanofibers and carbon black (CB) on natural rubber (NR) latex were investigated by varying concentrations of CHNFs on NR latex. The cure behavior, mechanical properties, swelling and dynamical characteristics of Neat-NR, NR/CB50, NR/CB50/CHNF composites were examined. The results revealed that there is a rise in the tensile strength and tear strength upon the addition of CHNFs. The optimum values were obtained for NRCHNF1.0 composite. The reinforcing ability of CHNFs in NR were confirmed by glass transition temperature as well as sorption studies. The sorption studies revealed the enhanced mechanical properties of NRCHNF1.0 composite. Furthermore, it was noticed that all the composites showed comparable thermal stability regardless of the amount of CHNFs. DMA analysis exhibited an increase in the storage modulus and decrease in the Tan δ upon the incorporation of CHNFs. This study will be a promising tool for the circular economy as it aims the development of green tyres using renewable resources.

Keywords: Chitin nanofibers, Natural Rubber latex, Carbon black, Circular economy

FABRICATION OF NANOCELLULOSE-POLYMER ADSORBENTS FOR WATER PURIFICATION APPLICATIONS

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Nanocellulose a most valuable renewable resource is an excellent material reported to have a wide range of applications in the field of water purification and environment remediation. With distinctive properties like high surface area, tailoring of surface properties, high crystallinity, biodegradability etc, various promising materials can be produced for the removal of pathogens from water, remediation of polluted water, degradation of toxic organic compounds, adsorbents for oil spill contamination, and environmental remediation. Herein we report the fabrication method of nanocellulose/polymer adsorbents which are surface modified through different routes depending on the contaminant to be removed from water. The nanocellulose based adsorbent are also suitable for environment remediation application like CO_2 capture which is a major reason for global warming.

Keywords: Nanocellulose, environment remediation, water pollution, clean water

SERICIN BASED NANO-COMPOSITES FOR WATER PURIFICATION

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Sericin is a vital protein refers to the group of glycoproteins expressed in the middle of silk gland of Bombyx mori. Silk consists of 20–30% sericin, has the property for gum coating the fibers and allowing them to stick to each other. Sericin have various application in different fields such as biomedical and food industries. However, reports say that one of its vital applications of sericin is water purification. In which it has been combined with other fillers and polymers such as PEG-DE, CNC, PHMB, Keratin, PVA, Polyester and Alginate to make it more effective for water purification. Nowadays, water pollution is the main concern of the mankind. It is a great challenge to treat waste water because of the inefficiency in developing strategies for waste water treatment. The traditional adsorbent materials have a lot of disadvantages such as high cost, low efficiency and lacks the ability to remove wide range of pollutants. Furthermore, the use of chemicals in the area of waste water treatment also leads to secondary pollution. Being an important adsorbent in the area of water purification sericin has an edge over because of its hierarchical fibrous structure and anti-bacterial properties. Based on its properties sericin based composites can be converted to films. Hydrogels and aerogels are the two types of sericin-based composites, can be created in addition to films. This review concise an overview of significance of sericin in waste water treatment, different extraction techniques, modifications and applications.

Keywords: water pollution, sericin, advantages, significance

ELASTOMER-BASED VITRIMERS - PREPARATION, CHARACTERIZATION, AND APPLICATIONS

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Elastomers and rubber products hold prime importance in all aspects of modern society. However, the permanent cross-links of those polymers enormously block their frontier developments and restrain them from being reproducible and reshaped. In consequence, the majority of the waste materials becomes landfill and their incineration leads to serious environmental crises. An intense search to handle the hurdles of the permanent cross-linking system has begun long before and a new group of polymers known as vitrimers came out that works on the backbone of dynamic covalent networks (DCN). These exchangeable bonds give the polymer reproducibility, self-healing, and recycling abilities along with enhanced mechanical properties. Vitrimers can be developed from bioresources or from petrochemical origins and various chemistries have been developed to formulate these polymers. Tremendous innovations have been employed in the area of elastomer-based vitrimers in recent years. The natural rubber-based vitrimers incredibly exceed the others in implementation and application segments as they developed from a bio-origin. Here our study enfolds the various types of elastomer-based vitrimers and focuses on their synthesis routes, characterization, property evaluation, and potential applications. The goal of this is to provide a comprehensive overview that combines the majority of elastomer-based vitrimers, their blends, and their potential future developments in a concise format.

Keywords: Vitrimers, Dynamic Covalent Networks, Cross-link density, Transesterification

SYNTHESIS OF ANION EXCHANGE MATERIAL BASED ON POLYACRYLONITRILE AND UREA

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The development of an adsorbent with high adsorption ability and favorable cyclic regeneration performance for the removal of Cr(VI) from wastewater is a task of vital importance. To this end, polyacrylonitrile fiber was modified with urea, and prepared anion exchange fibers. The novel fibers were characterized using techniques such as Fourier-transform infrared spectroscopy, X-ray diffraction analysis, and thermo gravimetric analysis. The new anion exchange fibers could effectively adsorb low-concentration Cr(VI) from real secondary effluents in a fixed-bed column experiment. Our work provides a promising and low-cost material for the removal of Cr(VI) in practical applications. It is known that temperature and time are the main factors affecting the course of chemical reactions. The influence of temperature and time on the reaction of nucleophilic addition of urea and modification of polyacrylonitrile fibers was studied. The modification process was initially carried out at different temperatures for a fixed period of 3 hours. The research results showed that the favourable temperature for modification of polyacrylonitrile with urea was 448-453K. It was also observed that the process has a negative effect on the mechanical strength of the polyacrylonitrile fiber at temperatures higher than those selected at this fixed time for modification. Changes in the physicochemical and sorption properties of anion exchange materials formed during the modification process were monitored by checking the value of the static exchange capacity. Values of the static exchange capacity ranging from 0.78 to 4.1 meq/g were obtained according to the temperatures mentioned. The effect of time on the modification process of polyacrylonitrile with urea was also investigated. Also, experimentally, a reaction time of 4 hours at 448K was found to be sufficient and optimal. Apparently, after a certain immobilization of urea molecules in the polymer matrix, the further possibility of the reaction is hindered by the large conformation of the modifying reagent. The sorbent's Cr(VI) adsorption was a chemically controlled and intermediate-controlled process and had activation energies of 35.18 kJ/mol. Analysis of the IR spectrum of modified polyacrylonitrile fabrics showed that due to the chemical reaction between polyacrylonitrile and urea, there was a decrease in the intensity of the absorption band in the 2242 cm^{-1} region belonging to the -CN group. This indicates a decrease in the number of –CN groups in the sample. Also, in the IR spectrum at 3303 cm^{-1} and 3214 cm^{-1} new extended absorption bands corresponding to -OH and $-NH_2$ groups appeared. In newly modified PAN, vibrations corresponding to -C=NH groups appeared in the region of 1246 cm^{-1}. In this work, an anion exchange material was synthesized and its physicochemical properties were studied in order to remove Cr(VI) from water systems. It was also found that the anion exchange material synthesized on the basis of polyacrylonitrile has a strong structure and is easily regenerated and efficiently removal Cr(VI) in the wastewater.

Keywords: Hexavalent chromium, Adsorption isotherms, Removal process, Chemical modification, Anion exchange material.

QUANTUM CHEMICAL INVESTIGATION INTO THE EFFECTS OF CORE STRUCTURE AND ENERGY LEVEL TUNING ON THE EFFICIENCY OF NONFULLERENE ACCEPTORS IN ORGANIC SOLAR CELLS

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Nonfullerene acceptors (NFAs) are a new focus in organic photovoltaics (OPVs) that continue to improve on the shortcomings of many fullerene-based electron acceptors. The goal of this research is to determine certain key characteristics that influence the efficiency of NF-acceptors in OPVs. These findings contribute to a better understanding of the influence of the NFA's core structure (electron rich/poor group) on photophysical and optoelectronic capabilities. Furthermore, the effect of the small ΔLUMO value (the subtle difference in energy between NFAs' LUMO+1 and LUMO orbitals; LUMO=lowest unoccupied molecular orbitals) on ultrafast charge transfer and charge separation processes in OPVs is investigated, which has recently been identified as a key factor for all top rated high performing NFAs. So far, ΔLUMO-based theoretical investigations have been limited to individual NFAs; here, we have expanded the study to the respective donor/acceptor complexes for the first time. Finally, based on first-principles density functional theory calculations with the seven reported NFAs, PC61BM, P3HT, and the seven newly modelled donor-acceptor complexes, this study sheds light on important factors that will provide trends and guidelines for further rational design of more efficient NF-acceptors for OPVs.

Keywords: Nonfullerene acceptors, charge transfer, donor-acceptor complexes, charge separation

A COMPREHENSIVE INVESTIGATION OF SILICONE RUBBER NANOCOMPOSITES FOR STRAIN SENSING: MECHANICAL, MORPHOLOGICAL, AND ELECTRICAL PERSPECTIVES

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In recent years, elastomeric-based sensing materials have seen significant advancements, resulting in a wide range of applications across fields including robotics, healthcare, and wearable technology. This study presents the development of silicone rubber-based soft elastomeric nanocomposites for strain sensing applications, utilizing multiwalled carbon nanotubes (MWCNTs), graphene nanoplatelets, and conductive carbon black as filler materials. Among these fillers, multiwalled carbon nanotubes demonstrate superior performance. Morphological characterization provides insights into the dispersion of filler materials within the silicone rubber matrix. The electrical characterization is a critical aspect in the development of piezoresistive strain sensors. These developed composites hold promise for practical applications, particularly in wearable health devices for real-time monitoring of body movements and postures in the context of fitness tracking and healthcare. Moreover, they exhibit potential in the realm of soft robotics, enhancing the adaptability and responsiveness of robots in human-machine interaction scenarios, such as prosthetics and assistive devices.

Keywords: Nanocomposites, Elastomeric-based sensing materials, Strain sensing, Multiwalled carbon nanotubes (MWCNTs)

ROLE OF CONTROLLED PROCESSING AND MODIFICATION ON NANOCELLULOSE/NATURAL RUBBER COMPOSITES

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The burgeoning demand for sustainability has contributed intensified researches in cellulosic materials. The research to explore the potential of nanocellulose is booming due to unique properties like renewability, biodegradability, light weight, high strength, non-toxic nature etc. In this study we evaluated the proficiency of nanocellulose as a reinforcing filler in natural rubber composite. Latex based master batches were prepared to improve the dispersion of nanocellulose in natural rubber matrix. Bis(3-triethoxysilylpropyl) disulfide (TESPD) silane coupling agent has been used to improve the compatibility between hydrophilic nanocellulose and hydrophobic matrix. The morphological studies confirmed better dispersion of nanocellulose in natural rubber matrix after TESPD modification. The improvement in hardness and abrasion resistance was significant for modified nanocellulose/natural rubber composites. The substantial increase in modulus of nanocomposite was evident from dynamic mechanical analysis. The improvement in tensile strength of nanocomposites was more evident at lower filler loadings of nanocellulose; presenting the potential of nanocellulose as a reinforcing filler. This impending biofiller can reduce the use of conventional fillers like carbon black and silica in rubber industries which inturn reduces the carbon footprint leading way to sustainability.

Keywords: nanocomposites, nanocellulose, natural rubber, modification, morphology

GREEN SYNTHESISED NANOCELLULOSE FOR CONTROLLED DELIVERY OF ANTIMICROBIAL AGENT

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Nanocellulose due to its unique properties like water retention, mechanical strength, biocompatibility, biodegradation, 3D structures mimicking the extracellular matrix has been a potential candidate for various biomedical applications such as drug carrier, tissue engineered scaffold material and 3D bioprinting ink. The process of extraction owes to its activity *in-vivo* because use of toxic and strong chemicals during its extraction can lead to changes in its active site groups and the residual chemicals can cause toxicity to cells. Thus, a green method and low-cost technique for extracting high quality nanocellulose is of great importance. Pre-treatment of the plant fibers with a green chemical followed by ultrasonication is the method we have adopted for a low cost and green extraction technique. The source of nanocellulose was chosen as water hyacinth which is considered as an invasive species which causes trouble to inland water transportation system and fisheries industry. The extracted nanocellulose was used in preparing films with essential oil and the delivery pattern was studied *in-vitro*. The extracted nanocellulose had a yield of 57%. Various parameters like concentration of the bleaching agent and reaction time were optimised and nanocellulose fibers with dimension of 50nm were obtained with impurities removed. The delivery of the antimicrobial agent, essential oil, showed a controlled release for a study conducted for 7 days. A facile, green, scalable, cost effective, non-toxic method for nanocellulose extraction was optimised and the extracted nanocellulose formed a good composite film and could deliver essential oil in a controlled fashion. Thus, the film could be used for wound healing application or as antimicrobial membranes for biomedical applications.

Keywords: Nanocellulose, Green Synthesis, Water hyacinth, Essential Oil, Antimicrobial Film

SUSTAINABLE DEVELOPMENT OF BIOENERGY FROM AGRICULTURE RESIDUES AND ENVIRONMENT

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This communication discusses a comprehensive review of biomass energy sources, environment and sustainable development. This includes all the biomass energy technologies, energy efficiency systems, energy conservation scenarios, energy savings and other mitigation measures necessary to reduce emissions globally. The current literature is reviewed regarding the ecological, social, cultural and economic impacts of biomass technology. This study gives an overview of present and future use of biomass as an industrial feedstock for production of fuels, chemicals and other materials. However, to be truly competitive in an open market situation, higher value products are required. Results suggest that biomass technology must be encouraged, promoted, invested, implemented, and demonstrated, but especially in remote rural areas.

Keywords: Biomass resources, wastes, woodfuel, biofuels, energy, environment, sustainability related with bioenergy development, disperse systems formulation science, surfactant sciences

BISMUTH SULPHIDE NANOPARTICLES ADORNED REDUCED GRAPHENE OXIDE/SILVER SUBSTRATE TO DETECTION AND DEGRADATION OF PHARMACEUTICAL DRUGS: ADSORPTION ISOTHERM, KINETIC, ECOLOGICAL RISK ASSESSMENT AND DEMOGRAPHIC STUDIES

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Bismuth sulfide nanoparticles (BiS NPs), were synthesized via the hydrothermal method, and the reduced graphene oxide(rGO), and silver nanoparticles (Ag) were prepared using the chemical reduction method, and this rGO/Ag composite acts as a substrate. The synthesized nanoparticles are subjected to characterizations such as X-ray diffraction(XRD), scanning electron microscope(SEM), UV-Vis-spectroscopy, and photoluminescence spectroscopy. Commercially available paracetamol-500mg (PAM) and aspirin-300mg (ASP) were selected for photodegradation under visible light using the as-prepared composites in an aqueous solution. Photoluminescence spectroscopy is used to detect PAM and ASP, using the photo-excited electron transfer (PET) process, the limit of detection(LOD) obtained for PAM(8.70ppm) and ASP(4.43ppm) with a sensitivity of 0.9954 and 0.8002. Fourier transform infra-red spectroscopy(FTIR) was used to analyze the before and after degradation products, to confirm the disintegrated products obtained using photodegradation such as –COOH and – CH- using photo-induced electron-hole pairs. The experimental data was found to fit well with the Freundlich isotherm, suggesting the as-prepared nanocomposites exhibit a heterogeneity nature for PAM(5119mg/L) and the pseudo-first-order kinetic model suggests ASP(1030 mg/L) with the R^2 value of 0.9119 and 0.7075. The risk assessment analysis on PAM was 9.823µg/L (RQ>1) and ASP 0.2106 µg/L(RQ<1), indicating that PAM is at higher potential risk than ASP. The demographic data on the subjects designates that PAM was the most stockpiled medicine at home, and they suggest that unused/expired tablets should be properly disposed.

Keywords: Pharmaceutical drugs, Photocatalytic degradation, Risk Assessment, Kinetic, adsorption, Demographic data

EXPLORING THE RHEOLOGICAL CHARACTERISTICS OF NATURAL RUBBER LATEX REINFORCED WITH GRAPHENE OXIDE-SILICA HYBRID

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In recent years, the incorporation of nanofillers into polymer matrices has gained significant attention to enhance the mechanical and rheological properties of polymer-based materials. This study investigates the potential of Graphene Oxide-Silica hybrid nanofillers (GO/NS) to improve the viscoelastic properties of natural rubber. Natural rubber is known for its remarkable elasticity but exhibits limitations in terms of mechanical strength and processability. The incorporation of nanofillers offers a promising avenue for addressing these limitations. The primary objective of this research is to analyse the impact of GO/NS on the rheological properties of natural rubber latex in its liquid state. A comprehensive methodology is employed to achieve this, involving shear rate ramp experiments and dynamic (oscillatory) measurements. By systematically varying the volume fraction of hybrid nanofillers, the study aims to elucidate and predict changes in the rheological properties of the composite material. The findings demonstrate that the addition of GO/NS has a profound influence on the viscoelastic behaviour of natural rubber latex. The shear rate ramp experiments reveal significant alterations in flow behaviour and shear-thinning characteristics, suggesting enhanced processability. Dynamic measurements further indicate changes in storage and loss moduli, highlighting the potential for improved mechanical properties.

AG NANOPARTICLES REDUCED FROM STARCH USING GREEN SYNTHESIS TO INHIBIT FUNGAL GROWTH IN PLANTS AND VEGETABLES

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Ag NPs are considered as one of the most valued precious noble metals, widely recognized for their special anti-bacterial, anti-cancer, antivirus, biosensor, and photocatalytic activity. Ag NPs also include wound dressing, catheters, and bone cement.[1] Ag NPs are further utilized in topical ointments and creams to prevent wounds and burn infections.[2] Likewise, due to their improved antibacterial properties, they can be utilized in water filtration systems for purification.

Antibacterial property, antiviral and antifungal efficiency of the material is previously reported. Chemical synthesis methods were widely adopted which is less efficient for medical and agriculture fields due to the toxicity of the used chemicals. In addition the chemical agents utilized in these procedures are environmentally hazardous[3]. Biological approaches for nanoparticle manufacturing including microbes, enzymes, and herbs or plant extracts have been considered environmentally eco-friendly alternatives to chemical and physical processes.[4,5]

The aim of the present study was to synthesise silver NPs from herbs and to determine their inhibitory effect against fungi which infect vegetables and plants. *Antifungal studies were carried out against Candia as Candida* is one of the most common causes of fungal infections. In this work, Ag nanoparticles were synthesized via in situ reduction using starch as the reducing agent. After structural analysis, Antifungal and Antibacterial studies were conducted through well diffusion method using Amikacin antibiotic as the control. The results showed that various concentrations of Ag NPs have antifungal properties against Candida. Antibacterial studies were conducted against *S. Aureus* which shows very good activity. The basic requirement for the possible usage of silver to suppress plant pathogens is getting more information about the antimicrobial and antifungal activity of the sample.

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EFFECT OF SILICON DIOXIDE NANOPARTICLE ON MICROSTRUCTURE, MECHANICAL AND BARRIER PROPERTIES OF BIODEGRADABLE PBAT/PBS FOOD PACKAGING

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Biodegradable polyester polymers including poly (butylene adipate-co-terephthalate) (PBAT) and poly (butylene succinate) (PBS) are used as sustainable and eco-friendly food packaging but poor water vapor barrier properties limit their applications with moisture-sensitive products. This research blended PBAT/PBS materials at 60/40 and 50/50 with silicon dioxide (SiO2) nanoparticles as master batch pellets via twin-screw extrusion before sheet-casting to improve food packaging barrier properties. PBAT/PBS/SiO2 nanocomposite films were investigated by X-ray diffraction (XRD) and Fourier transform infrared (FTIR) spectroscopy and also for mechanical relaxation, microstructure, surface topography, and barrier properties. Scanning electron microscopy-energy dispersive X-ray analysis (SEM-EDX) indicated dispersed SiO2 nanoparticle aggregation in polymer matrices at higher loading. FTIR spectroscopy results suggested modified C–O stretching vibrations in polyesters, concurrent with shifting X-ray diffraction angles depending on nanoparticle content and polymer blend ratios. Adding SiO2 nanoparticles at up to 1% exponentially reduced water vapor permeability by up to 26%, while decreasing oxygen permeability (up to 8%). Mechanical properties reduced when adding SiO2 nanoparticles but film stretching improved polymer orientation at higher loading, thereby increasing tensile strength and elongation. Compounding SiO2 nanoparticles with PBAT/PBS polyester polymer blends enhanced barrier properties for biodegradable food packaging.

PROGRESS IN THE PREPARATION AND APPLICATION OF ENGINEERED BIOCHAR FOR WASTEWATER REMEDIATION

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Nowadays, water contamination has become a global concern due to industrialization, urbanization and other domestic activities, all of which made a harmful impact on our aquatic resources. Treating wastewater not only downsizes water scarcity but also, simultaneously regains both energy and essential nutrients it helps to rectify the exploitation of important sources of water. Among various methods, wastewater purification through adsorption is a considerably favourable choice. Biochar is a commonly employed eco-friendly and effective adsorbent for pollutant removal. Furthermore, it can be easily produced from a variety of biomasses and is low in cost. Although, raw or unmodified biochar is not effective enough for water pollution. As a result, there is a growing interest in engineered biochars (those modified physically, chemically, or biologically) and their composites to improve the effectiveness of pollutant adsorption. This paper reviews on the significance of biochar in wastewater treatment, preparation and factors influencing biochar properties and adsorption mechanisms of biochar, with a main focus on highlighting different modification techniques of biochar and their application in wastewater remediation. This paper also discusses the challenges and future research of sustainable wastewater treatment by engineered biochar.

Keywords: wastewater treatment, engineered biochar, emerging modifications, applications.

AN OVERVIEW OF DRUG DELIVERY SYSTEMS: SERICIN AND SILK FIBROIN FOR BREAST CANCER TREATMENT

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Breast cancer continues to pose a significant global health challenge, demanding the development of innovative approaches to drug delivery. This review investigates the promise of sericin and silk fibroin, which are natural proteins sourced from silkworms, as potential materials for drug delivery systems tailored to breast cancer treatment. The review conducts a comprehensive analysis of existing literature on drug carriers based on sericin and silk fibroin, with a primary focus on their compatibility with biological systems, their capacity to load and release drugs, and their targeting mechanisms. Furthermore, it delves into the examination of in vitro and in vivo studies that have underscored the effectiveness of these proteins in addressing breast cancer. Insights from diverse sources affirm their ability to improve drug stability, diminish adverse effects, and augment drug concentrations precisely at the tumor site. The adaptability and degradability of these proteins render them attractive candidates for breast cancer drug delivery. This review not only consolidates the current body of knowledge but also underscores the importance of sericin and silk fibroin in propelling progress in breast cancer therapy, unveiling novel avenues for research in this domain.

Key words: Sericin, fibroin, drug delivery, breast cancer, nanocarriers.

A REVIEW ON THE EFFECT OF VARIOUS PARAMETERS ON BIOCHAR

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Biochar is a solid substance which is produced via thermochemical breakdown of biomass in a low oxygen atmosphere. It has been reported to have various applications in adsorption, fuel cell, soil improvement etc. Biochar based adsorption has been mainly used for dye removal and heavy metal removal from wastewater. Magnetic biochar are mainly used for the removal of heavy metals especially iron. Works revealed that biochar can undergo certain some surface modifications like surface functional group modification, acid and alkaline modification, biological modification, etc., Biochars have the ability to remove chemical, biological and physical contaminants. There are many factors which have been reported to affect the properties of biochar relay on its applications which include adsorbent concentration, pH, pyrolysis temperature, surface area and porosity, contact time, types of pyrolysis etc. Biochar are derived from waste materials which includes rice straw, pistachio shells, cashew nut shells, walnut shells, pecan nutshell, castor seed hull, wood, acacia green waste, bamboo stick, Proposis juliflora and so on. The characteristics of biochar play a significant role in the adsorption mechanism. We discussed the types of biochars, modifications, applications and its techniques for studying adsorption mechanisms.

Keywords: Biochar, Affecting parameters, Applications, Modifications, Examples

PROCESSING-MORPHOLOGY-PROPERTY RELATIONSHIPS OF REDUCED GRAPHENE OXIDE RUBBER NANOCOMPOSITES: A CRITICAL REVIEW

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Rubber nanocomposites represent a ground-breaking class of materials that have revolutionized rubber-based products' performance, durability, and versatility across various industries. These materials are the result of integrating nanoscale fillers into rubber matrices. Nanofillers like reduced graphene oxide have emerged as key components in rubber nanocomposite. Rubber materials are widely used due to their elasticity and flexibility in various industrial applications. The incorporation of rGO, a remarkable carbon-based nanomaterial, has shown tremendous potential in improving rubber's mechanical, thermal, and electrical properties. When adding rGO to rubber, it's crucial to consider the proper dispersion and compatibility to achieve these advantages effectively. The quality of property improvements is closely linked to the processing history and the morphology of nanocomposites. The research and development of rubber nanocomposites is expanding, promising to redefine the capabilities of rubber-based materials and drive innovation in various industries.

Keywords: Rubber nanocomposites, Nanofillers, Reduced graphene oxide.

SYNTHESIS, CHARACTERIZATION OF NCDS FROM BRAHMI (BACOPA MONNIERI) AND FE^{3+} AND NI^{2+} SENSING AND METHYLENE BLUE DYE DEGRADATION ANALYSIS

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Today, the presence of contaminants in water bodies poses a threat to humans as well as the ecosystem. It is often the root cause of several severe health disorders in humans, including cancer, organ damage, and other serious health issues. A proper understanding of water contamination is essential for a sustainable development. The purpose of this study is to develop a biosensor for the identification of the presence of heavy metal ions and methylene blue dye degradation using a biocompatible material. In the current work, nitrogen-doped carbon dots (NCDs) were synthesized using medicinal plant Brahmi (*Bacopa Monnieri*), under the hydrothermal process at 120^{0C} for 16 hours. The particle size and morphology of the nanoparticles were evaluated using HR-TEM, FE-SEM, and DLS analysis. The Raman spectroscopy, FTIR, and XRD were used for the spectroscopic analysis. For the optical study, UV and fluorescence spectroscopy were also used. Fluorescence quenching has been to cleared to examine the biosensing applicability of these NCDs. According to the findings, these NCDs have an outstanding quantum yield (QY) of 15.7% and exhibit a sharp quenching of NCDs in the presence of Fe^{3+} and Ni^{2+} ions. This study is an excellent solution for detecting heavy metal ions such as Fe^{3+} and Ni^{2+} in water bodies. This is a quick and high accuracy approach with, detection limits of 1.46 and 3.19 µM respectively. We also performed a degradation analysis of methylene blue dye, and the results were outstanding. This analysis validates the use of these produced NCDs in water bodies to remove dyes from various textile industries.

SYNTHESIS AND CHARACTERISATION OF CITRUS PEEL BIOFLAVONOID LOADED PCL/PEG SCAFFOLD BY SOLVENT CASTING METHOD

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Polymer matrix scaffolds with suitable biofillers are effective for biomedical applications. Biopolymeric based scaffolds can effectively act as good biomedical devices for tissue engineering, wound healing applications etc. Polycprolactone (PCL) is one such biocompatible, biodegradable biopolymer having effective scaffold fabrication properties. PCL belongs to the aliphatic polyester family, which is hydrophobic, semi -crystalline and has a longer biodegradation time. Chemically, PCL is composed of repeating un its of hexanoate which has a melting temperature of 332-337K. The low melting point of PCL allows it for good blending with other polymers and fillers for forming scaffolds and drug delivery systems. PCL is in the form of microspheres withsizes 50µm-20mm. Due to its spherical shape of PCL pellets, it can be used for the delivery of drugs, antigens, hormones, vitamins etc. Its stability in structure and non-toxicity makes PCL a suitable candidate for biomedical applications. Due to the viscoelastic and rheological properties of PCL, it can be used for the development of scaffolds. This work focuses on the development and characterisation of PCL-PEG scaffolds loaded with active citrus peel bioflavonoid for wound healing and anti -microbial activity.

Keywords: Polymeric bio-scaffold, Wound healing, Antimicrobial studies.

LA-CU ELECTRODE MATERIAL FOR LOW TEMPERATURE SOLID FUEL CELLS

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Over the past two decades, the escalating impact of anthropogenic factors on the environment has heightened the focus on "green technologies." Presently, researchers are actively exploring effective, renewable, and environmentally safe energy sources. In this realm, there has been a growing emphasis on extensive research into the utilization of solid oxide fuel cells (SOFC) over the years. This is attributed to the fact that, in contrast to other fuel cell types, SOFCs serve as high-temperature heat sources with prolonged operational lifespan and high efficiency (approximately 60% efficiency), presenting environmentally friendly features throughout their operation. Nevertheless, the elevated temperature within the membrane electrode assembly (MEA) of SOFCs poses challenges by diminishing the structure's lifespan, diminishing the catalyst activity at both the anode and cathode, and inducing diffusion between the electrolyte and electrodes due to thermal expansion. Consequently, recent research endeavors primarily focus on enhancing the composition of ceramic oxides employed in the formulation of electrode materials and membranes, along with endeavors to lower the operational temperature of SOFCs [1].

In this study, a binary oxide based on Cu and La was synthesized, and its physical and chemical properties were examined using FTIR, XRD, SEM, XPS, and BET methods. The findings revealed that the material's surface morphology is mesoporous, resulting from the coalescence of soft rods and the formation of the binary oxide La_2CuO_4 in both chemical and crystalline structures. Furthermore, the investigation demonstrated that within the temperature range of 500 - 700°C, there is a twofold increase in current density across the anode material with a 50°C temperature rise, coupled with an approximately threefold reduction in polarized resistance.

Keywords: Solid oxide fuel cells, SOFC, binary oxide, lanthanum cuprate.

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POSSIBILITY OF USING HYDROGEL BASED ON MICROCRYSTALLINE CELLULOSE FROM AGRICULTURAL WASTE AS A SOIL "CONDITIONER"

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Presently, the agricultural sector grapples with severe challenges posed by desertification and water scarcity. Desertification, a form of land degradation primarily induced by drought resulting from various factors including human activities and climate change, exacerbates the situation. Addressing this issue has spurred significant scientific interest in the development of hydrogels capable of absorbing and releasing substantial amounts of water or aqueous solutions while being prone to biological degradation. Conventionally, synthetic polymers have been employed in hydrogel synthesis. However, there is a growing imperative to address this concern by focusing on the synthesis of hydrogels based on cellulose derived from agricultural waste. This approach aims to yield materials with high water-holding capacities, biocompatibility, and biodegradability at a cost-effective scale. Notably, cellulose-based hydrogels, classified as "green" materials, exhibit eco-friendly attributes, causing no adverse effects on nutrients, soil chemistry, or other agrochemicals, and naturally degrade over time.

Hence, in this study, a two-dimensional hydrogel derived from microcrystalline cellulose and acrylamide, sourced from agricultural waste in the form of sunflower seed husks, was synthesized through organic-dissolving oxidation. The investigation delved into its kinetic behaviour, physicochemical properties, moisture retention in the soil layer, and biological attributes. Furthermore, the degradation properties of the hydrogel were meticulously examined. The morphological structure of the hydrogels underwent scrutiny using a scanning electron microscope (SEM), while the chemical composition was analyzed with an infrared spectrometer (IR), and the crystal structure was elucidated via an X-RAY diffractometer.

The investigation revealed that hydrogels based on cellulose exhibit a remarkable ability to expand in an aqueous solution, swelling to 700-1100 times their initial volume. Notably, these hydrogels demonstrated robust moisture absorption in the soil layer within the initial 5 days, retaining it for a prolonged period of 40 days. Subsequently, over the course of 77 days, the hydrogel experienced a 65% reduction in its original mass, initiating a process of biological decomposition.

This distinctive property of the 2D hydrogel proves instrumental in enhancing moisture retention within the soil layer, thereby contributing to increased crop yields.

Key words: cellulose, hydrogels, cross linked agent, biodegradation, water absorbent, water retention, FTIR, crystal structure.

DEHYDROCHLORINATION OF POLYCHLORINATED BIPHENYL WITH A PD-NI/AC$_M$ CATALYST SUPPORTED ON A MODIFIED ACTIVATED CARBON CARRIER

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Disinfecting and managing waste containing polychlorinated biphenyl (PCB) is a pertinent issue, considering the persistent nature of PCB as an organic pollutant. Consequently, comprehensive scientific research on this topic is still required.

Among the numerous techniques employed in neutralizing and disposing of PCB waste, the catalytic dehydrochlorination method for PCB oxidation stands out as one of the most advanced, leveraging achievements in nanotechnology. The quest for active, selective, and cost-efficient catalysts to facilitate this method remains pertinent. Literature review indicates that catalysts incorporating palladium and nickel demonstrate notable activity and selectivity in converting the oxidative burden of chlorinated compounds. This is directly linked to their capability to provide H_2 and facilitate the cleavage of the C–Cl bond.

In this study, a Pd-Ni/AC$_m$ catalyst was created, employing modified microporous carbon (AC$_m$) as a substrate for catalytic dehydrochlorination of PCBs. Specifically, BAU-A brand activated carbon underwent modification with hydrochloric, phosphoric, nitric, sulfuric, acetic acids, sodium hydroxide, and hydrogen peroxide. The physicochemical properties of the modified carbon were examined, and an effective modifier was identified.

The dehydrochlorination process of PCBs in the Pd-Ni/AC$_m$ catalytic system was conducted using an environmentally friendly approach under mild conditions. The reaction was carried out in the presence of methanol (volume 10 ml) at a temperature of 20°C, with a catalyst weight of 0.1 g, and a reaction time of 5 hours. The catalyzed dehydrochlorination of PCBs revealed biphenyl as the main product, with a conversion rate of 84.21%. The investigation indicated that the modified porous carbon support enhances the catalytically active surface, facilitates the reduction of metals with hydrogen, and increases the yield of the reaction product. The porous structure of the modified microporous carbon (AC$_m$) was found to be crucial in bolstering the mechanical stability of Pd-Ni nanoparticles and augmenting the dechlorination efficiency of PCBs.

Key words: PCB, dehydrochlorination, catalyst, modification

OBTAINING AGROMINERAL BASED ON KALZHAT CLAY MODIFIED WITH SILVER NANOPARTICLES

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In order to achieve a substantial crop yield, the soil needs to harbor adequate levels of essential minerals. The annual consumption of nutrients in the soil varies depending on the scale of agricultural production and diminishes by a specific amount. Consequently, to ensure a consistent and high yield from cultivated lands, the application of supplementary fertilizers to these plots is regarded as a crucial agrotechnical measure.

Bentonites and derived agrominerals are commonly employed in agriculture as carriers for insecticides and pesticides, effectively managing field crop pests while enhancing the agrochemical characteristics of sandy and less fertile soils. The integration of silver ions is significant in the evolution of agrominerals, particularly due to silver's inherent antibacterial properties, which hold great importance in crop cultivation. Renowned for their biocidal attributes, silver ions act as inhibitors against the proliferation of numerous bacteria, fungi, and viruses.

In the course of the study, Kalzhat clay underwent chemical modification with nitric acid to render it suitable for application as an agromineral. Post-modification, the clay's chemical composition was analyzed using a CPB-1M X-ray fluorescence spectrometer. The surface's morphological structure was examined using a JEM 1400 scanning electron microscope from JEOL, Japan. The charge of the bentonite was determined utilizing a Malvern Zetasizer NanoZS 90 device from Great Britain.

Silver nanoparticles were isolated employing the citrate method, and a glucose solution was employed for the stabilization of the nanoparticles. Subsequently, the silver nanoparticles were effectively encapsulated within Kalzhat clay. The morphology and dimensions of the resultant agrominerals were ascertained. Using the Image J program, it was determined that the size of silver nanoparticles integrated into acid-modified Kalzhat clay was 72.66 ± 23.8 nm.

Keywords: Clay, modification, montmorillonite, chemical composition.

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SYNTHESIS AND STUDY OF THE GROWTH-STIMULATING COMPLEX DMESA-AG$^+$

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Succinic acid derivatives show promise for diverse applications in the national economy, sparking interest in their properties. The complexes formed by succinic acid and its derivatives with silver exhibit the ability to stimulate the generation of reactive oxygen species in plants, thereby enhancing immunity and resistance to phytopathogens. Consequently, the insufficiently studied complex of dimethyl ester succinic acid (DMESA) with silver presents a pressing and understudied issue.

This study involved the synthesis of the DMESA-Ag+ complex, and a comprehensive investigation was conducted to explore its physicochemical attributes. The chemical structure of the complex was analyzed using IR and NMR spectroscopic methods. Structural-phase characteristics and morphology were determined through X-ray diffraction spectroscopy and scanning microscopy. The fungicidal and biostimulating properties of the complex were assessed in both laboratory and field conditions during soybean cultivation. Pathogen identification was investigated using microscopic methods.

The findings reveal that the DMESA-Ag+ complex demonstrates potent fungicidal activity while concurrently fostering the growth and development of plants, functioning as an intermediary metabolite of the Krebs cycle.

Keywords: complex, derivatives of succinic acid, pathogens, bioactive action.

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STUDY OF PHYSICAL AND CHEMICAL PROPERTIES OF ORTA TENTEK CLAY MINERAL

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Currently, clay minerals find applications in diverse sectors such as agriculture, medicine, mechanical engineering, processing and restoration, construction, and the oil industry. They are extensively utilized across various technological domains, influencing material properties such as viscosity, strength, ductility, absorbency, adsorption, color, and abrasion resistance. Kazakhstan boasts numerous deposits of clay minerals, with one example being the Orta Tentek clay. However, the complete exploration of its physical and chemical properties remains incomplete, and the specific application directions are yet to be conclusively determined.

Throughout the investigation, X-ray fluorescence analysis was employed to scrutinize the chemical composition of Orta Tentek bentonite. Utilizing an Xpert PRO X-ray diffractometer, a detailed analysis of its structural and phase characteristics was conducted. Furthermore, the chemical structure was examined through the application of an FT-801 FTIR spectrometer, while morphological and textural properties were meticulously examined using scanning electron microscopy and the BET method, respectively.

Following X-ray fluorescence analysis, it was determined that Orta Tentek clay is predominantly composed of silicon and iron. BET analysis indicated the potential presence of intergranular pores. X-ray phase analysis revealed that the phase composition of Orta Tentek comprises a hexagonal lattice of SiO_2, along with a minor amount of orthorhombic Al_2O_3, hexagonal Na_2O, and a cubic wall-centered lattice of MgO and Fe_xO_y. Infrared spectral analysis of the clay mineral Orta Tentek demonstrated its constitution to be complex oxides.

The primary challenge in utilizing clay minerals lies in the intricate and variable nature of their chemical composition. Furthermore, their physicochemical properties are contingent upon the predominant phase in the rock, the array of cation exchange forms, and the characteristics of impurities present. The adsorption properties and cation exchange capacity of clays are influenced by the chemical nature and concentration of alkali metal cations. An investigation was conducted to determine whether the montmorillonite bentonite found in Orta Tentek clay could serve as a sought-after raw material in the pharmaceutical industry. There exists a significant potential for harnessing this clay as a natural cosmetic product, acting as a sorbent carrier that imparts controlled effects on the product, addressing various external damage, and possessing antibacterial properties.

Key words: Orta Tentek, bentonite, phase, microstructure.

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LOW TEMPERATURE SYNTHESIS OF CARBON MATERIALS FROM AGRICULTURAL WASTES

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The exploration of low-temperature synthesis for carbon materials derived from agricultural waste presents a promising avenue for the efficient utilization of biomass and the development of novel functional materials. This research focuses on low-temperature synthesis technology methods to transform agricultural waste into carbon materials distinguished by unique structural and chemical characteristics. The suggested approach for synthesizing activated carbon from agricultural waste comprises several key stages. The initial stage encompasses the gathering and preparation of raw materials, identifying suitable waste types like plant stems or post-harvest residues. In order to prevent undesired reactions during activation, the raw materials undergo thorough drying. Subsequently, organic substances are eliminated from the source material through washing with acids at concentrations of 10%, 25%, and 50%, followed by neutralization with distilled water to achieve a pH of 6-7. The third stage involves carbonization for one hour in a vacuum tube furnace at a temperature of 400°C. In the subsequent phase, a comprehensive physical and chemical analysis of the resulting material is conducted. Pore size is determined using a scanning electron microscope (SEM). Additionally, the material is subjected to analysis on an IR spectrometer to identify binding energies and chemical structure. Sorption capacity is assessed, and oxygen-containing groups are determined through titrimetry. Following synthesis, the product yield is calculated, estimated to be approximately 25-50%. The investigation successfully pinpointed optimum synthesis parameters, encompassing temperature conditions and chemical reagents that facilitate the creation of carbon materials characterized by a high degree of purity and distinctive properties. These materials exhibit versatile applications in fields such as power generation, electronics, and catalysis. Emphasizing the environmental significance, the utilization of agricultural waste not only diminishes waste volumes but also mitigates environmental impact. This research marks a significant stride towards formulating sustainable methodologies for carbon material production, harmonizing waste management practices with the generation of innovative, high-value products.

Key words: carbon materials, biomaterials, FTIR, SEM

Acknowledgments

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OBTAINING AND APPLICATION OF VEGETABLE PECTIN FROM AGRO-INDUSTRIAL COMPLEX IN THE CREATION OF ENVIRONMENTALLY FRIENDLY AND SUSTAINABLE FOOD FILMS

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Derived from citrus fruits, apples, and other plants, pectin stands out as a natural polymer with distinctive qualities. Its widespread use in the food, pharmaceutical, and cosmetic sectors showcases its versatility across various industries. The significance of this subject lies in the pressing necessity to discover viable and sustainable substitutes for conventional plastic packaging. As awareness of environmental issues linked to plastic usage grows, the quest for biodegradable and edible packaging materials takes on a paramount role. The use of vegetable pectin obtained from apple waste is an innovative approach that not only reduces the environmental burden, but also creates sustainable and functional solutions for packaging materials. In this study, apple waste was used, hydrolyzed with succinic acid at 90˚C for 5-6 hours, which resulted in a pectin yield of 24%. The obtained pectin was used to create a film in combination with corn starch and food glycerin as a plasticizer. Consequently, the obtained film has exhibited notable resilience to mechanical impacts and biodegradability, rendering it a prospective material for edible packaging. The physical and chemical analysis has verified the film's outstanding attributes, encompassing elevated viscosity and resistance to oxidative processes. The structural-morphological and structural-phase features of pectin were identified through IR, SEM, and TGA analyses. The outcomes reveal potential avenues for leveraging vegetable pectin as an inventive material for edible packaging, offering enhanced functional attributes while minimizing adverse effects on the environment.

Keywords: pectin, film, biodegradable polymer, hydrolysis, succinic acid**.**

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DEVELOPMENT OF DRILLING FLUIDS BASED ON POLYANIONIC LOW-VISCOSITY CELLULOSE AND BENTONITE CLAYS

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In the dynamic realm of drilling technology, the pursuit of optimal drilling fluids remains of utmost importance. This research explores the cutting-edge domain of drilling fluid advancement, emphasizing the synergistic integration of low-viscosity polyanionic cellulose and bentonite clays. The primary objective is to formulate drilling fluids exhibiting superior performance, adeptly addressing challenges posed by diverse geological formations encountered in drilling operations. In this investigation, three distinct modifications were devised using bentonite clays sourced from the Kaljat and Orta Tentek deposits. These modifications involved blending the clays with water, a nine percent hydrogen peroxide solution, and a one percent sodium carbonate solution. The distinctive aspect of this approach lies in the thorough examination of the physicochemical properties inherent in these modifications, aiming to scrutinize the intricate interactions among the components and their impact on the fluid characteristics. The ensuing examination encompassed SEM analysis for surface morphology determination and X-ray phase analysis for crystal structure identification in the obtained clay modifications. The research findings obtained will facilitate a comparative analysis of the drilling fluid modifications against established standards, aiding in the identification of the most promising samples for practical applications. The importance of this endeavor is underscored by the quest for enhanced drilling fluids, the exploration of novel modifications and their impact on physicochemical properties, and a heightened comprehension of the intricate dynamics influencing the behavior of drilling fluids across diverse geological settings.

Keywords: drilling fluids, polyanionic low-viscosity cellulose, bentonite clays, fluid characteristics, modification methods, comparative analysis.

EXTRACTION OF MICROCRYSTALLINE CELLULOSE FROM CORN LEAVES GROWING IN KAZAKHSTAN BY «GREEN» METHOD

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Wood resources, the main source of raw materials for the production of cellulose, are becoming more demanded every year. Therefore, the extraction of cellulose from non-woody annual plant residues has become a topic of current research. The annual reserve of corn grain in the Republic of Kazakhstan is 1.2 million tons, the main waste remaining after harvesting is corn leaves, husks and stalks is burned. This indicates that the cellulose-rich resource is being disposed of inefficiently, polluting the atmosphere. Therefore, obtaining a cellulose product from corn residue is a way of purposeful use of agricultural residue.

The purpose of the research is based on determining the effective parameters of microcrystalline cellulose (MCC) extraction from the corn residue grown in Kazakhstan, and studying the structure and physicochemical properties of the obtained MCC. Microcrystalline cellulose is extracted from corn leaves by delignification with an organic solvent, was determined the effective hydromodulus ratio of the raw material and the solvent, the physical and chemical properties of MCC were investigated. The chemical structure of MCC was determined by infrared spectroscopy, the structure-phase characteristics were determined by XRD-spectroscopy, and the morphology was determined by scanning microscopy.

Key words: corn leaf, microcrystalline cellulose, nanocomposite, crystal structure.

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STUDY OF PHYSICAL AND CHEMICAL PROPERTIES OF THE TAGAN DEPOSITBENTONITES

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Despite recent advancements in pharmaceutical manufacturing, the significance of natural raw materials, such as mineral clays, in the medical field remains substantial. Bentonite, a mineral clay derived from volcanic ash with remarkable absorbent properties, stands out as one of these materials.

Given its unique chemical composition, natural bentonites find extensive applications in construction, oil drilling, the food industry, pharmaceuticals, and cosmetics. Recently, scientists have increasingly focused on conducting thorough investigations into mineral clays. The sorption properties, rheology, water swelling capacity, mechanical and chemical characteristics of bentonite clay undergo changes based on the levels of alkalinity and alkaline earth elements present. Thus, it becomes crucial to identify the primary characteristics and classifications of bentonite clay, outlining its diverse applications.

In this context, an investigation into the physical and chemical attributes of natural bentonite clays retrieved from five horizons of the Tagan deposit in the East Kazakhstan region of the Tarbagatai region was conducted. The analysis encompassed the examination of the bentonite's phase composition through X-ray diffraction, its chemical structure via an infrared spectrometer (IR), surface morphology using a scanning electron microscope (SEM), surface area and pore size employing the BET method, sorption properties through methylene blue adsorption, and the determination of montmorillonite content in the bentonite in accordance with state standard 28177-89.

According to the findings, it was determined that the bentonite clay falls within the montmorillonite category. The particle size of the bentonite was identified to be within the range of 848 nm to 2 microns, with a methylene blue sorption rate ranging from 75% to 93%. These results indicate that the bentonite sourced from the Tagan deposit holds significant promise for applications in the formulation of sorbents, particularly in pharmaceuticals and other medical domains.

Keywords: bentonite, montmorillonite, medicine, Tagan deposit.

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EXPERIMENTAL STUDIES OF ADSORPTION PROPERTIES OF NANOMATERIALS FOR WATER PURIFICATION

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Currently, environmental pollution is one of the most pressing problems, including the water problem. One type of environmental pollution is the pollution of oil, heavy metals and other toxic substances of both wastewater and surface water. In order to remove and clean up pollution, scientists pay great attention to finding effective ways. The presence of excessively harmful chemical impurities in the water negatively affects the health of people. In the research work, the innovative idea of obtaining nanocomposite sorbents was considered, taking into account the relevance of the problem of water pollution by harmful ions under the influence of an anthropological factor.

The main goal of the work is to synthesize and study the effectiveness of sorbents that are of practical importance in the field of water purification using nanotechnology. Increases the ability to dispose of local waste using agricultural waste as the main source of raw materials and helps preserve other sources of useful resources.

To achieve this goal, activated carbon was obtained from walnut shells, and silica from rice husks. In order to improve the efficiency of cleaning heavy metals in water, the samples were modified with a 2% content of silver nanoparticles (the presence of silver nanoparticles in a small mass fraction indicates a potential cost-effective raw material in economic terms). In order to study the physics-chemical properties of the obtained products, several instrumental methods were considered: X-ray phase analysis (XRD), scanning electron microscope (SEM), ultraviolet spectrometer (UV), mercury analyser and spectrophotometer. According to the results of the HachLange Dr-3900 spectrophotometer, silicon dioxide adsorbs sulfate (SO_4^{2-}), and activated carbon nitrate (NO^{3-}) anion well. The effectiveness of silver nanoparticles in cleaning heavy metals was considered on the example of mercury cations (Hg^{2+}) and iodides (I^-): the share of cleaning efficiency was in the range of 60-80%. Based on all the stated results, the conclusion was concluded that "activated carbon and silicon dioxide absorbed by silver nanoparticles have a high efficiency in cleaning polluting ions".

Keywords: activated carbon, silica, silver nanoparticles, adsorption, idides, mercury, nanocomposites.

SYNTHESIS OF MAGNETIC NANOPARTICLES BY ELECTROCHEMICAL DEPOSITION

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The use of nanoparticles opens many possibilities in various scientific and technological applications from catalysts to cosmetics. In recent years research area has been continuously exploiting the potential of solar collectors due to the unique thermal absorption properties that nanoparticles can capture and focus effectively are therefore of paramount importance. This thesis explores the production and characterization of metallic nanoparticles in detail, focusing on their potential applications in northern Kazakhstan areas, especially designed for solar collector applications, where extremely cold temperatures can pose significant challenges to daily life.

Nanoparticles obtained from dissolved 1,2 and 3 moles of NaCl in a liter of water each, thereby obtaining an electrolyte. Iron bolts were used as electrodes. Under the influence of a current of 0.5 A, electrolysis was carried out within 6 hours. The nanoparticles stuck to the cathode were washed and purified with distilled water, deposited in a centrifuge, and dried in a drying machine. Nanoparticles of iron can be used in various spheres, such as catalytic production, cosmetics, construction etc., but we decided to concentrate our attention on Solar collectors. By gaining heat of Sun, it can direct this heat to one point. It can be used in Northen parts of Kazakhstan, where temperature the temperature reaches 233 K and not everyone has access to central heating system.

Keyword: nanoparticles, solar collector, synthesis.

MICROPLASTICS POLLUTION OF FRESHWATER ECOSYSTEMS

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Plastic particles smaller than five millimeters are known as microplastics. They are found in rivers, lakes, and ponds, among other freshwater habitats. The ecology and the creatures who live in these ecosystems may suffer as a result of these microplastics. The breaking down of bigger plastic objects is one of the primary causes of microplastics in freshwater environments. Instead of biodegrading, plastics gradually fragment into ever-tinier fragments. Biochemical activity, mechanical stress, and UV radiation are some of the things that speed up this process. Microplastics are consequently discharged into the environment.

The direct or indirect discharge of microplastics from industrial operations is another source of microplastics in freshwater environments. Wastewater discharge from industries including textiles, plastics, and wastewater treatment can release microplastics into the environment. Microplastics can be dispersed and transported via a variety of pathways once they are present in freshwater environments. Microplastics can have detrimental effects on the environment and living things when they are present in freshwater habitats. Sediments are one place where microplastics may build up and stay for a very long time. The creatures that depend on these habitats and the quality of the sediment may be impacted by this buildup.

To sum up, microplastics pose a serious threat to freshwater ecosystems. They can get into these ecosystems through a number of different channels, such as industrial operations and the breakup of bigger plastic objects. Microplastics can be carried and dispersed by wind and water currents once they are in the environment. Microplastics may harm ecosystems and creatures, and there is a growing worry about how they can affect human health when they are present in freshwater habitats. To effectively reduce the pollution caused by microplastics and to get a better understanding of their origins, modes of transportation, and effects on freshwater ecosystems, further study is required.

Keywords: microplastics, freshwater pollution, environmental impacts.

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TECHNOLOGY OF OBTAINING A SUPERHYDROPHOBIC CLAY PRODUCTIONS FROM EAST KAZAKHSTAN BENTONITE

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Currently, many industries in Kazakhstan use a large number of organophilic clays imported from foreign firms. Despite the fact that the territory of Kazakhstan is rich in clay deposits, work on the extraction and creation of organ modified clay, which is the main raw material for many industries, is slow. The reason for this is the lack of research in this area and the small number of places for the production of domestic organ modified clays. Organoclays obtained by modification of clay minerals have a wide range of applications; they are used as organophilic fillers of paints, regulators or structuring agents of rheological properties of various industrial dispersions. In this regard, one of the urgent problems is the production of organophilic clays based on domestic Tagan bentonite clays by modifying clay minerals with cationic surfactants containing a quaternary amino group. In addition, the possibility of developing ways to obtain modified layered silicate composites based on alkyl salts of quaternary ammonium - a material with known strength, thixotropic, deformation properties, which is the basis of drilling fluids, various paints, moisture-resistant coatings, oil sorbents - will be expanded. The purpose of the work is to develop the possibility of obtaining organoclays from the clays of the domestic Tagan field, to develop its technology. Molecular bases with high or low surface activity and high molecular bases and halogen salts of positively charged non-quaternary amino groups are used as components necessary for obtaining organomodified clay. To obtain organoclay, montmorillonite of the Tagan deposit was used, converted to sodium form. At the same time, the purpose of the selected cationic surfactant is to modify the surface of clay particles with a hydrophobic layer as a result of the process of ion exchange with inorganic inter – layer cations of montmorillonite due to the presence of fourth amine groups in the molecular structure. In this scientific work, types of organoclay were obtained with the participation of octadecylamine (ODA). A drop of water was placed on the surface of the resulting organoclay powder, and it was found that the angle of transmission was higher than 140 degrees. According to the data obtained as a result of determining the angle of transmission, the hydrophobic nature of organoclay has been proven. Although the extraction of organoclay adsorbed by ODA is multi-stage, it was found that organoclay in powder form is not even infected with water, that is, it can remain on the water surface for several days on the interfacial surface.

Keywords: montmorillonite, clays, polyelectrolyte, hydrophobization, nanoclays.

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METAL COMPLEX BASED ON ETHYLENEDIAMINE SUCCINIC ACID FOR THE AGRICULTURAL INDUSTRY

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In contemporary agriculture, the extensive use of fungicides to safeguard plants from diseases raises concerns about environmental pollution. Consequently, the exploration of eco-friendly alternatives gains significance. Addressing this challenge, the synthesis of novel monoligand metal complexes involving dicarboxylic acid anions emerges as a compelling avenue for investigating compounds with diverse biological properties. Recently, d-element eco-bioligands have found applications in catalysts, medicine, ion exchange synthesis, porous materials, and pesticides. Furthermore, metal-organic frameworks based on metal carboxylates exhibit not only structural diversity but also biological activity, including DNA binding, nucleases synthesis, and noteworthy effects in antitumor, antibacterial, and antifungal applications. Organometallic complexes, particularly those involving Cu^{2+}, Ag^{+}, and B^{+} ions, demonstrate biological efficacy in combating pathogens. The derivative of succinic acid, ethylenediamine succinic acid (EDSA), shows promise in augmenting systemic plant resistance when combined with antimicrobial elements. EDSA operates at the cellular level, influencing various metabolic processes in plants, such as photosynthesis, respiration, ion exchange, and enzymatic reactions. This is achieved through the formation of stable complexes with metal ions, potentially inhibiting key enzymes and imparting a biostimulating effect. This dual action not only fortifies defense mechanisms but also enhances production processes, fosters growth, ultimately resulting in increased crop yields. Additionally, these complexes have the potential to serve as alternatives to pesticides, thereby minimizing the reliance on chemical agents. Furthermore, ongoing research indicates promising applications for these complexes in the realms of medicine and industry. Their multifaceted utility extends beyond pathogen protection, encompassing the reduction of fungicides and pesticides in agricultural practices.

In this study, monoligand metal complexes incorporating EDSA with copper, silver, and boron ions were synthesized through reactions in aqueous solutions. The synthesized complexes underwent characterization using scanning electron microscopy, X-ray diffraction, and infrared spectroscopy. Fourier transform infrared (FTIR) analysis substantiated the formation of novel bonds between metal ions and the oxygen atoms within the carboxyl group of EDSA. The monoligand complexes involving EDSA and copper, silver, and boron ions showcase unique surface morphology, presenting a monoclinic crystal structure with space group and a monoclinic crystal lattice, as elucidated by scanning electron microscopy analysis. Notably, the crystal shapes of the complexes varied depending on the ions employed. The biological efficacy of these complexes has been affirmed in their impact on legumes, aiming to enhance germination while concurrently mitigating the occurrence of phytopathogens and dwarfism.

Keywords: agriculture, ethylenediamine succinic acid complexes, metal complexes, antipathogenic properties, biological effectiveness.

Acknowledgments

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KINETIC MODELS OF SORPTION OF COPPER (II) IONS ON IONITE BASED ON POLYACRYLONITRILE

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Modern technologies are widely used in the rapid development of industrial production in the world and in solving environmental problems, the production of competitive and environmentally friendly products. It is especially evident in the preparation of water on an industrial scale, in the extraction of precious and non-ferrous metals from technological solutions, the treatment of wastewater using modern, including ion changes technologies. Due to its environmental friendliness, low cost, ease of application and the availability of multiple regeneration opportunities, ionizing materials are considered of great importance in the implementation of these processes. There are several methods for extracting heavy and precious metals from wastewater, including filtration, coagulation, and ions exchange. Today among these methods, the ions exchange method is one of the most effective. Ions exchange technologies for purification industrial waters from metal ions is an effective method even at low concentrations of metal ions. In this scientific work, the possibility of using polyacrylonitrile-based polyampholytes containing nitrogen and phosphorus as an absorbent of copper ions was investigated. For this, polyacrylonitrile-based ionite was used to extract non-ferrous metal ions from artificial solutions. The influence of various factors on the mechanisms of Cu^{2+} ion sorption processes on ionite was studied. For this purpose, $CuSO_4 \cdot 5H_2O$ crystalline hydrates were used to prepare solutions of Cu^{2+} ions in the concentration range of 0.075-0.0125 $mol \cdot l^{-1}$, and the sorption of metal ions from these solutions was studied. For this 0.2 g of dry sorbent with a static exchange capacity of 3.2 $m_{eq}*g^{-1}$ HCl and a static exchange capacity of 5.6 $m_{eq}*g^{-1}$ for NaOH was weighed on an analytical balance and a 250 ml conical were placed in flasks and $CuSO_4$ solutions were poured from 100 ml. The amount of metal ions absorbed by the sorbent was calculated by the following equation:

$$\frac{\Delta X}{m} = \frac{(C_0 - C_\tau) \cdot V}{M \cdot m}$$

Table

Kinetic parameters and activation energy of Cu^{2+} ion sorption on PAN-based polyampholyte.

Pseudo second order					Pseudo first order				**E_a** kJ*mol^{-1}
C_0mg*l^{-1}	q_{ex}mg*l^{-1}	q_{cal}mg*l^{-1}	R^2	k_2 g*mg min^{-1}	h g*mg min^{-1}	q_{cal}mg*g^{-1}	R^2	k_1 min^{-1}	
8	153,1	769,2	769	0.000015	3,49	527,8	0,888	-0,090047	22,942
16	164,7	384,6	0,882	0,000036	5,38	491,7	0,939	-0,0930412	
32	177,9	344,8	0,963	0,000057	6,79	507,4	0,931	-0,0928109	
48	187,8	312,5	0,991	0,000085	8,25	501,3	0,910	-0,0907382	

In this kinetic study the sorption of copper (II) ions from artificial solutions to new polyampholyte containing nitrogen and phosphorus based on PAN was studied at different initial concentrations and temperatures. It was shown that the sorption of Cu^{2+} ions to polyampholyte obtained on the basis of PAN have influenced metal ions as well as nitrogen and phosphorus groups in the sorbent. The activation energy of metal ions during sorption is 22,943 kJ*mol^{-1}. The sorption ions of Cu^{2+} is based on the electrostatic interaction between them and $–PO_3H_2$- groups on the ionite surface. From solutions containing metal ions, the hydrated of Cu^{2+} ions sorption is higher.

Key words: polyacrylonitrile, polyampholite, sorption, ionite, rate constant, kinetics, pseudo first and second kinetic models, copper (II) ion.

Author Index

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