Ninth International Conference

"Modern Trends in Science"

FMNS-2021

15 - 19.09.2021, Blagoevgrad, BULGARIA

BOOK OF ABSTRACTS

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Prof. Borislav Yurukov
Rector of the South-West University

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Conference Program

Registration (15.09.2021)
13:00 – 18:30

Opening Ceremony (16.09.2021)
10:00 – 10:30
Chairman: Prof. Mario Mitov, DSc, PhD

Plenary Lectures (16.09.2021)

10:30 – 11:15
Prof. Tony Spassov - Sofia University "St. Kliment Ohridski"
"Porous metallic structures by de-alloying amorphous and nanocrystalline materials"

11:15-12:00
Prof. Carlo Santoro – University of Manchester, UK
"Oxygen Reduction Reaction in neutral media: advancements and limitations"

Plenary Lectures (17.09.2021)

10:30 – 11:15
Dr. Manfred Schütze - Otto-von-Guericke University Magdeburg, Germany
"Models or reality - what is more useful? And how computer simulation can assist in this?"

11:15-12:00
Prof. German Perlovich - Russian Academy of Sciences
"Development of bioavailable drugs on basis of adamantine and memantine derivatives"

Cancelled

Section Sessions: 16 and 17.09.2021
13:30 - 18:20

Special session:
"Low-carbon energy for transport and household"
16.09.2021
13:30 - 18:20

Poster session: 16.09.2021
18:00 – 19:30

Social program
18.09.2021

Section: Chemistry

Thursday, September 16th	
Chairman:	***Assoc. Prof. Mitko Stoev***
13:30-13:45	**O-C-1** Chemical composition of underground waters in Demanová valley as a tool for finding connections between the Štefanová and Demanová cave system *David Havlicek, Pavel Herich, Katerina Havlickova*
13:45-14:00	**O-C-2** Synthesis and reactivity of a ferrocene distibine *Petr Stepnicka, Jiri Schulz, Jakub Antala*
14:00-14:15	**O-C-3** Synthesis and Coordination Behavior of New Ferrocene α-Aminobis(phosphine) *Michal Navrátil, Ivana Císařová, Petr Štěpnička*
14:15-14:30	**O-C-4** Coordination behavior of a new phosphinoguanidine ligand *Zdenek Leitner, Ivana Cisarova, Petr Stepnicka*
14:30-14:45	**O-C-5** Synthesis and reactivity of a stable primary phosphine oxide, and preparation of its heavier congeners *Filip Horký, Ivana Císařová, Petr Štěpnička*
14:45-15:00	**O-C-6** Isocyanoferrocene and its carbenes' complexes *Petr Vosáhlo, Michal Franc, Petr Harmach, Ivana Císařová, Petr Štěpnička*
15:00-15:30	**O-C-7** Obtaining granular activated carbon using a binder gelatin in the joint processing of rice and oil waste *Nurbol Appazov, Banu Diyarova, Baurat Bazarbayev, Bulat Dzhiembaev, Olena Lygina*
15:30-15:45	**O-C-8** Interactions and Reactivity of Various Thia- and Carbaboranes with Bases *Jan Vrana, Ales Ruzicka*
Coffee break	
Chairman:	***Assoc. Prof. Atanas Chapkanov***
16:15-16:30	**O-C-9** Cu-catalyzed reductions of brominated phenols in alkaline aqueous solution *Tomas Weidlich, Barbora Kamenická*
16:30-16:45	**O-C-10** Preparation, characterization and study of radiation stability of bulk Ti_2AlC MAX phase *Bauyrzhan Ismagulov, Jiri Plocek, Jiri Vacik, Jaroslav Kupcik, Jiri Nemecek*
16:45-17:00	**O-C-11** Extending of the NLO Materials Family – Novel Guanidine-based Molecular Crystals *Ivan Nemec, Irena Matulkova, Ivana Cisarova, Petr Nemec*
17:00-17:15	**O-C-12** Study of proton transfer trajectory in proton conductors using in situ X-ray powder diffraction measurements *Jiří Plocek, David Havlíček*
17:15-17:30	**O-C-13** Drinking water purification: Filtration, Reverse Osmosis and UV disinfection systems *Nadya Ivanova, Elitsa Chorbadzhiyska, Mitko Stoev*
17:30-17:45	**O-C-14** Application of the additive manufacturing technologies in the field of chemical engineering – an analysis *Apostol Apostolov, Dragomir Yankov, Elena Razkazova-Velkova*
17:45-18:00	**O-C-15** Influence of skin metabolites of the newly synthesized derivative of bexarotene and paracetamol on the potential antitumor effect *Ivelin Iliev, Yana Koleva, Svetlana Georgieva*

18:00-18:15	**O-C-16** Study of the reactivity of the generated liver metabolites of a newly synthesized derivative of bexarotene and paracetamol *Ivelin Iliev, Yana Koleva,Svetlana Georgieva*
18:15-18:30	**O-C-17** Investigations about thermodynamic and kinetic characteristics of adsorption process *Yordanka Tashesva*

Friday, September 17th	
Chairman:	***Assoc. Prof. Zhivko Velkov***
13:30-13:45	**O-C-18** Preparation of arginine complexes with heavy metal ions *Viktoriya Trifonova, Krasimir Vasilev, Yana Koleva*
13:45-14:00	**O-C-19** Synthesis, characterization and microbiological evaluation of new metronidazole derivatives *Sylvia Stamova, Svetlana Georgieva, Javor Mitkov, Maya Georgieva, Emilia Georgieva, Neli Ermenlieva*
14:00-14:15	**O-C-20** Establishing Effective Ventilation in Residential Bathrooms by CFD methods *Konstantina Stefanova*
14:15-14:30	**O-C-21** Advanced approaches for waste gases purification from SO2. Modelling and simulation *Konstantina Stefanova, Nadezhda Dermendzhieva, Elena Razkazova-Velkova, Daniela Dzhonova-Atanasova*
14:30-14:45	**O-C-22** Software based approach for prediction of microbial activity of new metronidazole derivatives *Sylvia Stamova, Yana Koleva, Svetlana Georgieva*
14:45-15:00	**O-C-23** The probable reactivity of a petroleum component *Yana Koleva*
Coffee break	
Chairman:	***Assoc. Prof. Petko Mandjukov***
16:15-16:30	**O-C-24** Memantine analogues with potential neuroprotective effects *Aleksandra Tencheva, Radoslav Chayrov, Ivanka Stankova*
16:30-16:45	**O-C-25** Radical-scavenging activity evaluation of a series of biogenic amines *Joanna Nacheva, Zhivko Velkov*
16:45-17:00	**O-C-26** Radical-scavending activity of phenolic compounds with different Structure **Cancelled** *Simona Dimitrova, Zhivko Velkov*
17:00-17:15	**O-C-27** Analysis of the structural requirements of angiotsin-converting enzyme-2 (ACE-2) *Tatyana Dzimbova, Atanas Chapkanov*
17:15-17:30	**O-C-28** Factors influencing on the tautomeric forms and spectral characteristics of 1-phenyl substituted pyrazol-5-ones *Atanas Chapkanov, Tatyana Dzimbova*
17:30-17:45	**O-C-29** Specificity of the binding in the active site of mu-opioid receptor (MOR) of the selective ligands *Tatyana Dzimbova, Fatima Sapundzhi, Nevena Pencheva, Peter Milanov*
17:45-18:00	**O-C-30** Biodestruction of polycaproamide textile materials *Elena Pekhtasheva, Elena Raykova, Tatiana Chalykh, Marina Polozhishnikova*

Section: Physics

Thursday, September 16th	
Chairman: ***Assoc. Prof. Svetoslav Kolev***	
13:30-13:45	**O-P-1** Photodynamic Treatment of Gastrointestinal Tumour Model Using Different Photosensitizers *Lidia Zaharieva, Biliana Nikolova, Ivan Iliev, Vanya Mantareva, Ivan Angelov, Gennady Meerovich, Alexander Khorovodov, Oxana Semyachkina – Glushkovskaya, Ekaterina Borisova*
13:45-14:00	**O-P-2** Near-Infrared Spectroscopy of Ex Vivo Cutaneous Melanin-Pigmented Neoplasia *Victoria Mircheva, Petranka Troyanova, Ivan Terziev, Yulia Khristoforova, Ivan Bratchenko, Lyudmila Bratchenko, Ekaterina Borisova*
14:00-14:15	**O-P-3** Polarimetric Studies of Cutaneous Degenerative Conditions Ex Vivo in Visible Spectral Range *Stoyan Ilyov, Tsanislava Genova, Deyan Ivanov, Boyko Kolev, Tatiana Novikova, Petranka Troyanova, Ivan Terziev, KM Sindhoora, Nirmal Mazumder, Ekaterina Borisova*
14:15-14:30	**O-P-4** Endogenous and Exogenous Fluorescent Diagnostics of Gastrointestinal Tumours - Advances and Challenges *Ekaterina Borisova, Tsanislava Genova, Boyko Kolev, Alexander Khorovodov, Ilana Agranovich, Oxana Semyachkina-Glushkovskaya, Vanya Mantareva, Ivan Angelov, Hristo Valkov, Borislav Vladimirov*
14:30-14:45	**O-P-5** Impact of physical and chemical modification on the immobilization of β-galactosidase in poly-lactic acid multilayer structures *Aleksandar Grigorov, Asya Viraneva, Temenujka Yovcheva, Ilia Iliev, Ivanka Vlaeva*
14:45-15:00	**O-P-6** Milk protein-based formulations as controlled delivery systems for Tolfenamic acid *Sofia Milenkova, Bissera Pilicheva, Nikolay Zahariev, Temenuzhka Yovcheva, Maria Marudova*
Coffee break	
Chairman**:** ***Assoc. Prof. Ralitsa Stanoeva***	
15:30-15:45	**O-P-7** Influence of humidity on surface potential decay of gamma irradiated polypropylene and poly(ethylene terephthalate) electrets *Asya Viraneva, Ivanka Vlaeva, Temenuzhka Yovcheva*
15:45-16:00	**O-P-8** Optical quartz fibers as non-linear media *Lyuben Mihov, Todor Cholakov*
16:00-16:15	**O-P-9** Non-invasive study of changes in venous oxygen saturation **Cancelled** *Sergey Mamilov, Sergey Yesman, Dmitry Velyhotsky, Alexander Gisbrecht*
16:15-16:30	**O-P-10** Investigation of hydrodynamic phenomena during an electric discharge in a liquid *Mitko Stoev, Nurgul Shuyushbayeva, Nazgul Tanasheva, Gulsinay Altayeva, Alyia Kaliyeva*
16:30-16:45	**O-P-11** Opportunities of ecologization physics course *Nurgul Shuyushbayeva, Aliya Kaliyeva, Nazgul Tanasheva, Gulsinay Altayeva, Moldir Talpakova*
16:45-17:00	**O-P-12** On matrixes of coefficients of thermoelastic and electromagnetic waves propagating in anisotropic media *Nurlybek Ispulov, Almar Zhumabekov, Kairat Dossumbekov, Anara Bektazinova*

Section: Geography, Ecology and Environmental Protection

Thursday, September 16th	
Chairman**:** ***Assoc. Prof. Lidia Sakelarieva***	
13:30-13:45	**O-GEEP-1** Morphometric analysis of the relief of Slavyanka mountain *Galina Bezinska, Krasimir Stoyanov, Siyka Keseva*
13:45-14:00	**O-GEEP-2** Wind Variations over Balkans since 1836 *Georgi Belev, Yavor Chapanov*
14:00-14:15	**O-GEEP-3** Seasons and Spatial Variations of Sea-Land Breeze over the Bulgarian Coastal Area *Georgi Belev, Yavor Chapanov*
14:15-14:30	**O-GEEP-4** Attitudes towards introduction of remote work beyond the Covid-19 pandemic among teachers in Southwestern Bulgaria *Vladimir Karadzhov, Milena Draganova*
14:30-14:45	**O-GEEP-5** Trends and challenges for the health system in Kyustendil region *Gergana Nikolova, Emilia Patarchanova*
14:45-15:00	**O-GEEP-6** The "Healthy city" – measurement of the achieved level of completion and development *Maria Shishmanova, Veselina Dalgacheva*
15:00-15:15	**O-GEEP-7** The Green city - oportunities to measure its potential *Veselina Dalgacheva, Maria Shishmanova*
Coffee break	
Chairman: ***Assoc. Prof. Emilia Varadinova***	
15:45-16:00	**O-GEEP-8** Assessment of the ecological purity and safety of non-traditional Bulgarian fruit wines *Stefka Minkova, Ivanka Vlaeva, Krastena Nikolova, Nadejda Petrova, Galia Gentscheva*
16:00-16:15	**O-GEEP-9** Morphological and cytogenetic characteristic of Belgica antarctica Jacobs (Diptera, Chironomidae) *Julia Ilkova, Paraskeva Michailova, Iryna Kozeretska, Pavlo Kovalenko, Artem Dzhulaj, Volodymyr Gorobchyshyn*
16:15-16:30	**O-GEEP-10** The effect of cadmium on salivary gland polytene chromosomes of Chironomus riparius Mg (Chironomidae, Diptera) *Julia Ilkova, Daniela Dimitrova*
16:30-16:45	**O-GEEP-11** In vivo assessment of incised wound healing in rats after application of a bigel formulation contained St. John's Wort extract *Stefan Stefanov, Stanila Stoeva, Svetlana Georgieva, Minka Hristova, Krastena Nikolova, Mirena Dobreva, Velichka Andonova*
16:45-17:00	**O-GEEP-12** Purification of soil from oil pollution using hydrocarbon-oxidizing microorganisms *Roza Narmanova, Nurbol Appazov, Andrey Filonov, Irina Puntus, Anipa Tapalova, Kenzhegul Kuanyshbaeva*
17:00-17:15	**O-GEEP-13** Colonising of decaying macroalgae debris by microarthropods with special references to Collembola *Izabella Olejniczak, Paweł Boniecki, Anita Kaliszewicz, Kamil Karaban, Ninel Panteleeva*
17:15-17:30	**O-GEEP-14** Responses of soil mesofauna to non-trophic activities of epigeic and endogeic earthworms *Kamil Karaban, Alexei Uvarov*
17:30-17:45	**O-GEEP-15** Resource partitioning between competing individuals: an experiment with bean weevil Acanthoscelides obtectus *Janusz Uchmański, Katarzyna Chajczuk, Krzysztof Opalinski*

17:45-18:00	**O-GEEP-16** A long-term study of some population characteristics of the Hermann's Tortoise Testudo hermanni and the Spur-thighed Tortoise T. graeca in the northwestern foothills of Pirin Mountains, Bulgaria *Emanuil Mitrevichin, Hristo Peshev, Emiliyan Stoynov, Atanas Grozdanov, Lidia Sakelarieva, Alexander Pulev*
18:00-18:15	**O-GEEP-17** Distribution and Activity of Bulgarian Viper, *Vipera ammodytes montandoni* Boulenger, 1904 (Reptilia: Viperidae) in South-Western Bulgaria *Alexander Pulev, Borislav Naumov, Lidia Sakelarieva*

Friday, September 17th	
Chairman**: *Assist. Prof. Galina Bezinska***	
13:30-13:45	**O-GEEP-18** Study of surface water from reservoirs located in the Norilsk Industrial district *Tatyana Bezelyanskaya*
13:45-14:00	**O-GEEP-19** Characteristics of microplastic pollution in inland waters under different anthropogenic pressure *Anita Kaliszewicz, Kamil Karaban, Tomasz Runka, Michał Winczek, Agnieszka Poniatowska*
14:00-14:15	**O-GEEP-20** Aquatic bryophytes in upland rivers in Bulgaria *Gana Gecheva, Silviya Stankova, Nikolina Gribacheva*
14:15-14:30	**O-GEEP-21** Ephemeroptera, Plecoptera and Trichoptera (Insecta) of mountain tributaries of the Struma River: Diversity in relation to environmental parameters and zoogeographic features *Violeta Tyufekchieva, Yanka Vidinova, Vesela Evtimova, Emilia Varadinova, Milcho Todorov*
14:30-14:45	**O-GEEP-22** Macrozoobenthos in mountain standing water bodies in Bulgaria *Emilia Varadinova, Galia Georgieva, Mila Ihtimanska, Yanka Vidinova, Vesela Evtimova, Violeta Tyufekchieva, Milcho Todorov*
14:45-15:00	**O-GEEP-23** Taxonomic composition and dominant structure of the macrozoobenthos in Maritsa River and some of its main tributaries, South Bulgaria *Jiyoung Park, Lidia Sakelarieva, Emilia Varadinova, Vesela Evtimova, Yanka Vidinova, Violeta Tyufekchieva, Galia Georgieva, Mila Ihtimanska, Milcho Todorov*
15:00-15:15	**O-GEEP-24** Characteristics of macroinvertebrate assemblages in karst and other spring ecosystems (R15 national river type) in Bulgaria *Yanka Vidinova, Vesela Evtimova, Violeta Tyufekchieva, Emilia Varadinova, Milcho Todorov, Mila Ihtimanska, Galia Georgieva*
Coffee break	
Chairman: ***Assist. Prof. Miroslav Ivanov***	
15:45-16:00	**O-GEEP-25** Age determination of Harbour porpoises (Phocoena phocoena relicta) from the Bulgarian Black sea coast *Violeta Evtimova, Dimitar Parvanov, Hristo Peshev, Petar Petrov, Atanas Grozdanov*
16:00-16:15	**O-GEEP-26** Ecological assessment of standing water bodies in Bulgaria through Hungarian Macrozoobenthos Multimetric Index for lakes *Marin Smilyanov, Emilia Varadinova*
16:15-16:30	**O-GEEP-27** Development of Bulgarian fish-based index for ecological assessment of the Lower Danube section (BRID) *Apostolos Apostolou, Luchezar Pehlivanov*
16:30-16:45	**O-GEEP-28** Determination of zones for reproduction of the fish fauna and zones for indwelling of economically valuable fish species within the West Aegean Sea basin region *Stefan Kazakov, Dimitar Parvanov, Borislav Borisov, Violeta Zinovieva, Luchezar Pehlivanov*
16:45-17:00	**O-GEEP-29** Methodological approach to identify zones for reproduction of the fish fauna – application in rivers of the Black Sea and East Aegean Sea basin regions *Luchezar Pehlivanov, Stefan Kazakov, Apostolos Apostolou, Tihomir Stefanov*

17:00-17:15	**O-GEEP-30** The herpetofauna of South park Sofia – species, distribution and conservation threats *Atanas Grozdanov, Anton Sokolov, Petar Petrov, Vasil Atanasov, Dimitar Dimitrov, Plamen Petrov, Hristo Peshev*
17:15-17:30	**O-GEEP-31** Specifics of birds of prey status in the areas of vulture reintroduction activities in Bulgaria *Emiliyan Stoynov, Hristo Peshev, Elena Kmetova–Biro, Ivelin Ivanov, Georgi Stoyanov, Simeon Marin, Atanas Grozdanov*
17:30-17:45	**O-GEEP-32** GPS tracking of Griffon vultures tagged on the Balkans - evaluation of the method, based on five years results *Hristo Peshev, Emiliyan Stoynov, Atanas Grozdanov*
17:45-18:00	**O-GEEP-33** Vertebrate diversity at the vulture feeding station in Kresna gorge *Hristo Peshev, Emiliyan Stoynov, Emanuil Mitrevichin, Atanas Grozdanov*

Section: Mathematics

Thursday, September 16th	
Chairman: ***Assoc. Prof. Nikolay Kitanov***	
13:30-13:45	**O-M-1** 2-norms generated by solutions of second-order linear differential equations *Slagjana Brsakoska, Alekso Malcheski*
13:45-14:00	**O-M-2** Recurrent solutions of the Lorenz system of differential equations *Biljana Zlatanovska, Donco Dimovski*
14:00-14:15	**O-M-3** A particular solution of the third-order shortened Lorenz system via integrability of a class of differential equations *Biljana Zlatanovska, Boro Piperevski*
14:15-14:30	**O-M-4** On a class off numerical semigroups with embedding dimension equal to 4 *Violeta Angjelkoska, Donco Dimovski, Irena Stojmenovska*
14:30-14:45	**O-M-5** Parabolic equations with causal operators *Tzanko Donchev, Nikolay Kitanov, Dimitar Kolev*
14:45-15:00	**O-M-6** Generalized solutions of nonlocal semi-linear systems with time lag *Tzanko Donchev, Nikolay Kitanov, Stanislav Stefanov*
15:00-15:15	**O-M-7** Maximal regularity for evolution equations and application to the Stefan problem *Martin Lukarevski*
Coffee break	
Chairman: ***Assoc. Prof. Vassil Grozdanov***	
15:30-15:45	**O-M-8** Analysis and prediction of the spread of Covid-19 in North Macedonia *Limonka Koceva Lazarova, Aleksandra Stojanova, Natasha Stojkovikj, Marija Miteva, Marija Ljubenovska*
15:45-16:00	**O-M-9** Vaccination queueing system simulation *Natasha Stojkovikj, Aleksandra Stojanova, Limonka Koceva Lazarova, Marija Miteva, Pamela Redzepovska*
16:00-16:15	**O-M-10** Comparison methods of estimating missing data in real data time series *Eljona Milo, Lorena Margo*
16:15-16:30	**O-M-11** Bootstrapping the coefficients of multiple logistic regression model in medicine data *Lorena Margo, Eljona Milo, Juliana Karanxha*
16:30-16:45	**O-M-12** On Simulation and Modeling in Economics *Mikhail Kolev, Sevasti Georgiadou*

Friday, September 17th	
Chairman: ***Assoc. Prof. Mikhail Kolev***	
13:30-13:45	**O-M-13** N-tuple orbits tending to infinity for Hilbert space operators *Sonja Mančevska, Marija Orovčanec*
13:45-14:00	**O-M-14** $H_p(N_0, b)$ space embedding into $l_q(N_0)$ space in the case $p \leq q$ *Vitaliy Zhurov, Lezzetzhan Mustafina, Nella Abayeva, Alina Yarullina*
14:00-14:15	Functions constructed over finite groups and uniform distribution of sequences *Vassil Grozdanov*

14:15-14:30	**O-M-15** The rank of the monoid of partial automorphisms on a crown *Ilinka Dimitrova, Joerg Koppitz*
14:30-14:45	**O-M-16** On some stochastic applications to real world problems *Iveta Nikolova, Krasimir Yordzhev, Ivelina Peneva*
14:45-15:00	**O-M-17** Transfer Learning for Medical Image Classification, *Irina Naskinova*
Coffee break	

Section: Informatics

Thursday, September 16th	
Chairman: ***Assoc. Prof. Radoslav Mavrevski***	
13:30-13:45	**O-I-1** The Impact of the Knowledge Management Strategy on Distance E-learning *Irena Atanasova*
13:45-14:00	**O-I-2** The Role of Organizational Culture and Knowledge Management for Knowledge Dissemination in Distance e-learning *Irena Atanasova, Elena Karashtranova, Nadezda Borisova*
14:00-14:15	**O-I-3** Scaling of clustering algorithms for big data sets with Weka *Aleksandar Stoimenovski*
14:15-14:30	**O-I-4** Application of Machine Learning in Software Development: A Systematic Mapping Study, *Metodi Erdelski, Ivo Damyanov*
14:30-14:45	**O-I-5** Research Work of Perceptron Algorithms for Recognition on Biometrics Data, *Margarita Todorova*
14:45-15:00	**O-I-6** Relational Database Design for University Course Timetabling Problem, *Velin Kralev, Radoslava Kraleva*

Section: Technical Sciences

Friday, September 17th	
Chairman: ***Assoc. Prof. Ivan Nedyalkov***	
13:30-13:45	**O-TS-1** Organizational-technological aspects in the construction of construction sites *Mira Zafirova, Dimitar Kaloshev*
13:45-14:00	**O-TS-2** Structure and properties of coatings based on hydroxyapatite obtained by the detonation method *Bauyrzhan Rakhadilov, Daryn Baizhan, Laila Zhurerova, Didar Yeskermessov, Aisulu Kalitova*
14:00-14:15	**O-TS-3** Electrolyte plasma hardening of 20X2H4A low-carbon steel *Bauyrzhan Rakhadilov, Zarina Satbaeva, Rauan Kozhanova, Lyaila Bayatanova, Aisulu Kalitova*
14:15-14:30	**O-TS-4** Production of coal powder by the electric pulse method *Ulan Nussupbekov, Mitko Stoev, Ayanbergen Khassenov, Dana Karabekova*
14:30-14:45	**O-TS-5** Investigation of the operation of a thermoelectric converter *Perizat Kissabekova, Dana Karabekova, Ayanbergen Khassenov, Lyubov Chirkova, Amangeldy Satybaldin*
14:45-15:00	**O-TS-6** Computer simulations for wireless network analysis *Iliyan Ivanov*
Coffee break	

Section: Methodology in Education

Thursday, September 16th	
Chairman: ***Assoc. Prof. Ivelina Kotseva***	
13:30-13:45	**O-ME-1** Possibilities for mathematical competences development in lower secondary school through game-based learning *Krista Mehandzhiyska, Daniela Tuparova*
13:45-14:00	**O-ME-2** The Constructivist Approach in Mathematics Education *Hristina Shekerliyska-Vachkova*
14:00-14:15	**O-ME-3** The problems of teaching higher mathematics with the use of distance learning technologies *Lezzetzhan Mustafina, Bayan Alimova, Dana Kapzhapparova, Bakhytzhan Mustafina*
14:15-14:30	**O-ME-4** The chemical experiment as a cross point in the development of the mathematical competence and competence in science, technology, engineering and entrepreneurship competence *Liliya Boyadzhieva, Elitsa Chorbadzhiyska*
14:30-14:45	**O-ME-5** Chemistry in our days *Alexandra Kamusheva, Elisaveta Mladenova*
14:45-15:00	**O-ME-6** Inquiry based science investigations for enhancing student learning *Elisaveta Malamova*
Coffee break	
Chairman**: *Assist. Prof. Liliya Boyadzhieva***	
15:30-15:45	**O-ME-7** The potential of YouTube as a learning tool in physics education: a syrvey among secondary students *Ivelina Kotseva, Nikolay Nikolov*
15:45-16:00	**O-ME-8** Analysis of problem-based learning in physics from the perspective of integrated STEM education *Ivelina Kotseva, Maya Gaydarova, Fabien Kunis, Konstantin Ilchev*
16:00-16:15	**O-ME-9** Applying collaborative activities in high school physics course during hybrid model of learning *Fabien Kunis, Ivelina Kotseva, Maya Gaydarova*
16:15-16:30	**O-ME-10** Investigation of instructional practices in high-school atomic and subatomic physics *Konstantin Ilchev, Ivelina Kotseva*
16:30-16:45	**O-ME-11** Communicating results in project-based and problem-based physics education: the perspective of engineering design in STEM *Ivelina Kotseva*
16:45-17:00	**O-ME-12** Application of the project method in physics education in classes with intensive studying of English *Georgi Malchev*

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Special session
"Low-carbon energy for transport and household"

Thursday, September 16th	
Chairman:	***Assoc. Prof. Yolina Hubenova, DSc***
13:30-14:00	**O-SS-1** Advanced alkaline water electrolysis with Co and Ni based non-carbon supported electrocatalysts *Evelina Slavcheva, Katerina Maksimova-Dimitrova, Galin Borisov, Hristo Penchev, Filip Ublekov*
14:00-14:15	**O-SS-2** Electrochemical hydrogen compressor – novel cell design, electrodes structure and catalysts *Galin Borisov, Nevelin Borisov, Evelina Slavcheva, Elefteria Lefterova*
14:15-14:30	**O-SS-3** Bio-hydrogen production *Tsvetomila Parvanova-Mancheva, Evgenia Vasileva, Venko Beschkov*
14:30-14:45	**O-SS-4** Biological hydrogen production by Clostridium sp. *Evgenia Vasileva, Tsvetomila Parvanova-Mancheva, Venko Beschkov*
14:45-15:00	**O-SS-5** Synthesis and characterization of photoactive titanium oxides by anodic oxidation *Iva Betova, Martin Bojinov, Vasil Karastoyanov*
15:00-15:15	**O-SS-6** Hybrid supercapacitors with innovative binder - ex-situ structural and morphological studies *Boriana Karamanova, Philip Ublekov, Christo Novakov, Ivailo Dimitrov, Antonia Stoyanova, Liubomir Soserov*
Coffee break	
Chairman:	***Assoc. Prof. Galin Borisov***
16:00-16:15	**O-SS-7** Capture of CO_2 by mesoporous CeO_2/ZrO_2 materials *Oyundari Tumurbaata, Margarita Popova, Hristina Lazarova, I. Spasova, S. Andonova, O. Lagunov, Dimitar Panayotov*
16:15-16:30	**O-SS-8** Organic acids and hydrogen production by a newly selected microbial consortium *Greta Naydenova, Dragomir Yankov*
16:30-16:45	**O-SS-9** Mg-Ca0.3 Electrochemical Activity Exposed to Hank's Physiological Solution and Properties of Ag-Nano-Particles Deposits *José Luis González-Murguía, Lucien Veleva*
16:45-17:00	**O-SS-10** Metal Recovery from silver(I) dithiosulfate complex by Microbial Electrochemical Snorkel *Milena Kehayova, Elitsa Chorbadzhiyska, Yolina Hubenova, Mario Mitov*
17:00-17:15	**O-SS-11** Electrocatalytic activity of Ni- and Co-modified graphitized paper towards hydrogen evolution reaction in neutral electrolyte *Desislava Apostolova, Elitsa Chorbadzhiyska, Galin Borisov, Mario Mitov, Yolina Hubenova*

POSTER SESSION

Chemistry	
P-C-1	Influence of electrolyte additives on the performance of the positive plates of lead batteries *Maria Matrakova, Albena Aleksandrova, Plamen Nikolov*
P-C-2	Effect of Organic Electrolyte Additives on the Performance of Electrodes of Lead Battery *Albena Aleksandrova, Maria Matrakova, Plamen Nikolov*
P-C-3	Absorption − Adsorption Method for Gas Purification from SO_2 in Power Plants *Boyan Boyadjiev, Petya Popova-Krumova,, Christo Boyadjiev, Elena Razkazova-Velkova*
P-C-4	CFD Modeling of Two-phase Flow in an Absorption-adsorption Column *Stela Panyovska, Daniela Dzhonova – Atanasova, Elena Razkazova Velkova*
P-C-5	Synthesis and characterization of electrode materials for supercapacitor systems *Borislava Mladenova, Boriana Karamanova, Svetlana Veleva, Toma Stankulov, Vania Ilcheva, Antonia Stoyanova, Mariela Dimitrova*
P-C-6	Butyric acid pertraction with and without car-rier in the organic membrane. Parameter identification *Petya Popova-Krumova, Dragomir Yankov, Madlen Lazarova, Raika Vladova, Artak Kostanyan, Andrey Voshkin*
P-C-7	Assessment methods for improving the Energy efficiency of Wastewater treatment plants *Rayka Vladova, Natasha Vaklieva-Bancheva*
P-C-8	Adsorption of Pd(II) on N- and S- modified silica sorbents *Petranka Petrova, Maya Chochkova, Metody Karadjov*
P-C-9	Possibilities of increasing the detection power of ICP-OES *Petranka Petrova, Serafim Velichkov, Nonka Daskalova*
P-C-10	ICP-OES - analytical characteristics and application in chemical analysis *Petranka Petrova, Serafim Velichkov, Nonka Daskalova*
P-C-11	Synthesis and biological activity of new N-dihydroxycinnamic acid hybrids *Maya Chochkova, Anna-Maria Hristova, Tsvetelina Ilieva, Hailun Jiang, Boyka Stoykova, Rui Liu, Yavor Mitrev, Martin Štícha, German Perlovich*
P-C-12	Effect of the final thermal sealing on the performance of combined Ce-O-Al films formed on AA2024-T3 aircraft alloy *Stephan Kozhukharov, Mihaela Georgieva, Alexander Tsanev, Christian Girginov, Maria Petrova*
P-C-13	Durability of Cu, Ni and Cu/Ni modified AAO layers, formed on AA2024-T3 aircraft alloy *Christian Girginov, Stephan Kozhukharov, Boriana Tsaneva*
P-C-14	Effect of the thermal sealing on Ce-O-Al coating primers in concentrated phosphate solutions *Stephan Kozhukharov, Angel Dishliev, Alexander Tsanev, Christian Girginov*
P-C-15	Factors, governing the metal affinity and selectivity towards HDAC8 enzyme active site *Nikolay Toshev, Diana Cheshmedzhieva, Todor Dudev*

P-C-16	Synthesis and characterization of new deep eutectic solvents *Denitsa Ivanova, Dragomir Yankov*
P-C-17	Effect of the ultrasound assisted mixing of Zn active mass with different content of BSCCO (2212) ceramics additives *Galia Ivanova, Antonia Stoyanova, Elefteria Leffterova, Violeta Petrova, Yordan Marinov, Georgi Hadjichristov, Angelina Stoyanova-Ivanova*

Physics	
P-P-1	Possibility of measuring the angular characteristics of the primary and secondary tracks of relativistic nuclear fragmentation by the nuclear track emulsion method *Ralitsa Stanoeva, Andrey Zaitsev, Pavel Zarubin*
P-P-2	Search for decays of the unstable nuclei in dissociation of relativistic nuclei ^{14}N *Elitsa Mitsova, Ralitsa Stanoeva, Andrey Zaitsev, Pavel Zarubin*
P-P-3	Correlation in formation of ^{8}Be nuclei and α-particles in fragmentation of relativistic nuclei *Andrey Zaitsev, Pavel Zarubin*
P-P-4	Influence of the Beam Power on the Microstructure and Mechanical Properties of Electron Beam Welded Joints of Copper and Stainless Steel *Darina Kaisheva, Angel Anchev, Vladimir Dunchev, Borislav Stoyanov, Milka Atanasova, Stefan Valkov, Maria Ormanova, Vladimir Todorov, Georgi Kotlarski, Stanislava Rabadzhiyska*
*P-P-5	Physicochemical and magnetic study of Dy-123 and Gd-123 bulk samples doped with nano Fe_3O_4 *Angelina Stoyanova-Ivanova, Svetoslav Kolev, Violeta Petrova, Ognyan Petkov, Lan Maria Tran, Michał Babij, Andrzej Zaleski, Valdek Mikli, Daniela Kovacheva*
P-P-6	Material and Optomechanical Characteristics of Polymers in Optical Design *Radostin Kasarov, Stefka Kasarova, Nina Sultanova*
P-P-7	Impedimetric response of phospholipid Langmuir-Blodgett films to methanol vapors *Todor Vlakhov, Georgi Hadjichristov, George Ivanov, Yordan Marinov*

Geography, Ecology and Environmental Protection	
P-GEEP-1	New data on the pteromalid fauna (Hymenoptera: Pteromalidae) associated with foliage of the Norway spruce, Picea abies (L.) H. Karst., from Bulgaria *Ivaylo Todorov, Mircea-Dan Mitroiu*
P-GEEP-2	Zoogeographical subdivision of Bulgaria based on the distribution of herpetofauna *Alexander Pulev, Lidia Sakelarieva*
P-GEEP-3	State and perspectives of citizen science for invasive alien species in Bulgaria *Rumen Tomov*
P-GEEP-4	Assessment of the motivation for participation in citizen science initiatives for invasive alien species in Bulgaria *Elena Tsvetkova, Galin Milchev, Hristina Stefanova*
P-GEEP-5	Soil magnetic susceptibility properties as indicators of heavy metals pollution in Bobov dol Termal Power plant area *Miroslav Ivanov, Konstantin Tyufekchiev*

Mathematics	
P-M-1	Constructing of an optimal portfolio on the Bulgarian stock market using hybrid genetic algorithm for pre and post Covid-19 periods *Miroslava Ivanova, Lilko Dospatliev*
P-M-2	Air pollution during Covid-19 pandemic: exploration in the Bulgarian city of Stara Zagora using interrupted time series ARMA model *Miroslava Ivanova, Lilko Dospatliev*

Informatics	
P-I-1	The Importance of Biological Databases in modeling of structure-activity relationship *Fatima Sapundzhi, Tatyana Dzimbova*
P-I-2	Computer modeling and model selection in bioinformatics, *Radoslav Mavrevski, Metodi Traykov*

Technical Sciences	
P-TS-1	Automatic Frequency Release Realized by Programmable Logic Controller UNITRONICS V1210 **Cancelled** *Gergana Kalpachka, Ventsislav Kalpachki*
P-TS-2	An android-based mobile application giving information for weather in real-time *Fatima Sapundzhi, Milosh Mladenov*
P-TS-3	Smart home automation based on Z-Wave technology *Fatima Sapundzhi*
P-TS-4	Optimization of the microbial production of 2,3-butanediol from glucose by *Bacillus licheniformis 24* *Lidia Tsigoriyna, Dimitar Ganchev, Penka Petrova, Kaloyan Petrov*

Methodology in Education	
P-ME-1	Results of the Pedagogical Observation and Survey of Students, Teachers and Students-Future Teachers Who Have Participated in Physics Teaching with Using Modern Educational Technologies **Cancelled** *Gergana Kalpachka*
P-ME-2	Multimedia Technologies in Physics Teaching *Gergana Kalpachka*
P-ME-3	An Integrated Approach to Teaching the Topic Light and Colors from the Seventh Grade Physics Syllabus *Radost Vassileva*

Special session "**Low-carbon energy for transport and domestic use**"	
P-SS-1	Cultivation, Isolation and Identification of Thermophilic Microorganisms and their Use for Redox Processes in Fuel Cells *Nadya Armenova, Dragomir Yankov, Stefan Stefanov, Elena Razkazova-Velkova*
P-SS-2	Study of novel carbon materials for sulphur oxidation/reduction reactions *George Pchelarov, Dzhamal Uzun, Aleksandar Tsanev, Adriana Gigova, Marinela Dimitrova, Ognian Dimitrov, Nadezhda Dermendzhieva, Elena Razkazova-Velkova, Konstantin Petrov*
P-SS-3	Membraneless Fuel Cells for Remediation of Sulfide and Nitrate Contaminated Fluxes *Stefan Stefanov, Elena Razkazova-Velkova, Tsvetomila Parvanova-Mancheva*
P-SS-4	Structured Zirconium Catalyst for Electrochemical Oxidation of Sulfide Ion *Nadezhda Dermendzhieva, Dzhamal Uzun, Elena Razkazova-Velkova, Konstantin Petrov, George Pchelarov, Ljutzkan Ljutzkanov*
P-SS-5	*Ab initio* study on development of a BOD/COD biosensor *Nikolay Vitanov, Elitsa Chorbadzhiyska, Mario Mitov, Yolina Hubenova*
P-SS-6	NiW- and NiMo-modified graphitized paper as potential cathodes for Microbial Electrolysis Cells *Elitsa Chorbadzhiyska, Mario Mitov, Yolina Hubenova*
P-SS-7	Electrochemical performance of nanotube sodium titanate in post Li- ion cells *Svetlana Veleva, Antonia Stoyanova, Radostina Stoyanova*

Plenary Lectures

Porous metallic structures by de-alloying amorphous and nanocrystalline materials

Prof. Tony Spassov

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Abstract: The report summarizes our results on the preparation of three-dimensional micro- and nanoporous metallic structures by selective dissolution of alloys. This is an approach used for de-alloying solid solutions and two-phase crystalline alloys. Our contribution considers the use of amorphous and nanocrystalline precursors for porous metals formation. The reason to focus on them as starting materials is their chemical and structural homogeneity, as well as the possibility of obtaining amorphous alloys with large compositional range. In the last few years we have focused on some easy glass formers based on Zr, Pd, Au. By optimizing the conditions of chemical and electrochemical selective dissolution, three-dimensional porous structures having high catalytic activity towards hydrogen evolution reaction (HER) as well as oxidation of ethanol were obtained. Another important application of these new materials is their use as electrodes in ion batteries.

Keywords: nanoporous structures, dealloying, amorphous alloys

Oxygen Reduction Reaction in neutral media: advancements and limitations

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Abstract: Microbial Electrochemical Systems (MES) are capable of converting organics directly into electricity. At the cathode, the oxygen reduction reaction takes place. Oxygen is the most used oxidant due to its low cost, weight, natural availability and red-ox potential. MESs operate in (circum)neutral pH environment in order to maintain bacterial activity. In these pH conditions, the concentration of H^+ and OH^- is quite low affecting negatively the oxygen reduction reaction (ORR) kinetics. MESs produce low electricity output mainly due to the high overpotentials and slow kinetics affecting the cathode ORR and improvements need to be pursued. Recent achievements in the cathode oxygen reduction reaction (ORR) using different catalysts (carbonaceous based and transition metal containing) are reported. Materials such activated carbon, despite being robust, suffer of low electrocatalytic activity towards ORR. Recently, PGM-free M-N-C (M as Mn, Fe, Co, Ni) electrocatalysts have shown to be high ORR electrocatalytic activity. The effect of the: i) transition metal; ii) precursors (nitrogen rich organic molecules); iii) catalytic loading; iv) synthesis steps; on the catalyst kinetics through rotating ring disk electrode (RRDE) technique is evaluated and their performance in MESs is also discussed. Important relationships between electrocatalysts surface chemistry and their electrocatalytic output are also reported.

Keywords: cathode, oxygen reduction reaction, neutral pH, electrocatalysts

Models or reality - what is more useful? And how computer simulation can assist in this?

Dr. Manfred Schütze

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Abstract: Our world is a complex system – there is no doubt about this! How can computer models, which are, in the best case, a simplified representation of reality, help us in understanding and managing the world? This plenary lecture provides some background and example applications of modelling in water engineering: (1) Discharges of untreated wastewaters in combined sewer systems into rivers can have negative impacts on the river water quality. Controlling discharges by real time control of sewer systems can help minimizing negative impacts. It also presents an example of use of models during a process and allows to illustrate the concept of a “Digital Twin”. (2) The analysis of different water management strategies by offline simulations, on the other hand, can assist in strategic planning. The lecture presents some insights into recent research projects.

Development of bioavailable drugs on basis of adamantine and memantine derivatives

Prof. German Perlovich

Institute of Solution Chemistry of Russian Academy of Sciences, Ivanovo, Russia

CANCELLED

Oral Presentations

Chemical composition of underground waters in Demänová valley as a tool for finding connections between the Štrefanová and Demänová cave systems

David Havíček[1], Pavel Herich[2,3], Kateřina Havlíčková[4]

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[2]*Slovak Speleological Society, Demänová Valley Caving Club, Ploštín, Slovakia*
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Abstract: Accurate chemical analyses of subterranean waters can be a useful tool for obtaining different information about the studied cave system. If the samples are collected at approximately the same time and at a constant weather, when discharge is not changing and the time needed for flowing water from one sampling point to another is not too long (up to several hours), we can assume, that chemical composition is subject to a significant change only due to mixing of waters of different compositions due to their different origins. The results can be used even better than the results from classical tracing experiments and with less efforts for cavers performing the work in the caves. Much more work is, of course, needed in the laboratory. We used this method twenty years ago when investigating the Bohemia Cave, Mt. Owen, New Zealand. Due to very clean atmosphere (no acid rains) and due to the fact that all the waters originated only from carbonate rocks it was sufficient to determine carbonate equilibria (total alkalinity) and the contents of magnesium and calcium and (in some cases) iron and/or manganese. In the last years we have used this method for finding connections in the largest cave system in Slovakia based on waters from different sources. In this case we have used the set of mixing equations expressing balance of the following indicators: hydrogen carbonates, calcium, magnesium, sulfates, chlorides and nitrates. After the computation we have obtained relative discharges of different sources. When our results were compared with measured discharges, the supposed model was confirmed.

Keywords: cave water chemistry, mixing equations, hydrographic model

Synthesis and reactivity of a ferrocene distibine

Petr Stepnicka, Jiri Schulz, Jakub Antala

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Abstract: While 1,1'-bis(diphenylphosphino)ferrocene, commonly abbreviated as dppf, has received considerable attention due to it versatile coordination and unique catalytic performance, the analogous bis-stibane has not yet been reported. To date, only a handful of ferrocene stibanes was described, mostly bearing additional donor groups capable of interacting with the Sb atom. This contribution will disclose the synthesis and detailed structural characterization of 1,1'-bis(diphenylstibino) ferrocene, investigations into its reactivity and coordination behavior.

Keywords: ferrocene ligands; stibines; reactivity; coordination chemistry

Synthesis and Coordination Behavior of New Ferrocene α-Aminobis(phosphine)

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Abstract: α-Aminophosphines ligands combine amine and phosphine donor groups separated by methylene moiety from each other. Here we present a new addition to this group, bis((diphenylphosphino)methyl)-ferrocenylamine $FcN(CH_2PPh_2)_2$ (Fc = ferrocenyl, Ph = phenyl) which was synthesized by condensation of ferrocenylamine with (diphenylphosphino)-methanol under dynamic vacuum. Furthermore, coordination properties of this new ferrocene ligand were tested. In total, ten different complexes with group 10 and 11 metal precursors were prepared, in which the ferrocene ligand was coordinated via phosphine groups. Although the amine moiety can coordinate to a metal ion, no bond between metal ion and the amine was observed. All synthesized compounds were characterized by standard spectroscopic methods (NMR, IR, MS ESI and elemental analysis). Majority of compounds provided crystals suitable for X-ray structure analysis.

Keywords: ferrocene, phosphine, coordination chemistry, structure elucidation

Coordination behavior of a new phosphinoguanidine ligand

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Abstract: Guanidinium motif is frequently used as a hydrophilic moiety, which increases solubility of phosphine ligands and the corresponding complexes in water or other polar solvents. Although these properties are beneficial for applications in homogeneous catalysis, coordination chemistry of such ligands is quite poor, due to inhibited coordination of protonated guanidinium nitrogen atom. Considering that nitrogen donor coordination can be observed for neutral guanidines and that only few neutral phosphinoguanidine ligands were reported to date, we decided to prepare a neutral mixed donor ligand combining phosphine and guanidine moieties and to evaluate its coordination properties in square planar complexes with Group 10 Lewis acids, namely with palladium(II) and platinum(II). Interesting differences in the reactivity towards analogous starting materials were observed and will be discussed in this contribution.

Keywords: ligand design, coordination chemistry, Group 10 metal complexes, P,N-donor ligands

Synthesis and reactivity of a stable primary phosphine oxide, and preparation of its heavier congeners

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Abstract: Primary phosphine oxides, unlike their secondary and tertiary counterparts, have a reputation as highly reactive compounds with low thermal stability and tendency toward spontaneous oxidation and disproportionation. Because of their difficult synthesis, they received very little attention in the past. Similar applies to the heavier congeners, i.e., primary phosphine sulfides and selenides, of which the latter were declared too unstable to be isolated. Air-stable phosphine oxide was obtained by oxidation of (ferrocenylmethyl)phosphine and its reactivity was examined in reactions with various unsaturated compounds. Coordination properties of oxide were investigated in complexes of soft and hard transition metal cations. All products were characterized by elemental analysis, spectroscopic methods (NMR, IR and MS), and their solid-state structures were often determined by single-crystal X-ray crystallography.

Keywords: primary phosphine oxide, primary phosphine chalcogenides

Isocyanoferrocene and its carebenes' comlexes

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Abstract: The ferrocene celebrates this year 70th anniversary of discovery. During the last half of century, a huge number of ferrocene derivatives have been prepared and some of them became very successful ligands in transition metal-catalyzed reactions. Most of the studies were focused on preparation of ligands with phosphorus donor. This contribution describes coordination behavior of isocyanoferrocene and preparation of ligands with carbon donor. Firstly, the isocyanoferrocene was compared with isomeric cyanoferrocen in precious metal complexes. Further, the isonitrile was inserted into metal-carbon bond to obtain a serie of imidoyl complexes, which were subsequently transformed into Fisher-type carbenes. All newly prepared compounds were characterized by nuclear magnetic resonance, infrared spectroscopy, elemental analysis, mass spectrometry and X-Ray analysis of monocrytals.

Keywords: Ferrocene, Isonitrile, Carbene Comlexes

Obtaining granular activated carbon using a binder gelatin in the joint processing of rice and oil waste

N.O. Appazov[1, 2], B.M. Diyarova[3], Б. М. Bazarbayev[1], B. Zh. Dzhiembaev[3] , O. Lygina[4]

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Abstract: In this article, the effect of gelatin as a binder has been studied to obtain granular activated carbon by joint processing of rice waste (husk and straw) and oil sludge. Carbonation and activation of the granules were carried out in a high-temperature vacuum tube furnace of the BR-12 NFT series with a length of 200 mm, in a heating glass tube made of quartz glass with a length of 300 mm and a diameter of 60 mm. Carbonation was carried out at a temperature of 500°C, activation-by water vapor at a temperature of 850°C in the ratio of water and carbonizate 2:1. The effect of the ratio of gelatin binder, rice waste and oil sludge on the properties of activated carbon was studied. The optimal ratio of the joint processing of the mixture is rice husk:oil sludge:gelatin 9:1:2 (by weight). The studies were carried out according to the following indicators: adsorption activity for iodine, total pore volume for water, mass fraction of moisture, adsorption activity for methylene blue, and bulk density. Granulated activated carbon corresponds to the BAU-MF brand.

Keywords: activated carbon, rice husk, rice straw, oil sludge, gelatin, granules.

Interactions and reactivity of various thia- and carbaboranes with bases

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Abstract: The reactivity of boron clusters has been extensively studied in the recent decades.1 In contrast to organic chemistry, the corresponding reaction mechanisms can be very complex since there are very small energy differences between many intermediates and transition states. On that basis, reactions of boron hydrides can involve many competing pathways. However, much progress has been made so far in the understanding of the reaction mechanisms of boron hydrides and the carboranes derived from them.
We will present the reactivity of thiaboranes and several types of 10- and 12-vertex dicarbaboranes with various bases including N-heterocyclic carbenes. We have found various pathvays to novel reactivity of clusters, stabilization of unusual fragments of Main Group elements, prepared the first series of robust air/water stable cationic carboranes and established new group of porous materials suitable for separation of molecules in gas-phase.

Keywords: boron, cluster, base

Acknowledgements: We thank the Science Foundation of the Czech Republic for financial support.

Cu-catalyzed reductions of brominated phenols in alkaline aqueous solution

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Abstract: The effect of copper and its alloys and oxides with coaction of sodium borohydride on reduction of brominated phenols in alkaline aqueous solution will be discussed. Herbicide Bromoxynil (3,5-dibromo-4-hydroxybenzonitrile) and tetrabromo-bisphenol A were the studied bromina-ted phenols. Devarda´s Al-Cu-Zn alloy and copper oxides with $NaBH_4$ were tested as the very effective debromination agents. On the other hand, metallic copper is the worse debromination catalyst using $NaBH_4$ as reductant. Differences in the solid-state structures of used Cu-based heterogeneous catalysts after the mentioned hydrodebromination process have been studied using the powder XRD and SEM techniques. The aim of this study was to discover simple and sustainable process for effective treatment of nonbiodegradable halogenated phenolic aqueous contaminants. It is well known that dehalogenation of halogenated aromatic compounds significantly increases biodegradability of obtained dehalogenated products. For recycling of spent copper catalysts, the hydrometallurgical treatment was evolved.

Keywords: Devarda´s alloy; Cu catalyst; dehalogenation

Preparation, characterization and study of radiation stability of bulk Ti_2AlC MAX phase.

Bauyrzhan Ismagulov[1,2*], Jiri Plocek[1], Jiri Vacik[3], Jaroslav Kupcik[1], Jiri Nemecek[4]

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Abstract: MAX phases, a growing family and exciting class of carbides or nitrides with unique combination of physical properties, such as with high hardness, high-temperature oxidation tolerance, electrical conductivity, under thermal damage resistivity. Hexagonal layered structure of MAX phases has big chance to be resistive to high-energy-particles irradiation (both, ions and neutrons). Herein, we study preparation of Ti_2AlC bulk MAX phase synthesized by sintering of a compressed mixture consisting of (Ti, Al, C) elemental powders. The structure was characterized by XRD and microscopic examination (TEM, HR-TEM, SEM, EDS) confirmed that the resulting material is MAX phase. The Ti_2AlC sample was irradiated by 2MeV high-energy of W^+ ions in order to generate and analyze the radiation induced structural defects and study radiation stability. We compare phase compositions, hardness and elastic properties before irradiation, after irradiation with the fluences 10e14 and 10e15. Mechanical properties were studied by nanoindentation methods.

Keywords: MAX phase; Ti_2AlC; irradiation; XRD; nanoindentation

Extending of the NLO materials family – novel guanidine-based molecular crystals

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Abstract: Hybrid materials based on selected organic molecules as carriers of nonlinear optical properties are very attractive class in the field of nonlinear optics (NLO). The guanidinium cation is a well-known example which still attracts scientific attention. This planar cation with the high level of □-electron delocalization represents ideal building unit with trigonal symmetry for crystal engineering of novel molecular crystals for NLO.

These novel materials profit from the existence of hydrogen bonds as the driving force of molecular self-assembly and crystal packing. Hydrogen bonds interconnecting guanidinium cations with suitable cocrystallization partners hold not only crucial structural role but also positively influence observed NLO effects.

The representative examples of currently studied guanidine compounds will be presented within this contribution. The contribution will be focused not only to crystallographic aspects and vibrational spectroscopy results but also to phase stability and observed NLO properties.

Keywords: Nonlinear optics, Crystal structure, Vibrational spectra, Phase transformations

Study of proton transfer trajectory in proton conductors using *in situ* X-ray powder diffraction measurements

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Abstract: Proton conductors are important in many areas of technical applications. One of the large family of proton conductors are salts of oxoacids. The conductivities of these salts, are not so high, but are still several orders higher than conductivities of insulators and still have wide practical use.

Here we will present the study on model compounds of powder $CsHSO_4$ samples. We studied changes of X-ray diffraction pattern sample measured on the "conditions of proton conductivity", i.e. under high voltage (DC). On approx. 60 % diffraction lines we have observed broadening and in some cases also the significant shift of diffraction lines both to higher and smaller angles. The same measurement on normal salt without hydrogens did not show any changes of the pattern under high voltage. The analysis of patterns showed, which lines were affected by proton transfer and defined the "direction" of conductivity through crystal, even the measurement is made on powder sample. Base on deep analysis of changes in diffraction patterns, we were able to construct 3D graphic representation of proton transport channels obtained from in situ powder-XRD measurement under high voltage.

Keywords: proton conductivity, powder samples, in situ XRD measurement

Drinking water purification: Filtration, Reverse Osmosis and UV disinfection systems

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Abstract: The drinking water resources of South-West Bulgaria and particularly in the region of Blagoevgrad are discussed. The main contaminants of tap water, spring water and ground water for drinking purposes are shown. The national and EC requirements for the quality of drinking water are presents. The quality of drinking water is improved locally by filtration, reverse osmosis (RO) and UV disinfection. The applications of local water purification systems as a 7-stages system with RO and UV disinfection and a simple system with filtration, UV disinfection and pump are critically discussed. After chemical analysis of a water purification are present recommendations for a local improving quality of water by applications of advanced innovative water purification systems.

Keywords: Drinking Water, Filtration, Reverse osmosis, UV disinfection, Water purification systems

Application of the additive manufacturing technologies in the field of chemical engineering – an analysis

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Abstract: One of the most complicated problems in chemical engineering is process scaling-up. This problem is shared between different engineering disciplines. Over time people created different ways to ensure faster, safer and cheaper scaling-up for their ideas. Nowadays we are working with computer models, but still, it has to be tested in real conditions before turning it into a full-scale process. The development of material science and electronics brought to the world the 3D printing. Using 3D printers, we can create precise and cheap prototypes from different materials and test our ideas before giving them publicity. The following article presents an analysis, which can give to the reader the following: what types of additive manufacturing technologies are developed now; what kind of materials these technologies use; what kind of work we can do with 3D printers; how we can use the additive manufacturing in the field of chemical engineering.

Keywords: chemical engineering, rapid prototyping, additive manufacturing, 3D printing, chemical processes, scailing up

Influence of skin metabolites of the newly synthesized derivative of bexarotene and paracetamol on the potential antitumor effect

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Abstract: The present work is structured to predict probable skin metabolites, DNA and protein binding of newly synthesized compound of bexarotene and paracetamol. Predicted skin metabolites of the newly synthesized derivative of bexarotene and paracetamol are three in the following mechanistic domains - A_N^2, non-covalent interaction, non-specific, radical mechanism, S_N^1 and S_N^2 by DNA binding and two reactive metabolites in the mechanistic domain (Michael addition) by protein binding. Metabolites containing structural alerts with a potential toxic effect may complement the possible antitumor effect.

Keywords: bexarotene derivative, predict, metabolic activation, skin, QSAR Toolbox

Study of the reactivity of the generated liver metabolites of a newly synthesized derivative of bexarotene and paracetamol

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Abstract: The present work is focused in predicting probable hepatic metabolites (in vivo and in vitro rat) and in studying their reactivity mechanisms (DNA and protein binding). The parent structure of the newly synthesized compound of bexarotene and paracetamol can bind to DNA but it cannot bind to protein. Experimental metabolic pathways of action were not observed for rats in vivo and in vitro. The reactivity of the predicted hepatic metabolites for both conditions (in vivo and in vitro) have different mechanisms of action (A_N2, non-covalent interaction, non-specific, radical mechanism, S_N1 and S_N2). The protein reactivity of the bexarotene derivative has the following mechanisms of action (Michael addition, Nucleophilic addition, Schiff base formation, S_N2).

Keywords: bexarotene derivative, predict, metabolic activation, hepatic, QSAR Toolbox

Investigations about thermodynamic and kinetic characteristics of adsorption process

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Abstract: In recent years, the requirements for sulfur content and polycyclic arenes in diesel fuels have changed the most in the world and in Bulgaria. From 31.07.2018 the requirements for sulfur content in the Republic of Bulgaria for a commodity product - gas oil for industrial and communal purposes is below 0.1%, 0.02% and 0.01%. Of particular importance and place in oil refining are the adsorption methods for separation and purification of oil fractions, which make it possible to comprehensively address issues related to the purification of sulphur compounds, obtaining high quality products and environmental protection. In this paper, the thermodynamic and kinetic characteristics of the middle distillate fraction purified by adsorption are studied. It have been shown that adsorption laboratory processes are thermodinamically possible.

Keywords: adsorption, diesel fraction, Gibs Energy, entropy, sulfur

Preparation of arginine complexes with heavy metal ions

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Abstract: Bidentate complexes of the amino acid arginine with heavy metal ions - MoO_2^{2+}, VO^{2+}, Fe^{2+}, Co^{2+} и Cu^{2+} were synthesized. The complexes with MoO_2^{2+} were prepared in aqueous-acidic solution at pH= 2. The remaining complexes were prepared in aqueous solution at room temperature. The complexes were washed with distilled water until neutral reaction and dried in a vacuum desiccator to constant weight. The complexes thus obtained were characterized by IR-FT spectroscopy. New absorption bands characterizing the Me-COOH and Me-NH_2 group bonds have been reported. The probable structures, the activation energy and lengths of metal-ligand bonds in the obtained complexes are presented, calculated and compared by the *in silico* methods.

Keywords: arginine, metal complexes, quantum-chemical calculations, geometry optimisation.

Synthesis, characterization and microbiological evaluation of new metronidazole derivatives

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Abstract: The antimicrobial agents were discovered more than 100 years ago. However, the struggle with bacterial agents continues at present. The development process of searching for new antimicrobial drugs include global research efforts. Obviously, the synthesis of new antimicrobial drugs can take many years to complete. The aim of the present scientific work is to obtain, structurally characterize and investigate for antimicrobial activity, non-described in the literature, two new amide metronidazole derivatives. As a part of our research on new metronidazole derivatives, we report their characterization by IR, NMR and UV-VIS spectroscopies. Their antibacterial properties were evaluated by agar and broth dilution assays. The observed data show that novel amide derivatives possessed more potent antibacterial activity against Bacteroides fragilis than parent structure of metronidazole.

Keywords: amide, antibacterial, identification

Establishing effective ventilation in residential bathrooms by CFD methods

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Abstract: Effective ventilation in indoor wet areas such as the residential bathrooms reduces the risk of developing molds and fungi causing allergies in humans and directly reduces the consumption of household chemicals, water, energy and harmful emissions in the environment (including VOC, CO2 et al.). In the presented work are shown the CFD simulations of the air flows at different arrangement of the inlet fresh air flow and the outlet air flow in a real existing bathroom are considered. The obtained visualizations of the airflow in our object show that the ANSYS Fluent method used at given the individual characteristics, such as the geometry of the enclosed space and arrangement of furniture, is suitable for making recommendations for effective ventilation of residential bathrooms.

Keywords: Effective ventilation, CFD airflow bathroom, indoor wet area, ANSYS Fluent

Advanced approaches for waste gases purification from SO_2. Modelling and simulation.

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Abstract: The environment is still awaiting the development of better technologies, apparatus and equipment to reduce gas emissions in the atmosphere, where one of the most hazardous atmospheric air pollutants is sulphur dioxide. The present work makes analysis of approaches to predict the mass transfer and respectively to optimize the equipment for purification of waste gases from SO_2 in the available or new technologies by means of the mathematical modeling and CFD simulations. It also discusses and summarizes the various methods and proposals for increasing the efficiency of the processes in SO_2 removal technologies.

Keywords: gas purification, SO_2, mathematical modeling, CFD simulation

Acknowledgements: This work has received funding from the National Research Fund project No КП-06-Н37/11/ 06.12.2019 “Integrated absorption-adsorption process for waste free decontamination of gases from sulphur dioxide”.

Software based approach for prediction of microbial activity of new metronidazole derivatives

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Abstract: Recently many protozoa and bacteria has developed resistance to existing antibacterial drugs. It is a global problem which can cause thousand lethal outcomes for millions of people every year. Therefor is necessary to be found new potential anti-infection agents. Two new metronidazole derivatives were synthesized with suspected extended bacterial spectrum of activity. The aim of this work is to predict the probable microbial metabolites and their DNA and protein binding of the new metronidazole derivatives by software based approach QSAR Toolbox. The reactive metabolites of Microbial transformation simulator of the new metronidazole derivatives are with radical mechanism via ROS formation, S_N1, nucleophilic attack after nitrenium ion formation, A_N2 and non-covalent interaction by DNA binding. The reactive metabolites which were found after microbial activation for protein binding are with Schiff base formation, nucleophilic addition and Michael addition.

Keywords: amide, antibacterial, identification, QSAR

The probable reactivity of a petroleum component

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Abstract: The presence of sulfur compounds in petroleum products can cause harmful effects on living organisms. Toxicological data of organosulfur compounds in oil are limited. Alternative methods are used to assess their toxicological properties. In the present work, the probable reactivity of the parent structure (2-methylbenzothiophene) and its generated hepatic metabolites (for both conditions (rat in vivo and in vitro)) with respect to DNA and protein binding has been studied. The parent structure of 2-methylbenzothiophene cannot bind to DNA and protein and experimental metabolic pathways of action were not observed for rat in vivo and in vitro. The reactivity of some of the generated hepatic metabolites for both conditions (in vivo and in vitro rat) has different mechanisms of action (radical mechanism, A_N2, S_N2 and non-covalent interaction) by DNA binding. The protein reactivity of the hepatic metabolites has the following mechanisms of action (Michael addition, S_N2 and Schiff base formation).

Keywords: 2-methylbenzothiophene, predict, metabolic activation, hepatic, QSAR Toolbox

Memantine analogues with potential neuroprotective effects

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Abstract: Memantine is a NMDA-receptor antagonist that inhibits excessive calcium in-flux induced by overstimulation of the NMDA receptor. Memantine is ap-proved in the US and the EU for the treatment of patients with moderate to severe dementia of the Alzheimer's type. A series of memantine derivatives incorporating N-methylglycine, N,N-Dimethylglycine and peptides Glycyl-glycine, Glycyl-glycyl-glycine have been synthesized for the first time and their cytotoxicity and neuroprotective effects in vitro have been studied.

Keywords: memantine, peptides, neuroprotective effects

Acknowledgments: The authors acknowledge the financial support of bi-lateral projects BULGARIA–RUSSIA, Contract KP-06-Russia-7/ 27.09.2019, NSF.

Radical-scavenging activity evaluation of a series of biogenic amines

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Abstract: Due to the huge variety of positive effects, antioxidants have attracted the attention of chemists around the world for more than 40 years. Oftentimes, these positive effects are result to the fact that antioxidants directly neutralize active radicals in the body – they are radical-scavengers.

The most commonly studied radical scavengers are hydroxyl derivatives of cinnamic acid, benzoic acid, flavonoids and etc. However, there are also various biogenic amines whose activities is a consequence of radical-scavenging activity.

Here will be presented our results of quantum-chemical study of a group of biogenic amines. The enthalpies of the O-H bond dissociations by different mechanims are the calculated descriptors of radical-scavenging activity. The calculations were performed using the hybrid DFT functional B3LYP and the orbital basis 6-311++G(d,p). Calculations were performed taking into account the polarizing effect of the water as a solvent.

The obtained results will provide an opportunity to determine the order of activity of the studied amines, to determine the preferred mechanism of the O-H bonds dissociation, as well as to compare the obtained results with the experimentally found radical scavenging abilities of these compounds.

Keywords: DFT calculations, radical-scavenger modeling, biogenic amines

Radical-scavending activity of phenolic compounds with different structure

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Abstract: Phenolic antioxidants/radical-scavengers have been the subject of many studies using various methods - experimental and theoretical. So far, in our research we have studied hydroxyl derivatives of cinnamic acids, benzoic acid, 2-phenylbenzopyranones (flavones), as well as benzopyran derivatives - tocopherols and trolox, but we have never compared the radical-scavenging activity of them.

In the present study will be compared the radical-scavenging activity of antioxidants with different structures. In addition, the structural reasons for the differences between them and the reasons why they show different activity against DPPH will be sought. This study may also clarify the order in which radical scavengers can reduce each other and restore their radical-scavenger properties.

The study was performed using the DFT/B3LYP functional, the triple-ξ orbital basis 6-311++G(d,p) and taking into account the polarizing effect of water as a solvent.

Keywords: DFT calculations, radical-scavenger modeling, enthalpies calculationds

Analysis of the structural requirements of angiotsin-converting enzyme-2 (ACE-2)

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Abstract: Over the past year and a half, scientists' attention to ACE-2 has intensified as a result of the rapidly evolving pandemic of severe acute respiratory syndrome coronavirus (SARS-CoV-2) infection worldwide. In addition to its use as a target a group of compounds that have a potential effect on hypertension, congestive heart failure, post-myocardial infarction, and diabetic nephropathy, it may serve as a potential target for antiviral therapeutics. The aim of the present study is to investigate the structural requirements and the way of binding in the active site of ACE-2, which will help to create potentially active inhibitors. The enzyme-substrate complexes of various compounds were obtained by docking. The energies of the complexes, the enzyme-substrates interactions and the energies of these interactions were analysed. The size and presence of certain functional groups for the manifestation of the inhibitory effect were assessed. As a result of the study, basic requirements for potential ACE-2 inhibitors have been identified, which can serve for faster and more accurate design.

Keywords: ACE inhibitors, docking, GOLD 5.2, Molegro Molecular Viewer

Factors influencing on the tautomeric forms and spectral characteristics of 1-phenyl substituted pyrazol-5-ones

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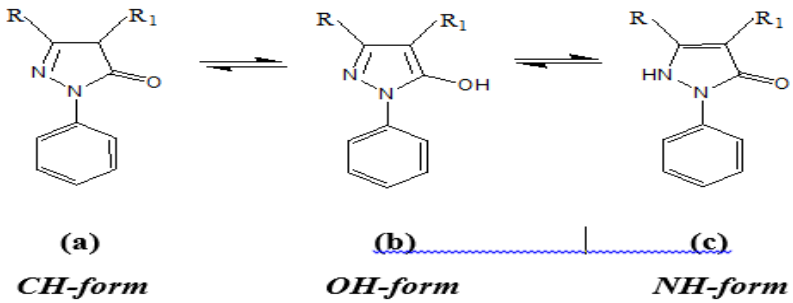
Abstract: The pyrazolones are heterocyclic compounds with significant chemical activity and practical application. They exist as three possible tautomeric forms: CH (a), OH (b) and NH (c) (Scheme 1), where the relative proportion depends on the structure compounds, medium effects, and possibilities for inter- and intra molecular interactions. Spectral analysis of tautomeric forms of 1-phenyl substituted pyrazolones and their photochemical behavior was carried out. The experimental spectral data in solution has been compared with these ones after UV- light irradiation. The obtained results showed different spectral characteristics and photochemical behavior including presence of the photoisomerization process between tauto-meric forms depending on the structure compounds (substituents at 3- and 4-position), solvent effect, time of irradiation, temperature and concentration.



Scheme 1

Keywords: 1-phenyl-pyrazol-5-ones, spectral analysis, photoinduced tautomeric forms.

Specificity of the binding in the active site of mu-opioid receptor (MOR) of the selective ligands

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Abstract: Opioids are the most potent analgesics but their clinical use is limited by side effects like respiratory depression and their high potential for abuse. Understanding mechanisms of addiction and the development of non-addicting and highly selective and effective opiates, remain unfulfilled. The aim of the present study is to investigate the structural requirements and the way of binding in the active site of MOR, which will help to create potentially active agonists or antagonists. The receptor-ligand complexes of various compounds were obtained by docking. The energies of the complexes, the enzyme-substrates interactions and the energies of these interactions were analysed. The size and presence of certain functional groups for the manifestation of the inhibitory effect were assessed. As a result of the study, basic requirements for potential MOR agonists/antagonists have been identified, which can serve for faster and more accurate design.

Keywords: MOR, docking, GOLD 5.2, Molegro Molecular Viewer

Acknowledgements: This work was supported by the project "Information and Communication Technologies for Unified Digital Market in Science, Education and Security" of the Scientific Research Center, NIS-3317, funded by the Ministry of Education and Science, Republic of Bulgaria.

Biodestruction of polycaproamide textile materials

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Abstract: The work solves the problem of biodegradation of synthetic polymers that have exhausted the resource of their work, and the choice of microorganisms that are capable of biodegradation. As synthetic polymers, the most common ones used for the production of clothing, decorative and technical fabrics, etc., polyamides are taken. For research purposes, polycaproamide (PCA) in the form of model porous-fibrous systems of different densities was used. As objects of microbiological impact, bacterial cultures adaptive to PCA fibers (microflora of active wastewater sludge, spontaneous microflora of nylon) were used. Bacillus subtilis k1 was identified as the most active strain of PCA biodegradable bacteria. The presumptive mechanism of degradation with ε-aminocaproic acid release is established, in which bacteria affect the weak amide bond in the macromolecular chain of polycaproamide.

Keywords: bacteria-bio degradors, ε-aminocapronic acid, polycaproamide fibers

Photodynamic treatment of gastrointestinal tumour model using different photosensitizers

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Abstract: Investigations into efficacy and mechanisms of impact in photodynamic treatment with different photosensitizers on the basis of porphyrins, phthalocyanines and bacteriochlorins with different molecular charges on gastrointestinal tract cancerous neoplastic cells and tissues were carried out. Dynamics of accumulation of different sensitizers, as well as their fluorescent response in the tumour cells were evaluated. Experiments *in vitro* on cell lines and *in vivo* on experimental animals (rats) were made to evaluate the applicability of different photosensitive drugs from the point of view of their diagnostic value, based on fluorescence emission and contrast obtained for tumour vs. normal cells / GIT tissues respectively, as well as photodynamic treatment efficiency.

Keywords: photosensitizers, photodynamic therapy (PDT), GIT tumour

Acknowledgements: The investigations were supported by the Bulgarian National Science Fund and RussianFBR under joint bilateral grant # KP-06-Russia/9/11.12.2020 and under Ministry of Education and Science NRRI 2020-2027 funding agreement #D01–392/18.12.2020 “National Center of Biomedical Photonics”.

Near-Infrared spectroscopy of Ex Vivo cutaneous melanin-pigmented neoplasia

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Abstract: Near – infrared fluorescence (NIRf) and diffuse reflectance spectroscopy (DRS) modalities have the potential to be noninvasive diagnostic tools, which can detect the tumors presence, type and stage of lesions' development. In case of cutaneous melanin pigmented neoplasia their high sensitivity to small alterations in the optical properties could be extremely useful for development of differentiation algorithms and discrimination of malignant melanoma (MM) from less severe cutaneous neoplasia. Ex vivo and in vivo spectral measurements were made on pigmented benign and dysplastic nevi, as well on MM lesions to compare the specific spectral differences and to evaluate useful diagnostic parameters. For NIRf measurements diode laser at 785 nm (100 mW) was used as excitation source, and for DRS measurements broad-band halogen lamp (400 – 1000 nm) was applied. Detection was made using QE65000 (OceanInsight Inc.) spectrometer. We found a good correlation between the histological diagnoses of pigmented cutaneous lesions and the spectral characteristics from patient to patient of the same type of lesion obtained in vivo and ex vivo.

Acknowledgements: The research is supported partially by joint program of RFBR and Bulgarian National Science Fund respectively under contracts No. 19-52-18001 Bolg_a and #KP06-Russia/19/28.09.2019 and partially under Bulgarian NSF grant #KP06-N28/11/14.12.2018.

Keywords: NIR fluorescence, diffuse reflectance spectroscopy (DRS), malignant melanoma

Polarimetric studies of cutaneous degenerative conditions Ex vivo in visible spectral Range

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Abstract: Investigation and characterization of the basic polarimetric characteristics on different cutaneous degenerative conditions (Syndrome of Raynaud, lupus, and sclerodermia) histological samples was carried out to evaluate their potential for development of polarimetric-based diagnostic tool. Eosin&hemoxylin–stained histological samples from the different groups of degenerative conditions of the skin were histologically addressed and unstained slices from the same biopsy samples were used for polarimetric measurements. Diode lasers' linear and circular polarized beams on 405 nm, 532 nm and 635 nm were used for irradiation of the samples and polarimeter, working in the visible spectral range 400-700 nm (model PAX1000VIS/M, ThorLabs Inc.) was applied for polarimetric measurements. These studies will allow creating of a generalized polarimetric features database for normal and for degenerative skin conditions based on alterations in collagen anisotropic structuration in extracellular matrix during pathology development that could be used as indicators of the tissue condition.

Keywords: polarimetry, cutaneous degenerative diseases, collagen

Acknowledgements: This work was supported by the Bulgarian National Science Fund under grants #KP06-India-8/07.08.2019 and #KP06-N28/11/14.12.2018. Polarimetric equipment used is purchased under the NSF grant #DO-02-112/2008.

Endogenous and Exogenous Fluorescent Diagnostics of Gastrointestinal Tumours - Advances and Challenges

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Abstract: Tumours of the gastrointestinal tract (GIT) rank third in the number of newly diagnosed cases annually, being ones of the most frequently diagnosed types of cancer. Early diagnosis is crucial for timely therapy and high survival rate of the patients. Therefore, different optical techniques are developed for more precise early diagnostics of GIT tumours, including fluorescence detection with and without exogenous markers. We will present our results on autofluorescence and exogenous fluo-rescence (using protoporphyrin IX) of in vivo and ex vivo GIT tumours, dis-cussing the advantages and drawbacks of the both modalities as well as further steps for improvement of gastrointestinal tumours diagnostics using UV-VIS fluorescence detection.

Keywords: fluorescence spectroscopy, porphyrins, phthalocyanines, GIT cancer

Acknowledgements: The investigations were supported by the Bulgarian National Science Fund under grants #KP06-N38/13/2019 and #KP06-H29/11/2018, as well under Ministry of Education and Science NRRI 2020-2027 funding agreement #D01–392/18.12.2020 "National Center of Bio-medical Photonics". Spectrofluorimetric equipment used was purchased under the NSF grant #DO-02-112/2008.

Impact of physical and chemical modification on the immobilization of β-galactosidase in poly-lactic acid multilayer structures

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Abstract: The present paper investigated the effects of a combination of two different techniques for modification of poly(D-lactic acid)(PDLA) films on the creation of polyelectrolyte multilayers of chitosan and xanthan, used for enzyme immobilization. PDLA films were modified both physically under negative corona discharge (CD) and chemically with N-Ethyl-N′-(3-dimethylaminopropyl) carbodiimide hydrochloride (EDAC) in four configurations (only CD, only EDAC, EDAC then CD, CD then EDAC). Negative corona was chosen in combination with the chemical modification as it activates the carboxyl groups of the modified PDLA surface. Before EDAC treatment, substrates were first hydrolyzed with NaOH. The surface contact angle for all samples was measured and their surface energy was determined. The enzymatic activity of the immobilized enzyme (β-galactosidase) was investigated using the ONPG method. The modified multilayer structures retain up to half of the initial enzymatic activity up to one month after immobilization.

Keywords: modification, EDAC, poly-lactic acid, enzyme immobilization, polyelectrolyte multilayers

Milk protein-based formulations as controlled delivery systems for Tolfenamic acid

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Abstract: Casein-based gels were examined as potential drug carrier for model drug, namely Tolfenamic Acid (TA). TA is widely applied as anti-cancer agent along with its ability to induce degradation of specific tumor proteins and decrease metastasis in liver in the case of pancreatic cancer [1]. Casein-based spheres were formulated at high pH by ionotropic gelation in the presence of crosslinker $CaCl_2$. To optimize their chemical content and structure, casein concentration, TA concentration and casein/crosslinker ratio were varied. Sizes and morphology of casein gels loaded with TA were examined. The structures' thermal stability and phase state were tested with Differential Scanning Calorimetry. ATR-FTIR was used to establish the crosslinking process between casein and $CaCl_2$. The efficiency of the loading process of drug was calculated. Studies on the drug release kinetics were conducted under simulated physiological conditions and were mathematically modeled.

Keywords: casein, particles, tolfenamic acid, drug delivery system

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Influence of humidity on surface potential decay of gamma irradiated polypropylene and poly(ethylene terephthalate) electrets

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Abstract: In the present paper gamma irradiated polypropylene and poly(ethylene terephthalate) electrets stored at different humidity were studied. Polymer films were irradiated in air by a ^{60}Co source with total dose of 5 kGy. After irradiation, the samples were charged in a corona discharge system, which consist of a corona electrode, a grounded plate electrode, and a metal grid placed between them in two polarities - positive or negative. All investigated samples were stored in desiccators at different humidity (0%, 55% and 100%). After that the surface potential was measured periodically out of the desiccators by the method of the vibrating electrode with compensation. Time storage dependences of electrets surface potential at different relative humidity for all samples were investigated. The results obtained were analyzed with the percolation 2D model. The model allowed to analyze the surface potential decay, caused by the influence of the humidity at which they were stored. It was established that the higher values of the relative humidity led to a faster decay of the surface potential.

Keywords: polypropylene, poly(ethylene terephthalate), electrets, humidity, gamma irradiation

Optical quartz fibers as non-linear media

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Abstract: Because of their ability to maintain high energy density over long distances due to the small cross section and low optical losses the fused quartz fibers are very appropriate media for observation of nonlinear optical effects. In this article is examined the possibility by using nonlinear optical processes occurring in the fused quartz fibers to determine their geometrical parameters. Non-linear optical frequency-resolved method is proposed to determine simultaneously most of the important fiber parameter, without accounting for the specific refractive index profile and is experimentally demonstrated. The accuracy of the obtained data is satisfactory.

Keywords: non-linear optics, optical fibers, four-photon mixing

Non-invasive study of changes in venous oxygen saturation

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Abstract: Determining the level of venous oxygen saturation simultaneously with the saturation of the arterial blood with oxygen allows you to control the oxygen delivery in peripheral tissues of the body. We studied the change in the magnitude of venous blood oxygen saturation during laser-stimulated photodissociation of oxyhemoglobin. It is shown that only strong changes in the saturation of arterial blood with oxygen lead to a change in the level of venous oxygen saturation. The original optical technique for measurement of venous and arterial blood saturation based on the pulseoximetry is presented.

Keywords: photodissociation, oxyhemoglobin, venous oxygen saturation

Investigation of hydrodynamic phenomena during an electric discharge in a liquid

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Abstract: The electrohydraulic effect, widely used in technology, is a method of direct, rapid conversion of the energy of an electrical discharge in a liquid into mechanical energy. Elucidation of the influence of the presence of solid particles, gas bubbles in a liquid on the amplitude of the explosion pressure is of scientific and practical interest. Our numerical calculations of the pressure dynamics, based on the thermodynamic analysis of the nonlinear process of the electrohydraulic effect in a heterogeneous medium, takes into account the influence of the degree of dispersion of the medium and changes in the channel geometry on the propagation of the shock wave by introducing refinement coefficients into the heat balance equation. The time dependence of the coordinate of the shock wavefront is numerically determined for different indices of the polytrope and dispersion of the medium, the dependence of the relative pressure $P(\tau)/P_0$ at the front of the shock wave for different indicators of the polytrope, the dependence of P_m/P_0 of the maximum pressure on the concentration of bubbles of water vapor and dissolved air φs. Thus, the calculated results obtained based on the isentropic approach to real polytropic processes have very important scientific and practical values, and therefore an experimental verification of the main calculation results is required. The proposed theoretical calculations reflect real processes and are in good agreement with the experimental results.

Keywords: electrohydraulic effect, shock wave, electric discharge, pulse pressure, polytropic index.

Opportunities of ecologization physics course

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Abstract: The priority of environmental aspects in the modern educational space is based on the solution of environmental issues as a leading role of education. The article considers and analyzes the possibilities of considering environmental issues in the course of physics - the most common scientific and methodological literature. In addition, the methodological and psychological, and pedagogical bases of the conditions of formation of environmental education and upbringing are studied. The main goals, principles, and objectives of environmental education and upbringing in secondary school are given. In the context of the study, the most important areas that link ecology with physics are identified. In the content of the course of physics in the field of ecology, by the issues of environmental education, such as compulsory education, optional interpretations of this knowledge are established. The greening of education allows us to visualize human activities in the natural environment and to address regional and global environmental issues. The article states that the essence of many environmental laws is that they are realized in connection with the fundamental laws of nature, and the flow of energy and metabolism in ecosystems is governed by general natural laws.

Keywords: physical laws, ecology, nature, ecological culture, facts.

On matrixes of coefficients of thermoelastic and electromagnetic waves propagating in anisotropic media

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Abstract: Thermoelasticity describes a wide range of phenomena and generalizes the classical theory of elasticity and the theory of heat conductivity. Thermoelastic and electromagnetic waves propagation in anisotropic media is of the most interest, at present. Within the bounds of this area, based on use of physical-mechanical properties of anisotropic mediums, bound heat and mechanical fields are being studied.

The article is devoted to study of thermoelastic wave propagation in anisotropic mediums of hexagonal system in the case of the second order axis symmetry and heterogeneity along X - axis. In the article, by means of analytical matricant method, set of motion equations of thermoelastic medium are reduced to equivalent set of the first order differential equations.

The structures of the matrixes of the coefficients of the constitutive equations and the structure of the matrix for waves of an acoustic and electromagnetic coupled field in thermoelastic, piezoelectric, piezomagnetic and magnetoelectric anisotropic media are presented.

Keywords: Anisotropic medium, thermoelastic and electromagnetic waves, matricant.

Morphometric analysis of the relief of Slavyanka Mountain

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Abstract: In this article a morphological, morphometric, geological and geomorphologic features of Slavyanka Mountain (Southwest Bulgaria and North Greece) were examined and mapped. Topographic and geological maps of the region were used to this end. GRID models of some morphometric parameters were obtained for the detailed study. A digital elevation model (DEM) was used for the surveyed territory and the application of a cartographic algebra in the GIS environment. Different thematic maps (i.e. Surface runoff direction, Classification of the river network, Orientation of the catchments, Topographic factor of the slope of catchments, Kernel drainage density, Standard deviation of elevation, Basin-scale Ruggedness etc.) have been elaborated. These thematic maps support geomorphologic research and can be successfully applied in solving various geomorphologic problems..

Keywords: Thematic maps, Mountain relief, Geomorphologic analyses

Wind Variations over Balkans since 1836

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Abstract: The analyze of wind variations over the Balkans is important in air quality and ecology disasters assessment. The variations of wind velocity, u- and v- components of wind over part of Balkans since 1836 are studied by means of time series provided by the Twentieth Century Reanalysis Project, Version 3 Dataset of US National Oceanographic and Atmospheric Administration (NOAA). The selected area of Balkans is between 22° - 30° East Longitude and 41° - 47° North Latitude. The analyzed parameters are monthy values of u- and v- wind components at 1000 hPa, 700 hPa and 500 hPa; temperature at 1000 hPa and 700 hPa geopotential height. The long-term and periodical variations of these parameters and wind velocity are deter-mined by the Method of Partial Fourier Approximation (PFA). Periodical oscillations of wind and temperature are compared with some solar cycles and harmonics. The rising trends in last decades, due to anthropogenic effects of climate change are determined. The possible use of common solar, climate and wind cycles in long-term forecasts of ecological disasters is discussed.

Keywords: wind variations, wind velocity, climate change, solar activity

The Seasons and Spatial Variations of Sea-Land Breeze over the Bulgarian Coastal Area

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Abstract: The breeze circulation on the Bulgarian Black Sea coast plays an important role in the analysis of the general metrological picture and information about the air quality in this important region for the national tourism. The aim of the present study is to identify seasonal and spatial variations in breezes. The study was based on meteorological data processed in a geoinformation environment with the task to spatially visualize the studied events. The activation of the local breeze circulation has been determined by means of spatial and statistical analysis. As a result of this activation during the summer sea-son, the constant manifestation of breezes is established as an annual phenomenon caused by global climate change, which has an impact on all local events.

Keywords: surface winds, breeze, wind velocity, seasonal variations, climate change

Attitudes towards introduction of remote work beyond the Covid-19 pandemic among teachers in Southwestern Bulgaria

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Abstract: In Bulgaria, the remote form of work became popular after the introduction of a state of emergency in the country in order to control the spread of the Covid-19 pandemic in the spring of 2020. The aim was to preserve the life and health of all Bulgarian citizens, especially those who are most vulnerable. Such are undoubtedly the teachers who work with many different children in contact with their families. Education was the sector that responded most quickly and adequately to the new situation. In a few days, the entire education system of Bulgaria switched from the traditional present form to the distance form of work. After returning to classrooms many people were wondering: are there attitudes among teachers to continue the distance form of work after the end of the Covid-19 pandemic? For example, working from home part of the time, one or few days of the week, but permanently henceforth? The present study examined the attitude of teachers from Southwestern Bulgaria on the topic.

Keywords: Covid-19, remote work, education, teachers

Trends and challenges for the health system in Kyustendil region

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Abstract: Healthcare is an activity of very high humanitarian and public importance. The policy for its development at the district level is mainly influenced by the number and age structure of the population. Despite the stated principles of accessibility and equality in receiving medical care and the availability of an approved health card, the population of remote settlements in the district encounters serious difficulties in providing it. Hence the specific problem of the health system in the study area, which contributes to the intensification of the processes of depopulation of villages and the concentration of hospitals in the regional center of Kyustendil and the second larger municipal center - Dupnitsa. Good health is an asset and a source of economic and social stability. The health status of the population is crucial for poverty reduction while contributing to sustainable territorial development. The main challenges are related to the deteriorating indicators of the health and demographic condition of the population in the study area, the increase of health inequalities and the inability of the regional health system to adequately respond to the needs for affordable and quality health services.

Keywords: health system, economic and social security, sustainability, health inequalities

The “Healthy city” – measurement of the achieved level of completion and development

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Abstract: The UN's 2030 Agenda, adopted by world leaders in 2015, represents the new global sustainable development framework and sets 17 Sustainable Development Goals (SDGs). Health promotion efforts based on the healthy cities approach can contribute to these goals, including SDG 11: "make the cities and other populated areas inclusive, safe and sustainable". The study is based on the documents regulating the nature and significance of a healthy city. Some good examples of healthy cities were studied. The approach to create a healthy city, based on principles for its healthy spatial planning, was analyzed. The main purpose of the research is to compile a criteria system for determining the achieved level of development of a city, in order to be marked as healthy.

Keywords: sustainable development, healthy city, principles, criteria system

The Green city - oportunities to measure its potential

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Abstract: The proposed study is based on the philosophy and importance of the green city. In order to create green cities, it must be assumed that they are like living systems that consume, transform and release materials and energy, and also they develop and adapt. The cities interact with living things and other ecosystems. It is thought that they must be managed and protected like any other ecosystem. An analysis of the approaches to assessing the urban environment to determine a city as green was made. The main purpose of the study is to build an index to measure the potential of the "green city" through a combination of different indicators. Urbanization is "unstoppable" and the cities must increasingly be seen as focal points of the so-called "green revolution".

Keywords: green city, ecosystems, approaches, index

Assessment of the ecological purity and safety of non-traditional Bulgarian fruit wines

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Abstract: White wines from melon and white wines with cherry purchased from the trade market were studied. The aim of the present work is to evaluate the safety and ecological purity of beverages by determining their physicochemical properties. The analysis of certain elements in wines is of particular interest, for some elements, it is important due to their toxicity, for others because they affect the organoleptic properties of wine, as well as the elements that are beneficial to the body. Some organic components of wine of important interest have also been identified due to their health benefits. For this purpose the total phenolic content (TPC), the total flavonoids content, total monomeric anthocyanins content (TMA), and antioxidant activity by using 4 different methods (ABTS, DPPH, FRAP and CUPRAC) were determined. The correlation between these parameters and emission maxima of fluorescence spectra was obtained for excitation wavelength of the light 245 nm and 285 nm.

Keywords: fluorescence, antioxidant activity, white wines from melon, white wines with cherry, chemical elements

Morphological and cytogenetic characteristic of *Belgica antarctica* Jacobs (Diptera, Chironomidae)

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Abstract: *Belgica antarctica* Jacobs 1900 (Diptera, Chironomidae), the only insect endemic to maritime Antarctica, is the southernmost holometabolic free-living wingless species. Its larvae are extremely tolerant to cold, dehydration, UV exposure and other forms of environmental stress. The larvae 4th stage were collected from Wiencke Island, 500 m to SW from Port Lockroy in Antarctic Peninsula. Larvae of *B. antarctica* were studiued in two aspects. 1) An analysis of some larval morphological characteristics was performed. Differences were established between the localities we studied as well as the previous data. The malformations in mentum and mandibles were found (23,8%-19%). 2) The cytogenetic analysis of *B. antacrica* polytene chromosomes showed the chromosome set is 2n = 6, with three polytene chromosomes, three Nucleolar Organizer (NOR) and one Balbiani ring (BR). Heterozygous inversions in II and IIIrd chromosomes were detected (12%-25%). Some of them have been described in *B. antarctica* from almost in the same region in Antarctic Peninsula more than 40 years ago. The existence and preservation of these aberrations for long time, leads us to the conclusion that these inversions have an adaptive value for the species and contribute to its survival under existing specific environmental conditions.

Keywords: *Belgica antarctica,* Antarctica, polytene chromosomes, heterozygous inversions, morphological characteristics,

The effect of cadmium on salivary gland polytene chromosomes of *Chironomus riparius* Mg (Chironomidae, Diptera)

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Abstract: The genotoxic effect of cadmium ions on the model species *Chironomus riparius* (Diptera, Chironomidae) was studied. The larvae were chronically treated in laboratory conditions with different concentrations of $CdCl_2$ (0.1µg/ml, 1,1µg/ml and 4.0µg/ml). Many somatic chromosome aberrations were found in all four polytene chromosomes (paracentric and pericentric heterozygous inversions, deletions). They affected significantly more cells in the treated material compared to the control ($P<0.001$) and increased in a dose-dependent manner. On the base of the observed somatic rearrangements S (somatic) index was calculated. While in the control the S-index is 0.727, its values increase with increasing concentration of $CdCl_2$ (from 3.0 to 4.789). These data show increased sensitivity and genomic instability of the species. Alterations in activity of Balbiani Rings (BRs) and Nucleolar Organizer (NOR), as well as decondensations, ectopic conjugations and appearance new active puffs were also observed after treatment. In addition, a large number of individuals with morphological deformities affecting mouthparts were found (44%-58%). The induced changes at the cytogenetic and phenotypic level can be considered as a reaction of the individuals to the influence of Cd ions, which confirms their toxic and genotoxic effect.

Keywords: *Chironomus riparius*, Cd, genotoxicity, chromosome aberrations, mouthpart deformities

In vivo assessment of incised wound healing in rats after application of a bigel formulation contained St. John's Wort extract

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Abstract: St. John's Wort (Hypericum perforatum L.) contains essential bioactive ingredients. The present study aimed to evaluate the healing intensity of incised wounds on rats treated with a semi-solid hydrogel/organogel (bigel) formulation containing a hyperforin-rich extract from St. John's Wort. Three methods to obtain hyperforin-rich methanol extract from St. John's Wort were applied and evaluated for effectiveness – percolation, ultrasonic, and Soxhlet extraction. The extracted amount of hyperforin was determined by reverse-phase HPLC analysis. The Soxhlet extraction technique was the most appropriate for this study (3.552 mg/ml). Hyperforin-rich methanol extract was included in a bigel as a semi-solid formulation. The therapeutic potential of the developed formulation was evaluated for healing intensity and compared with a commercial product. Both were applied for a certain period (10 days) on incised wounds (50 mm) inflicted on rats. The efficacy parameter is defined as the breaking strength applied on already healed wounds through a particular experimental setup. An in vivo experiment was performed with 21 male Wistar rats, divided into three groups at random. Group A was not treated with therapeutic products. Group B and C were treated with a commercial product and the bigel contained an extract of St. John's Wort, respectively. The breaking strength registered for group B ((3.7±0.2) N) is lower than stated for group C ((6.4±0.7) N). The obtained differences are statistically significant ($p<0.05$). The bigel formulation with St. John's Wort extract can be proposed for wound healing in animals and humans.

Keywords: bigel, St. John's Wort, breaking strength

Purification of soil from oil pollution using hydrocarbon-oxidizing microorganisms

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Abstract: The article presents the results of studies conducted on experimental samples of biological products created based on the selected microbial associations and their ability to degrade oil pollution in soils at moderate and elevated temperatures (up to 50°C). It was shown that the compositions of microbial associations consisting of 3 bacterial strains-Rhodococcus erythropolis KZ1, Rhodococcus erythropolis KZ2, Pseudomonas putida KZ3 have mycostatic activity. The residual content of PAHs (μg) and their degree of destruction (%) in the studied samples was determined by capillary gas-liquid chromatography. The association can be used in saline (up to 8% salt) soils in the pH range 4-9, as well as in low-humidity soil (about 10%).Keywords: hydrocarbons, oil, chromatography, oil destructors, bioremidiation, biological products, microbial associations, alkanes, polycyclic aromatic hydrocarbons, thermotolerant bacteria-oil destructors, biomass.

Keywords: hydrocarbons, oil destructors, biological products, microbial associations, thermotolerant bacteria-oil destructors.

Colonising of decaying macroalgae debris by microarthropods with special references to Collembola

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Abstract: Macroalgae accumulated onshore play an important role as links between marine and terrestrial ecosystems. However, knowledge about the patterns of biodiversity and the colonisation of macroalgae debris by terrestrial, soil microarthropods remains scarce, especially in the sub-polar region of the Arctic. The study was conducted in coastal tundra of the Barents Sea near the Dalnye Zelentsy settlement (69°7'N, 36°3'E) located on the Kola Peninsula. Samples of 100 cm2 size of fresh algae were placed in the coastal tundra and decaying macroalgae debris. The samples were taken at the following time intervals: 24, 72, 144, 216 and 288 hours after setting the fresh macroalgae. We found differences in the rate of colonisation by microarthropods of decaying macroalgae and the coastal tundra and also differences in collembolan communities diversity.

Keywords: microarthropods, sub-Arctic, colonisation

Responses of soil mesofauna to non-trophic activities of epigeic and endogeic earthworms.

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Abstract: Earthworms can affect the abundance and diversity of mesofauna by competing for the common trophic resources or through various non-trophic pathways. In a laboratory experiment we tried to evaluate responses of a mesofauna community to different forms of earthworm non-trophic activity. In two-section microcosms representing litter/topsoil and soil horizons effects of epigeic (Lumbricus rubellus) and/or endogeic (Aporrectodea calgiinosa) earthworms on mesofauna were investigated. In five exerimental treatments we simulated different aspects of earthworm activity.

Effects of earthworms on mesofauna were species-specific, and mesofauna responses to earthworm effects were group-specific. For microarthropods both presence of living L. rubellus and its simulated non-trophic effects were mostly negative. Activities of A. caliginosa in general weakly affected microarthropod populations, but sometimes interacted with the activities of L. rubellus compensating its effects on mesofauna. Non-trophic activities of L. rubellus positively affected enchytraeid populations.

Keywords: earthworms, mesofauna, non-trophic activities, ecological interactions

Resource partitioning between competing individuals: an experiment with bean weevil Acanthoscelides obtectus

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Abstract: The aim of this paper is to proof that intraspecific competition leads to uneven resource partitioning. Bean weevil *Acanthoscelides obtectus* larvae were used in the experiment. They feed inside bean seeds drilling corridors. Different numbers of larvae can live together in one seed. The corridors were filled with a dentistic material. Following variables were measured in the experiment: weight of bean seed before and after the experiment, the number of larvae living in each seed, weights of filling which is a measure of the amount of resource consumed by a larva and the weight of adult individual emerging from each marked corridor of known size. Weights of fillings and weights of adult individuals are variable even when they are taken from seeds with only one larva living inside. However in this case there are no other relations between variables measured in the experiment. When many larvae are living together in one seed the variability of weights of fillings is greater and the distribution of weight of adult individuals is positively skewed. Additionally there is statistically significant positive relationship between weight of fillings and weight of adult individuals and negative relationship between the length of larval period and weight of adult individual together with weight of filling.

Keywords: bean weevil *Acanthoscelides obtectus*, intraspecific ompetition, resource partitioning

A long-term study of some population characteristics of the Hermann's Tortoise *Testudo hermanni* and the Spur-thighed Tortoise *T. graeca* in the northwestern foothills of Pirin Mountains, Bulgaria

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Abstract: A long-term study (from 2012 to 2021) on the populations of two species of tortoises (Testudo hermanni and T. graeca) in the vicinity of the village of Rakitna, the northwestern foothills of Pirin Mountains, was conducted. The study aimed at determining the populations' status and the long-term survival of the two species in an area of particular conservation interest. The specimens have been captured, marked, released, and recaptured. The total number of specimens marked was 96, with a clear prevalence of T. hermanni (80 ind. / 83.3%). The ratio between the numbers of specimens of both species (c. 5:1) has been reported previously in other studies. The age structure of the populations of both species was relatively identical and was characterized by a predominance of adult specimens over juveniles and subadults. In both species, the sex ratio in adults was female-biased.

Keywords: Testudines, population ecology, age distribution

Distribution and Activity of Bulgarian Viper, *Vipera ammodytes montandoni* Boulenger, 1904 (Reptilia: Viperidae) in South-Western Bulgaria

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Abstract: The purpose of the study is to supplement, summarize and analyze data about the distribution and activity of Vipera ammodytes montandoni in south-western Bulgaria. The new data about the species were collected from 1997 to 2021 during herpetological surveys. All data available indicate, that V. ammodytes is widespread in the study area. All localities have been marked on a map. V. ammodytes is active from February untill November. The seasonal activity is presented in decades.

Keywords: Serpentes, ecology, Balkan Peninsula

Study of surface water from reservoirs located in the Norilsk Industrial district

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Abstract The article presents the results of summer field research expeditions on the Taimyr. In 2020, reservoirs adjacent to the Norilsk – Talnakh, Norilsk – Kayerkan - Dudinka highways were surveyed. Information about sampling is printed. The table shows the calculations of the content of substances in water and soil extract. Visualization of numerical values is performed. A comparative analysis of water samples in 2020 with the results of sample studies in 2019 was carried out.

Keywords: natural water, soil extracts, pollutants, ecological monitoring, environment.

Characteristics of microplastic pollution in inland waters under different anthropogenic pressure

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Abstract: Plastics are mass-produced, which is not indifferent to the environment. An increasingly observed problem is contamination with microplastics (<5 mm). Studies mainly focus on microplastic pollution and its impact on the marine environment. In inland waters, the topic is not as popular, although this problem is also present. We aimed to estimate the level of microplastic pollution of lakes located in areas differing in the intensity of human impact and under legal protection. The hypothesis is that lakes exposed to higher levels of anthropopressure will have higher levels of microplastic pollution. We analyzed water of 11 lakes in Poland. We found microplastic fibers and particles in all tested lakes. There are differences in the pollution of lakes exposed to direct human impact (≤900 fibers /m^3)and those distant from roads and buildings (18-75 fibers/m^3). Microplastics are present even in lakes under legal protection although their amounts are not large compared to other places in the world. Tourism and the vicinity of buildings may contribute to an increased level of microplastic contamination. Legal protection makes sense and should be preserved, especially in places of particular natural value.

Keywords: microplastic fractions, inland waters, nature reserves, microplastic contamination

Aquatic bryophytes in upland rivers in Bulgaria

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Abstract: Aquatic bryophyte diversity in mountain and semi-mountain rivers in Bulgaria (national river types R2, R3, R4, R5) with mixed carbonate-siliceous bedrock and located at variable altitude was studied during the vegetation season in 2020 and 2021. Mountain and semi-mountain bryophyte communities were replaced by assemblages dominated by helophytes and hygrophytes, and by aquatic vascular plants character for lowland rivers. The main pressures were (i) small hydropower plants causing periodic and rapid flow fluctuations, (ii) modified river morphology and (iii) pollution. Bryophyte communities' response to environmental variables linked to the above pressures was considered.

Keywords: aquatic mosses, pressure, hydromorphology

Ephemeroptera, Plecoptera and Trichoptera (Insecta) of mountain tributaries of the Struma River: Diversity in relation to environmental parameters and zoogeographic features

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Abstract: The study presents results on diversity and geographical distribution of orders Ephemeroptera, Plecoptera and Trichoptera (EPT) in eight mountain tributaries of the Struma River. The EPT benthic fauna was studied for the first time in the Otovitsa and Mochura Rivers. During the study, a total of 19 mayfly, 18 stonefly and 20 caddisfly taxa were found. The dominant taxa were of the family Heptageniidae (Ephemeroptera), Nemouridae (Plecoptera) and Limnephilidae (Trichoptera). Ordination analyses indicated the EPT fauna at the locality in the Mochura River was the least similar to the others, owing to the high altitude and prevalence of stone substratum. The recorded EPT taxa belongs to six zoogeographical categories (Holarctic, Palearctic, European, Mediterranean, Pontic and Endemic), with overall dominance of taxa of European and Mediterranean complexes (ca. 67 % of all species and subspecies). Leuctra hirsuta Bogoescu & Tabacaru, 1960 and Ecdyonurus (H.) epeorides Demoulin, 1955 are Balkan endemic species, while Odontocerum hellenicum Malicky, 1972 is considered a subendemic species.

Keywords: mayflies, stoneflies, caddisflies, Struma River tributaries, Bulgaria

Macrozoobenthos in the mountain standing water bodies in Bulgaria

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Abstract: A survey on macrozoobenthos in selected standing water bodies was performed. The study was conducted in the summer of 2020 (July-August) at one lake (Trevisto) and eight reservoirs (Batak, Bebresh, Belmeken, Golyam Beglik, Hristo Smirnenski, Ognyanovo, Shiroka polyana – two sites, Yovkovtsi – two sites). They belong to two ecoregions and are characterized as mountain types of water bodies according to the Bulgarian national typology. The found macroinvertebrate communities were characterized by compositions specific to the lentic waters and were dominated by oligochaete worms and chironomid larvae. The larvae of dragonflies, mayflies and caddisflies, as well aquatic beetles, freshwater gastropods and mussels, were also found in the bottom invertebrates communities with a richer variety. A cluster analysis of the similarity in the taxonomic composition between the studied water bodies and of the species-factors interaction was done.

Keywords: macroinvertebrates, taxonomic composition, lake, reservoirs

Taxonomic composition and dominant structure of the macrozoobenthos in Maritsa River and some of its main tributaries, South Bulgaria

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Abstract: Maritsa River is the largest river on the Balkan peninsular. It originates in the Rila mountains, Bulgaria, flows south-east, leaves the country at the village of Kapitan Andreevo, passes through Turkey and Greece and flows into the Aegean Sea.Thus, the European and national water requirements, as well as the transboundary nature of the river catchment area impose the need to maintain the stability of the water communities and integrity of the aquatic ecosystems. The aim of this study was to identify the current taxonomic composition and dominant structure of the macrozoobenthos communities in the Maritsa River (12 sampling sites along its course on the territory of Bulgaria) and in three of its main tributaries – Chepelarska, Stryama and Topolnitsa (one site in each tributary).The samplings were conducted in August and September 2020.The total number of the macrozoobenthos taxa identified was 170. Caenis pseudorivulorum showed the highest frequency of occurrence (pF = 73.3%) and dominance (DF = 40%). Gammaridae Gen. sp., Baetis alpinus, B. melanonyx, B. vernus, Centroptilum luteolum, Ecdyonurus helveticus-Gr., Ischnura elegans and Platycnemis pennipes are the taxa that had the highest degree of dominance (DT = 100%).

Keywords: river ecosystems, macroinvertebrate benthic animals, dominant analysis

Characteristics of macroinvertebrate assemblages in karst and other spring ecosystems (R15 national river type) in Bulgaria

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Abstract: The karst springs are a poorly studied type of rivers in Bulgaria. The focuses of this research were the taxonomic diversity, communities' structure and habitat preferences of bottom macroinvertebrate assemblages in karst spring ecosystems in relation to the environment. We examined sev-en karst springs areas during the summer of 2020 with sampling sites located at different distance from the sources. We found diverse communities in terms of taxa richness and abundance, with a total of 148 taxa, determined at the lowest possible level (species, genus or family). The strong variability of the number of taxa (S – from 6 to 51), absolute abundance (N – from 351 to 7956 specimens) and the values of the structural parameters (diversity indi-ces, dominance and evenness) proved the extremely variable character of these benthic communities, resulting in the low level of similarity at taxon lev-el (less than 21%). The correlation between biota and environmental varia-bles, such as altitude, distance from source, substratum types and basic physical and chemical parameters was also analyzed. The gradients reflected the specifics of each of the sampling sites and were related for example to water temperature and silt bottom (for Devnenska River), to distance from the source and middle-sized stones (for Petrovska River) or to altitude and big-sized stony substrata (for Iztok River).
Keywords: benthos, community structure, environmental heterogeneity, karst springs, Bulgaria

Age determination of Harbour porpoises (*Phocoena phocoena relicta*) from the Bulgarian Black sea coast

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Abstract: The following research present the results of pilot for Bulgaria age determination of one of the three cetacean species in the Black sea, the Harbour porpoise (Phocoena phocoena relicta), based on analysis of growth layers groups (GLGs). Knowledge of age structure and longevity (maximum age) are essential for modeling of marine mammal population dynamics. For small cetaceans, growth layers groups deposited in the teeth are most useful measure, because they indicate chronological age. Teeth were taken from 41 Harbour porpoises (Phocoena phocoena relicta). The samples were collected from dead, stranded individuals from the Bulgarian Black sea coast. The maximum duration of life, which we found in this study was 10 years. The age structure showed dominance of individuals of two age groups - up to one year old and 5 years old. In the present study, we did not find significant differences in the age structure in the different areas where the samples were taken, which led to the conclusion that the age distribution of the stranded individuals Phocoena phocoena relicta in researched area was even.

Keywords: Harbour porpoise, Age determination, The Black sea

Ecological assessment of standing water bodies in Bulgaria through Hungarian Macrozoobenthos Multimetric Index for lakes

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Abstract: Three years study on macrozoobenthos in selected standing water bodies situated in Ecoregion 7 was conducted. Survey was done seasonally (spring, summer and autumn) in the period 2018-2020. Totally 79 samples from 14 lakes and reservoirs which are situated in Ecoregion 7 Eastern Balkan (South Bulgaria) and belong to 7 lake types according national typology (Alpine lakes, Lowland and semi-mountain lakes and swamps, Riverside wetlands, Large deep reservoirs, Medium-size and small semi mountain reservoirs, Large lowland reservoirs up to middle depth and Small and medium size reservoirs) were taken.

Applicability and reliability of a new Hungarian Macrozoobentos Multimetric Index for lakes, which was intercalibrated and regulated in national water legislation for Riparian lakes and marshes (Ecoregion 12), was tested. Type-specific ecological quality ratio scales were used for current ecological status assessment of the studied lentic waters through biological quality element macrozoobenthos.

Keywords: lentic waters, typology, ecological quality ratio scale.

Development of Bulgarian fish-based index for ecological assessment of the Lower Danube section (BRID)

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Abstract: Assessment of the state of fish fauna in large rivers is a challenge due to difficulties in the sampling, determination of referent conditions etc. Intercalibration of methods within the XGIG is not yet achieved, as large rivers around Europe show heterogeneous environmental parameters and variable pressures even in different river sections, complicating the task.

In 2014 and 2015 a methodology was developed for ecological assessment and monitoring of the waters based on fish community parameters, applicable for the Lower Danube. For the purpose sampling according CEN 14011 was performed at 15 sites along the Bulgarian Danube section. The obtained results were compared with the reference conditions determined using historical data and expert knowledge. Developed BRID is a WFD compliant multimetric index based on 8 fish community parameters, defined after the classification of each recorded species at given ecological guilds. It was developed as a modification of the Type-specific Bulgarian Fish-based Index, which was successfully intercalibrated for the common European river types. The ecological state of the selected 15 sampling sites was assessed by BRID as Moderate or Good although the response of BRID to pressures was found to be low, probably because the gradients of both the pressure and fish community distribution are not clearly expressed along the Lower Danube.

Keywords: WFD, fish community, ecological assessment, water quality, Lower Danube, intercalibration

Determination of zones for reproduction of the fish fauna and zones for indwelling of economically valuable fish species within the West Aegean Sea basin region

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Abstract: Two types of zones were determined for the needs of Bulgarian River Basins Management Plans (RBMP) as follow: 1) Zones for reproduction of the fish fauna (ZRFF) and 2) Zones for natural indwelling of economically valuable fish species (ZNIEVFS). Zone determination was based on biotic criteria, as: fish presence, abundance, population structure, ecological assessment by fish-based indices and abiotic criteria, as: river typology, protection status, location, as well degree of hydromorphological pressure.

About 25 fish species were identified in the water bodies within the West Aegean sea basin region including 4 species of economical value, i.e. Brown trout (Salmo trutta/Salmo macedonicus), Pike (Esox lucius), Wels catfish (Silurus glanis) and Common carp (Cyprinus carpio). Thirty-three ZRFF were determined, 17 of which in salmonid and 16 - in cyprinid waters. Furthermore 25 ZNIEVFS were determined 19 of which in salmonid and 6 – in cyprinid waters.

Keywords: fish, salmonid waters, cyprinid waters, reproduction, indwelling

Methodological approach to identify zones for reproduction of the fish fauna – application in rivers of the Black Sea and East Aegean Sea basin regions

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Abstract: The presented methodology was developed in 2018 initially for the rivers of the Black Sea basin region where it was tested from 2018 to 2020 in 35 river sections. In 2020 the methodology was furtherly adapted and applied in 21 rivers of the East Aegean Sea region. Two-tier approach is used. At the first tier, target fish species are defined based on available information (i.e., species of conservation, ecological and/or economic significance, so called "umbrella" species etc.). At the second tier, a set of criteria is applied to define the rivers/river sections suitable for reproduction of fishes, such as: 1) habitat criteria (according to the requirements of the target species to the habitat features); 2) ecological state of the rivers by BQE Fish (as defined in WFD); 3) river connectivity and 4) abundance of 0+ age group of the target species. Twenty-three river sections of the Black Sea region and 15 – of the East Aegean Sea region have been proposed as zones for reproduction of the fish fauna.

Keywords: fish reproduction, target species, habitat features, ecological state, river connectivity

The herpetofauna of South park Sofia – species, distribution and conservation threats

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Abstract: A long-term study (2005-2021) of the herpetofauna of South park in Sofia, based of intensive monitoring of the area. The researched zone includes a variety of habitats as is characterized by relatively low level of human maintenance, compared to other green areas of the capital. Our observations showed presence of 7 species of amphibians (Triturus ivanbureschi, Bufo bufo, Bufotes viridis, Hyla orientalis, Pelophylax ridibundus, Rana dalmatina, Pelophylax ridibundus) and 7 species of reptiles (Emys orbicularis, Trachemys scripta, Lacerta agilis, Podarcis muralis, Natrix natrix, Natrix tesselatta, Zamenis longissimus). A detailed information of species distribution was gathered, with notes on the behavioural specifics observed. Main conservation threats were also commented with proposals for their mitigation.

Keywords: Urban herpetofauna, reptile conservation, species distribution

Specifics of birds of prey status in the areas of vulture reintroduction activities in Bulgaria

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Abstract: The vulture reintroduction work in Bulgaria depends of a wide range of supporting activities. One of the most important of them is the maintaining of supplementary feeding stations, which are regularly provided with carcasses, thus attracting many other species, mainly birds and mammals. The present study, pilot for Bulgaria, focuses on the vertebrate species presence on the territory of vulture feeding station at Kresna gorge, identified by intensive direct observations and with camera traps for a period of 12 years. As a results, a total of 24 species of birds and 7 species of mammals were found in the researched area, including rare, endangered or previously unpublished for the vicinity of Kresna gorge. Additionally, comments were added for the type of benefits from the feeding station for all presented species, based on our observations.

Keywords: raptor diversity, bird conservation, species reintroduction

GPS tracking of Griffon vultures tagged on the Balkans - evaluation of the method, based on five years results

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Abstract: The tracking of the bird movements has increased significantly over the last decade, due to the technology improvements and the more affordable prices. In practice, various methods are used to mount the given type of transmitters, which raises the need of detailed equipment comparison, in order to identify the best option for the particular bird species and how such activity affect the behavior and flying abilities of the researched individual. The present study compared the tracking data of fifty Griffon vultures (Gyps fulvus), equipped with different transmitter types - OrniTrack-P33 with patagial attachment , OrniTrack-30 and OrniTrack-50, attached by "leg-loop" method. Our research compared the length of daily flights, the flight speed and the flight altitude over a period between 60 - 1190 days for each of the individuals, during their movements on the territory of the Balkan Peninsula and the Middle East.

Keywords: bird tracking, conservation, Griffon vulture, gps-transmitter,

Vertebrate diversity at the vulture feeding station in Kresna gorge

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Abstract: The vulture reintroduction work in Bulgaria depends of a wide range of supporting activities. One of the most important of them is the maintaining of supplementary feeding stations, which are regularly provided with carcasses, thus attracting many other species, mainly birds and mammals. The present study, pilot for Bulgaria, focuses on the vertebrate species presence on the territory of vulture feeding station at Kresna gorge, identified by intensive direct observations and with camera traps for a period of 12 years. As a results, a total of 24 species of birds and 7 species of mammals were found in the researched area, including rare, endangered or previously unpublished for the vicinity of Kresna gorge. Additionally, comments were added for the type of benefits from the feeding station for all presented species, based on our observations.

Keywords: camera trap, species richness, feeding station

2-norms generated by solutions of second-order linear differential equations

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Abstract: In this work second-order linear differential equations will be considered, as well as their solutions in terms of solutions from the work of Prof. Dr. Dragan Dimitrovski (see here what they are called). Then, based on those solutions, will be determined 2-norms of the space from the solutions of a second-order linear differential equation. Some additional properties will also be considered.

Keywords: second order differential equations, 2-norms, 2-standardized spaces, solutions of linear differential equations

Recurrent solutions of the Lorenz system of differential equations

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Abstract: By introducing new variables in the systems of difference equations from the paper [1], new systems of difference equations are obtained. The solutions of these new systems of difference equations depend only on the initial values a_0, b_0, c_0 and the coefficient a_i, $i \in N$ .The power series whose coefficients are these solutions present the recurrent solutions for the Lorenz system of differential equations. A comparison between the behavior of the Lorenz system of differential equations and the local behavior of its recurrent solutions for small time steps is examined in examples by computer simulations, as in the papers [1], [2], [3] and [4]. The computer simulations will be made by mathematical package Mathematica.

Keywords: Lorenz system, difference equations, recurrent solutions, power series, locally approximations.

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A particular solution of the third-order shortened Lorenz system via integrability of a class of differential equations

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Abstract: In [1] for the class of second-order linear differential equations of B.S. Popov, necessary and sufficient condition for reductable according to Frobenius is obtained. By using the class of second-order linear differential equations from [1], an expanded class of second-order linear differential equations in [2] is presented. In this paper, a subclass from the expanded class of second-order linear differential equations for which is supplied a new condition for reductable according to Frobenius is obtained. The explicit formulas of a particular solution for the subclass of second-order linear differential equations are obtained. In [3], a third-order shortened Lorenz system which is obtained from the Modified Lorenz system with offered an explicit solution in [4] is presented. In this paper, a particular solution of the third-order shortened Lorenz system via the integrability of the subclass of second-order linear differential equations under certain conditions is obtained. In end, in Mathematica via graphical visualization, the theory is supported by examples.
Keywords: Shortened Lorenz system, difference equations, particular solution, condition for reductable according to Frobenius.
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On a class of numerical semigroups with embedding dimension equal to 4

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Abstract: We give a description of the class of numerical semigroups with embedding dimension equal to 4, given by pairwise relatively prime non-negative integers n, m, k, tn-k. This description gives a way to determinate the characteristics of the numerical semigroups, such as Frobenius number, gaps, genus, etc.

Keywords: Numerical semigroups, Frobenius number, gaps, genus

Parabolic equations with causal operators

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Abstact: We consider partial differential equations of parabolic type with causal operator in a Banach space. The theory of causal operators starts by a work of Corduneanu (2002). Also R. P. Agarwal, V. Lupulescu, V. Lakshmikantham, S. Leela , Z. Drici contribut in this direction. For instance the general class of causal operators includes the Niemytzki operator, Volterra integral operator, Fredholm operator and so on. The class of differential equations with causal operators include evolution differential equations with delay, integro-differential equations, Voltera integral equations and neutral equations. To our knowledge no works cocerning partial differential equations in any cocrete form. In the present tolk we demonstrate the monotone iterarive technique for the existence of solutions to a reaction-diffusion equation.

Keywords. Causal operator**,** evolution differential equation, monoton iterative method.

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Generalized solutions of n0nlocal semi-linear systems with time lag

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Abstact. We study nonautonomous semi-linear differential inclusions with nonlocal initial conditions in a Banach space. We define here geralized solutions which in fact coincide with the quasi-trajectory. We give a relative short proof of the fact that the solution set of nonlocal semi-linear differential inclusion is dense in the weak solution set of the corresponding convexified system.

Keywords. Nonlocal problems, time lag, weak solutions, density.

Acknowledgements. The work was supported by the Bulgarian National Science Fund under Project KP-06-N32/7.

Maximal regularity for evolution equations and application to the Stefan problem

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Abstract: Maximal regularity is a useful tool for solving abstract parabolic evolution equations. A variant of the one-phase quasistationary Stefan problem can be reduced to a single evolution equation. We tackle this problem using H^{∞}-calculus to show that the operator in the evolution equation has maximal regularity and then apply an existence theorem for this type of evolution equation. We use as an assumption that one particular result on the solvability of a degenerate oblique derivative problem extends in an appropriate way.

Keywords: maximal regularity; evolution equation; Stefan problem; H^{∞}-calculus

Analysis and prediction of the spread of COVID-19 in North Macedonia

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Abstract: COVID-19 pandemic is the worst global disasters in the last century. Its pandemic spread and influence in everyday social life, economics and health is in central interest of concern for all governments in the world. North Macedonia is one of the countries with very high percentage of COVID-19 deaths. The health system in a few periods was before collapse. In this paper, we analyze the COVID-19 epidemic situation in North Macedonia from its beginning. We make analysis and comparations of the situation in different time epidemic periods. We use regression models and machine learning algorithms in order to make predictions, which can be used as efficient tool to give directions of the authorities to deal with COVID-19 challenges.

Keywords: COVID-19, regression models, machine learning, prediction.

Vaccination queueing system simulation

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Abstract: In order to respond of different requirements in banks, airports, hospitals and other organizations, queueing models are used to help in managing and allocating of the resources. Because we are living in the pandemic of COVID-19 mass vaccination is necessary for getting of the collective immunity. For mathematical modeling of the vaccination's process, we use a queueing system as a useful tool for estimating of the capacity requirements and service time. For that purpose, we have made simulation in AnyLogic Simulation Modeling Software. In that simulation, the processes of the vaccination and revaccination are considered. Also, the capacity of queue, the capacity of system, the average waiting time in the queue and in the system are estimated.

Keywords: vaccination, queueing system, mathematical model, simulation.

Comparison methods of estimating missing data in real data time series

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Abstract: Missed data are encountered in many researches and they are also found in well-conducted and controlled studies. Missing data can reduce the statistical strength of a study and may produce biased estimates, leading to invalid conclusions. This study is focused in the problems and types of missing data, together with the techniques for their approach. The mechanisms by which the missing data are obtained and the methods to study these data are illustrated.
We have dealt with the multiple imputation as a very efficient method of imputing the missing data and applying these methods in some simulation cases and in real data time series.
We have also prepared and adapted the scripts in the programming language R to conduct the simulations. The proposed mice and Amelia packages for imputing the missing values provide fairly good approximations even in the case of real data.

Keywords: Missing data, imputation, time series, mice, R.

Bootstrapping the coefficients of multiple logistic regression model in medicine data

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Abstract: Bootstrap is becoming a useful and very popular tool for obtaining estimations and confidence intervals for coefficients in many researches in different scientific fields without making assumption about the population. Our goal is to apply bootstrap technique in parameter estimation and confidence intervals for the coefficients in multiple logistic regression model in a study using medical records.

We will use R programming language and SPSS to obtain the coefficients of the model and the estimations using non-parametric bootstrap and also we will make a comparison of the results emphasizing the importance of using resampling methods even in a study with real data.

Keywords: Bootstrap, estimation, confidence interval, logistic regression.

On Simulation and Modeling in Economics

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Abstract: This paper is devoted to a description of the modeling of economics and in particular, of business processes. More specifically, it describes the process and the conditions of creating a user-friendly and correct models, as well as the advantages, disadvantages and problems in applying the method of busi-ness process simulation. The process of simulation in the field of queueing systems and stock management, which are two of the most basic decision-making areas for all enterprises, is described in more detail. Nowadays, tech-nology offers many solutions for every researcher with hi-end simulation tools, like simulation languages and other software packages. Simple exam-ples are given and commented from computational and economical points of view.

Keywords: Simulation models, Business, Queueing System, Stock Management

N-Tuple Orbits Tending to Infinity for Hilbert Space Operators

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Abstract: In [2] we gave some results on the existence of a dense set of vectors each having an n-tuple orbit tending to infinity for sequences of mutually commuting bounded linear operators acting on an infinite-dimensional complex Banach space. In this paper we will show that, in the case of operators on an infinite-dimensional complex Hilbert space, this type of set exists under weaker conditions.

Keywords: Hilbert spaces, orbits tending to infinity, n-tuple orbits, sequences of operators

$H_p(N_0,\beta)$ Space Embedding into $l_q(N_0)$ Space in the case $p \le q$

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Abstract: Weighted spaces arise naturally when considering differential equations with variable coefficients. It is important to note that properties (embedding theorems) of weighted spaces are widely studied and applied to the study of spectral issues of semibounded operators. The paper generalizes some well-known compactness criteria of the embedding operator, obtained in works of M. Otelbayev and his students. After all weighted function averaging first introduced by M. Otelbayev allows to obtain bilateral assessments of norms of some embedding operators, discreteness criteria of the spectrum and assessments of the distribution functions of some semi-confined operators spectrum.

Unlike the embedding operators for continuous variable's functions whose apparatus is well developed, the embedding theorems for discrete argument functions (difference embedding theorems) are relatively poorly studied.

Keywords: embedding, sequence, space, finite sequence, embedding operators.

Functions constructed over finite groups and uniform distribution of sequences

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Abstract: The author uses the set $\mathbf{W}_{G,\varphi}$ of the Walsh functions and the two sets $\mathbf{h}/_{G,\varphi}$ and $h//_{G,\varphi}$ of the Haar type functions constructed over the finite group G with respect to the bijection φ to show some their applications in the theory of the uniformly distributed sequences. The bilateral relations between the functions of the systems $\mathbf{W}_{G,\varphi}$, $\mathbf{h}/_{G,\varphi}$ and $h//_{G,\varphi}$ are obtained. The notions of multidimensional modified integrals from the Walsh functions and the both Haar type functions are introduced. Analogues of the LeVeque inequality are presented. They are upper bounds of the extreme discrepancy in the terms of the introduced three kinds of the modified integrals. The Koksma' s formula is presented. Here, the quadratic discrepancy is expressed in the terms of the considered modified integrals. The inequality of Erdös-Turán-Koksma for the quadratic discrepancy in the terms of the modified integrals of the Walsh functions is presented. The bilateral relations between the modified integrals of the Walsh functions and the both kinds of the Haar type functions are presented. The integral Weyl's criterion is expressed in the terms of the considered modified integrals.

Keywords: Walsh and Haar type functions over finite groups; Discrepancy; Inequality of LeVeque; Koksma' s formula; Inequalities of Erdös-Turán-Koksma; Integral Weyl' s criterion.

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The Rank of the Monoid of Partial Automorphisms on a Crown

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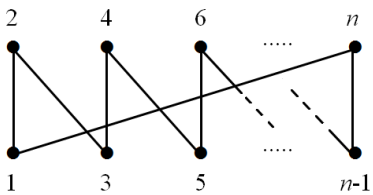
Abstract: For $n \in 2\mathbb{N}$, let $X_n = \{1, 2, \ldots, n\}$ be a finite set and let $C_n = (X_n;<)$ be a crown, i.e. a partially ordered set in which the order relation forms a path with alternating orientations where the only comparabilities are

$$1 < 2 > 3 < 4 > \ldots < n > 1.$$

Moreover, a crown C_n can be considered as an n-ordered set with Hasse diagram isomorphic to the following:
We consider the monoid $PAut(C_n)$ of all partial automorphisms on the



crown C_n. Clearly, $PAut(C_n)$ is an inverse monoid under composition of maps with the identity mapping id as the identity element.
The rank of a monoid S is the least number of generators of S. Our main objective is to give formula for the rank of the monoid $PAut(C_n)$.

Keywords: partial automorphism, crown, generators, rank.

On some stochastic applications to real world problems

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Abstract: Main combinatorial definitions and theorems will be reviewed. They are related to events when choices of discrete objects have to be done or some sequences of objects have to be calculated. As examples combinations, variations and permutations can be given. These notions can be related to various real phenomena. As examples some games and gene properties can be mentioned. We will describe some interesting events and phenomena. Further, their main properties will be found and modelled by the use of concepts introduced earlier. By the use of the mathematical propositions the corresponding modelled problems will be studied. As result we will obtain main characteristics of the phenomena and comment them from the practical point of view. Examples from medical genetics are studied.

Transfer Learning for Medical Image Classification

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Abstract: Among the wide variety of different deep learning (DL) architectures available for medical image analysis, convolution networks (CNN) are more efficient for medical imaging task such as classification, segmentation, object detection, severity grading, etc. Full training of a CNN from scratch requires a large, labeled dataset, and extensive computational and memory resources. In medicine, such large, labeled datasets are rare. Yet, the accuracy of prediction is dependent on the quantity and quality of medical image dataset The limitation insufficient or poor quality of the medical image dataset is almost removed by the transfer learning. Transfer learning uses pertained models and fine-tunes them for feature extraction of the dataset. There are numerous pre-trained models including AlexNet, LeNet, MobileNet, GoogleNet, etc. Currently ResNet and DenseNet are proven to be best suited to chest x-ray classification models. In the research we will use transfer learning to detect pneumonia from a chest x-ray dataset. We will compare the performance of shallow fully trained CNNs and transfer learning models.

Keywords: transfer learning, neural networks, convolutional neural networks, CNN, medical image classification

The Impact of the Knowledge Management Strategy on Distance E-learning

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Abstract: Do knowledge management strategies impact the various distance e-learning processes? Distance e-learning is a sector of the university level that uses knowledge and knowledge management for stimulating innovation, improving student services, achieving operational perfection, increasing the knowledge regards research and development, improving teaching methods and also for achieving a competitive advantage in the learning process. Knowledge management is a field that has a positive impact on all activities at the university level. Knowledge management and its well-developed strategies contribute to distance e-learning by stimulating initiatives for acquiring, creating, and sharing knowledge to achieve, as business goals, excellence in education.

In this article, not only the methodology for developing knowledge management strategies in distance e-learning is presented but also the process of applying an appropriate strategy is being investigated. This strategy contributes to strengthening the connections between learning and teaching processes on one hand and the interests of business and industry on the other hand.

Keywords: Distance e-learning, Knowledge Management, Strategies

The Role of Organizational Culture and Knowledge Management for Knowledge Dissemination in Distance e-learning

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Abstract: In the modern university educational space, knowledge management (KM) is the driving force behind the competitiveness of universities. Moreover, KM is a continuous process in which knowledge is increased and accumulated. The dissemination of knowledge of distance e-learning in universities is influenced by various factors. One of the most important of them is the organizational culture (OC) of universities. The form of education "Distance e-learning", on one hand, as distance learning, is strongly related to the processes of KM, and on the other hand, e-learning is influenced by the type of communications. Distance e-learning, regardless of its type - synchronous or asynchronous, is significantly influenced by the trust, the organizational structure of the university, and the motivation of the administrative and academic staff.

The purpose of this article is to examine the impact of KM and OC upon the practices of knowledge dissemination and knowledge sharing in distance e-learning. One part of the data, needed for the research, was collected through questionnaires (published in the e-learning platform Blackboard), and the other one is a sample from the platform's databases. This research proves the hypothesis that the components of organizational culture, namely - the organizational structure, trust, communication, motivation system and leadership skills, have a significant impact on the processes of KM and especially on the processes of knowledge sharing and knowledge dissemination.

Keywords: Distance e-learning, Knowledge Management, Organizational Culture

Scaling of clustering algorithms for big data sets with Weka

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Abstract: Data Mining term refers to the method of extracting helpful models of data. Sometimes, a model will be an outline of the info, or it can be the set of most extreme options of the data. The standard feature-based model appearance for the foremost extreme samples of a development and represents the data by these examples. A standard style of data mining drawback involves discovering uncommon events hidden inside large amounts of data.

Keywords: Data Mining algorithms, Clustering methods, Weka Tools.

Application of Machine Learning in Software Development: A Systematic Mapping Study

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Abstract: Software development process has changed dramatically over the last decades with the introduction of different development methodologies. The industry is very competitive, and software companies strive to accelerate their development process while ensuring good quality and fast delivery. In order to improve development and to keep pace with the competitive environment, many researchers have proposed applying machine learning for improving software development. The main objective of our work is to identify the quantity and the types of research on the application of machine learning in software development, to identify the approaches and the needs for further research. A systematic mapping study was conducted with 3 research questions and assessed publications from two major scientific databases – Web of Knowledge (Clarivate Analytics) and Scopus (Elsevier B.V.). Our study attested the increasing and ongoing interest in research on the subject and revealed open research questions.

Keywords: machine learning, software development, systematic mapping.

Research Work of Perceptron Algorithms for Recognition on Biometrics Data

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Abstract: The development of methods for solving recognition and data analysis tasks includes many software tools and a variety of methods. This provides the option to select the algorithm with possible more exact solution. In this work is presented a study of perceptron algorithm for patterns recognition and classification to solving a specific application task. To achieve the objectives of the study the following tasks are solved: create a database; conduct experiments with perceptron algorithm, realized with the Toolbox of Matlab and PRTools. The work of procedures Gendatc, Gendatb, Gendatd and Gendatb are illustrated with the relevant figures. Three criteria are studied and compared: performance (execution time), the number of errors in classification and the influence of the selection and structuring of data. The research results are presented in graphical and tabular form.

Keywords: Pattern Recognition, Classification, Clustering, Feature Extraction, Feature Selection

Relational Database Design for University Course Timetabling Problem

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Abstract: This article discusses the design of a relational database for storing information related to a university course timetable. All relations (relational schemes) are described, which includes their primary and foreign keys. SQL scripts for creating tables in the database are presented. In addition, different ways of presenting the data are considered, using a method based on dynamic data structures in memory - dynamic arrays. Two different data storage methods are considered - one based on a relational database and the second based on dynamic arrays. The two methods are compared, and their efficiency and effectiveness have been experimentally proven. The experiments include the time analysis to retrieve information from the database and from the dynamic array. The obtained results show that the method based on relational-database has the following advantages: centralized storage of data in a separate database server, access to data through a system for managing relational databases, the possibility of simultaneous multi-user access to data, and easy scaling by creating web services to access the data using an intermediate application server. Representing data in memory using dynamic structures (dynamic arrays) has a significant advantage in terms of faster retrieval of data from memory and buffering it in the address space of the application, but this approach is limited to single-user systems.

Keywords: university course timetabling; relational database management systems; databases; dynamic arrays;

Organizational-technological aspects in the construction of construction sites

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Abstract: The characteristics of the construction builds in the most general form include:

- volume-compositional solution – the purpose type and character of the facility (or the building) are clarified;
- constructive decision- the accepted constructive scheme, the type and constructive features of the elements and of the facility as a whole, some specific constructive requirements are indicated;
- technological features – the type of the adopted construction technology the type and volumes of construction and installation works (the quantity bill is also used).

In organizational and technological solutions, when drawing up the plan for safety and health (PBZ) the technology, the methods and sequence of execution of all construction and installation works for the overall construction of construction are clarified and proposed.

The purpose of the development is to analyze the impact of different technologies in the construction of construction site on the organization and operational management in their implementation.

For this purpose it is provided:

- to consider different technologies in the construction of construction sites;
- to trace the impact of the chosen technology on the main resources needed for the construction of the sites.

Keywords: organization, technology, construction sites

Structure and properties of coatings based on hydroxyapatite obtained by the detonation method

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Abstract: The article considers the research results of the formation process of a hydroxyapatite coating on a titanium substrate during detonation spraying. Powders for sputtering and obtained coatings of hydroxyapatite were studied by the methods of Raman spectroscopy and X-ray structural analysis. It was determined that the appearance of α-$Ca_3(PO_4)_2$ phases is characteristic for a coating of pure hydroxyapatite obtained by detonation spraying, but the hydroxyapatite phase is retained in the coating composition. Results obtained by Raman spectroscopy indicate that hydroxyapatite is the main phase in coatings. The morphology of the sprayed coatings was characterized by using SEM, and there was also obtained the EDS analysis of the elemental composition of the coatings. EDS analysis showed that the elemental composition of the obtained coatings is similar to the elemental composition of the initial powder, which is very important for the characteristics of biocompatibility and preservation of the service life of the coatings.

Keywords: hydroxyapatite, detonation spraying, structure, phase composition, microhardness.

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Electrolyte plasma hardening of 20X2H4A low-carbon steel

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Abstract: The article presents the results of a comparative study of the effect of bulk and surface hardening on the structure and properties of 20Cr2Ni4A steel. Surface hardening was carried out by the electrolytic plasma method. Bulk quenching was carried out by heating to a temperature of 870 °C, followed by cooling in water and oil. The structural-phase states of 20Cr2Ni4A steel samples were studied by metallographic and X-ray structural analysis. Tribological tests of the samples were carried out according to the ball-disk scheme, and the microhardness of the samples was also determined. It has been determined that after volumetric and surface hardening, the hardness and wear resistance of 20Cr2Ni4A steel increase. In this case, the most significant change is observed in samples that have undergone electrolytic plasma hardening. It has been established that high values of hardness and wear resistance of 20Cr2Ni4A steel after electrolytic plasma hardening are associated with the formation of fine-needle martensite.

Keywords: structure; phase composition; electrolytic plasma hardening; microhardness; wear resistance.

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Production of coal powder by the electric pulse method

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Abstract: Burning coal leads to the formation of harmful substances that negatively affect the environment. In this regard, it is recommended to use coal in the form of components of coal-water fuel. The paper investigates the effect of pulsed discharges on the intensive grinding of material in order to obtain the necessary product for water-coal fuel. The electric impulse installation consists of a power-control unit, a storage capacitor, an air converter and a working channel. Using the electro-pulse method, raw materials with a powder diameter of 100 microns were obtained. The following values are taken as effective parameters of pulse discharges: discharge energy - 157 J, discharge frequency - 2.5 Hz.

Keywords: electric pulse, coal grinding, discharge energy, pulse discharge frequency.

Investigation of the operation of a thermoelectric converter

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Abstract: In this article, a heat flux meter is considered for diagnosing the state of thermal insulation of underground pipelines by measuring the surface distributions of the heat radiation density over the laying. The heat flux meter is an indicator of the state of the underground heat pipeline by the nature of changes in heat losses or the temperature of the ground surface above the researched object. The developed heat flow meter is based on the principle of using an «auxiliary wall». On the transducer of heat flux, which is applied to the surface of the enclosing structure, a temperature difference is created in the steady-state heat exchange mode, proportional to the density of the heat flux passing through the barrier. This heat flux meter consists of a thermometric unit, which is based on a battery-operated thermoelectric transducer. The battery sensor is a sealed laminated round disk, which is mounted in a stainless steel ring with an internal groove and filled with epoxy resin. The lamp soot is added to the epoxy resin to increase the level of disc absorption. The disk provides the same conditions for heating the sensor element by the radiation flow and the electric current passed through the heater. This allows the equivalent heating of the sensor element by the radiation current flow. The developed device is designed to analyze the state of thermal insulation of underground pipelines of heat networks.

Keywords: heat flux meter, heat flow, thermometric unit, battery-operated thermoelectric transducer

Computer simulations for wireless network analysis

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Abstract: The wireless computer networks are a product from the natural evolution of computer systems with regards to their flexibility in using compute resources and the diversity of user locations in space and time. The current technological solutions used in wireless transmission of data are based on geographical location of the user and the distance of data transmission.

Wireless local networks (Wireless LAN – WLAN) constitute one part of wireless networks that have a function to enable computer communication and network application in the local domain of the „in-root, in-building or campus area" type. Their purpose is similar to the cable-based LAN – to transmit data between mobile or fixed stations that are part of the network, while enabling the following additional functions as well:

- Expanding the traditional local networks to mobile devices.
- Equal access local networks of the **Ad Hoc** type.
- Remote access bridges of the **Inter-Lan Bridge** type.
- Computer and communication devices integration.

The goal of this article is to provide an overview of the most-widespread methods to access the WLAN communication environment and the relevant MAC protocols, the way computer networks function and are built, as well as the types of computer networks.

Computer simulations using the MATLAB software are another aspect of this report where we examine some characteristics of wireless protocols. We will present results and conclusions on the digital processing of the signal. We will use **wave flat**, **fast Fourier transform (FFT), factor** and other analyses for the mathematical computer simulations. We will present an analysis of different characteristics of hardware devices and how those can be adapted to optimize the devices' work.

Keywords: Local networks, MATLAB, WLAN.

Possibilities for mathematical competences development in lower secondary school through game-based learning

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Abstract: In this article, a heat flux meter is considered for diagnosing the state of thermal insulation of underground pipelines by measuring the surface distributions of the heat radiation density over the laying. The heat flux meter is an indicator of the state of the underground heat pipeline by the nature of changes in heat losses or the temperature of the ground surface above the researched object. The developed heat flow meter is based on the principle of using an «auxiliary wall». On the transducer of heat flux, which is applied to the surface of the enclosing structure, a temperature difference is created in the steady-state heat exchange mode, proportional to the density of the heat flux passing through the barrier. This heat flux meter consists of a thermometric unit, which is based on a battery-operated thermoelectric transducer. The battery sensor is a sealed laminated round disk, which is mounted in a stainless steel ring with an internal groove and filled with epoxy resin. The lamp soot is added to the epoxy resin to increase the level of disc absorption. The disk provides the same conditions for heating the sensor element by the radiation flow and the electric current passed through the heater. This allows the equivalent heating of the sensor element by the radiation current flow. The developed device is designed to analyze the state of thermal insulation of underground pipelines of heat networks.

Keywords: heat flux meter, heat flow, thermometric unit, battery-operated thermoelectric transducer

The Constructivist Approach in Mathematics Education

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Abstract: The traditional approach to mathematics education involves students passively learning mathematical ideas, established facts, skills, and concepts that other people invented and recorded in texts and that have been taught to them by teachers. Constructivism offers ideas radically different from this view. The report presents a theoretical study of the constructivist approach in the context of mathematics education. A conceptual framework in which the essence of this approach is described and explained in a comparative plan with the traditional approach to education is presented. Possible methods for use in mathematics education arising from the constructivist approach are analyzed, such as: cooperative or group learning, problem-based learning, project-based learning, contextual learning, experiential learning.

Keywords: mathematics education, constructivist approach, constructivist methods

The problems of teaching higher mathematics with the use of distance learning technologies

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Abstract: The main aim in education has always been to provide quality education, nowadays there has also emerged the need for accessible quality education. Today, distance education has become more relevant because of the pandemic and the imposed quarantine, which has entailed a number of restrictive measures and, in particular, traditional forms of learning are not always possible.

Distance education is widely used in the USA, China, the UK and other countries. Today, the effectiveness of e-learning is officially recognized at the UN and UNESCO levels. Distance education involves the provision of a range of services that ensure the exchange of learning information at a distance through a specialized information and education environment. In this case, there should be active independent work of the student with the learning material under the guidance of a teacher who is in touch with him or her.

Keywords: distance education, mathematics, higher education.

The chemical experiment as a cross point in the development of the mathematical competence and competence in science, technology, engineering and entrepreneurship competence

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Abstract: Key competencies are defined as a combination of knowledge, skills and attitudes needed by everyone for personal realization and development, which are acquired in the process of learning. Competencies can be applied in many different situations and in a variety of combinations. They overlap and are interconnected; the aspects that are most important in one area support competence in another. Interactive methods and new learning techniques contribute to the development of independence, initiative, creativity, critical thinking in students and guide them to a specific effective result. In the past decade, the shift of focus in teaching from teaching knowledge to mastering key competencies and developing problem-solving skills brings to the fore the main features of the competency approach: integrated interdisciplinary interaction; practical orientation of the training; results orientation; application of innovative approaches and practices in the process of teaching and learning.

Keywords: key competencies, chemical experiment, ideas into actions, creativity

Chemistry in our days

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Abstract: The Chemistry 19th Annual National Meeting was held in May 2021, Sofia – traditional annual meeting for students (5 – 12 grade) organized by the Union of Chemists in Bulgaria, the Faculty of Chemistry and Pharmacy, Sofia University "St. Kliment Ohridski", the Federation of the scientific engineering unions in Bulgaria, the Regional Management of Education Sofia-city and the Bulgarian Union of Chemistry Teachers. The participants had the chance to choose from three categories – an essay, a poster or a presentation; from three topics in three age groups (5-6 grade, 7-10 grade, 11-12 grade): "The fake chemistry around us"; "The important chemical compounds for a healthy person"; "Chemistry in space, the stars and…". The total number of participants was 317 from 82 schools in Bulgaria. The teachers that took part in the preparation and showing of the students' work were 99.

Participants from each category and of all age groups were distinguished and got first, second or third award as well as special and rewards incentives. All students and teachers received official letters of gratefulness and certificates confirming that they have attended the Chemistry 19th Annual National Meeting 2021 in Sofia.

Keywords: school, students, chemistry

Inquiry based science investigations for enhancing student learning

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Abstract: The study focuses on inquiry-based method as an approach that helps students build their knowledge of concepts through research and exploration activities based on existing knowledge. The individual science investigation is a component in the final assessment of the students in the International Baccalaureate program, and its assessment model follows certain criteria and indicators to evaluate the levels of performance. This study discusses aspects such as designing teaching and learning strategies that increase student motivation, enhance the development of high order thinking skills, abilities to communicate knowledge, as well as student engagement and successes.

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Keywords: inquiry-based learning, student engagement, high-order thinking skills, International Baccalaureate Programme

The potential of YouTube as a learning tool in physics education: a syrvey among secondary students

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Abstract: Online education is based on modern ICTs, the potential of which is being revealed more and more recently. During the long distance learning in the pandemic conditions of COVID-19 in Bulgaria we decided to explore the potential for creating video lessons on YouTube and to explore some attitudes among students. A YouTube physics training channel was set up, and students had to answer a few questions. The report presents an algorithm for creating an educational YouTube channel and video lessons in physics, as well as summarized results of the survey among students. The questions in the survey are designed to assess the effectiveness, visibility and accessibility of video lessons, as well as the motivation of students to learn from YouTube.

Keywords: Online education, physics education, YouTube, video lessons

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Analysis of problem-based learning in physics from the perspective of integrated STEM education

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Abstract: Problem-based learning is a specific instructional strategy which is applicable to the teaching of a variety of scientific content in school. In this article, we analyze the main characteristics of problem-based learning and argue that it is one of the most appropriate practices for integrated STEM education. Our arguments are based on several key concepts and principles that are common to problem-based learning and the integrated approach to STEM. In addition, we find common difficulties in the implementation of problem-based learning and the integrated approach, which are also discussed. This offers new perspectives for problem-based learning in connection with the future development of integrated STEM education.

Keywords: problem-based learning, integrated STEM education, physics

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Applying collaborative activities in high school physics course during hybrid model of learning

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Abstract: Many large educational institutions and international studies point out that collaborative problem solving is a key competence for the successful integration of students into society and the workforce. Therefore, it is important for teachers to apply methods and activities that develop students' teamwork skills. But for two school years now, we have been facing the challenges of distance learning because of the coronavirus crisis. In the absence of the possibility for full attendance of students in the classroom, there is a need for an innovative and flexible approach to be applied by teachers in order to be able to cope with this emergency situation. This report examines the possibilities for implementing collaborative activities in the high school physics course during hybrid model of learning. Surveys were conducted among students from ninth to eleventh grade in order to investigate whether there is an increase in interest in physics and STEM disciplines, if collaborative activities are implemented in high school physics course during hybrid model of learning.

Keywords: collaborative activities, hybrid learning, collaborative problem solving, physics education

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Investigation of instructional practices in high-school atomic and subatomic physics

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Abstract: Education research has illuminated numerous student misconceptions of atomic and subatomic physics. Furthermore, there is evidence that high-school students' engagement is positively correlated with an increase in the variety of applied teaching methods (based on data from the TIMSS Advanced (2015) research). In this paper, we investigate and compare proposed methods which are likely to improve high-school students' understanding of the microscopic world. This includes specific application of models, cooperative learning, problem-based learning and others. We also comment on the role and potential of virtual demonstrations.

Keywords: Physics education, secondary education, instructional practices, atomic physics, nuclear physics

Acknowledgements: This work was supported by the Research Fund of Sofia University under contract number 80-10-142/26.03.2021.

Communicating results in project-based and problem-based physics education: the perspective of engineering design in STEM

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Abstract: The introduction of engineering design in STEM education in recent years provides new opportunities for the development of key competencies such as teamwork, responsibility, decision making, communication, leadership and others. In this article we focus on opportunities to improve communication skills through project-based and problem-based physics education. On the other hand, the stage of communicating project results in engineering design is very well studied and developed and is guided by certain principles. Based on this and some modern models of integrated STEM education, instructions for communicating results of students' project- or problem-based learning in physics are offered, which may benefit the science education as a whole.

Keywords: project-based learning, problem-based learning, engineering design, communication skills

Acknowledgements: This work was supported by the Research Fund of Sofia University under contract number 80-10-142/26.03.2021.

Application of the project method in physics education in classes with intensive studying of English

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Abstract: The article is dedicated to project-based learning as a way to create an interactive educational environment that stimulates students' cognitive activity. It dwells on the essence of the project method and the preliminary stages the preparation of a training project goes through. Emphasis is placed on the application of this method in physics education. The article also presents an option, a feasible one in common pedagogical practice, of including project-based physics education in the school curriculum of 9th graders with intensive study of English in junior high.

Keywords: physics education, project method, English language, information technology, interdisciplinary relations

Advanced alkaline water electrolysis with Co and Ni based non-carbon supported electrocatalysts

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Abstract: The AEM water electrolysis based on alkali-doped polymer electrolyte membrane is an efficient method to produce hydrogen with higher purity, which offers several advantages over the traditional technologies: higher current density, low ohmic resistance, possibility to operate at higher working pressure, as well as usage of platinum free electrocatalysts. The technology still has some problems such as non-sufficient stability of the polymer electrolyte at elevated temperature, low conductivity of the commercially available membranes, and intensive corrosion on the bipolar plates of the cell. This work presents a research on development of highly efficient membrane electrode assembly (MEA) with carbon free electrodes containing non-noble metal catalysts (Co and Ni supported on Magnelli phase titania), and laboratory prepared para-PBI anion exchange membrane. It is found that the optimal amount of the catalysts for hydrogen and oxygen evolution reactions is 1.0 mg.cm-2 and 0.5 mg.cm-2, respectively. The electrochemical performance of the prepared MEA shows low over potentials concerning both partial reactions and stable behavior at elevated temperature of 80 oC with current density of 0.6 A.cm-2 at cell voltage of 2.0 V. The enhanced efficiency of the electrolysis is explained with the observed homogeneous distribution of the nano-sized catalyst crystallites on the non-carbon carrier, reduced ohmic resistance of the electrode, and high anion conductivity of the used polymer electrolyte membrane.

Keywords: AEM water electrolysis, catalysts, MEA, hydrogen generation

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Electrochemical hydrogen compressor – novel cell design, electrodes structure and catalysts

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Abstract: The electrochemical hydrogen pump is an efficient device for hydrogen cleaning and compression which offers several advantages overall the mechanical compressors such as absence of moving parts, no need for vacuuming and periodic lubrication, possibility to operate at higher differential pressure, etc. However, the technology is still a challenge due to the need of high catalytic loadings of Pt-based catalysts for both partial reactions, which makes the system rather expensive. This work presents a newly developed laboratory prototype of electrochemical hydrogen pump/compressor (EHC), operating with proton conductive membrane at differential pressure of up to 5 bar and innovative bi-metallic (Pt/Pd) catalyst for HER. The laboratory tests performed, demonstrated that the design of the developed device and the architecture of the electrodes ensure high efficiency of both HOR and HER as well as a possibility to operate with identical rate of gas compression at different input hydrogen pressure efficiency.

Keywords: Electrochemical hydrogen compressor, bi-metallic catalyst, hydrogen compression

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Biological hydrogen production by *Clostridium sp.*

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Abstract: In recent years various studies has been conducted to obtain a sustainable source of energy that can replace fossil fuels and which do not have a negative impact on the environment. Hydrogen is one alternative fuel substitute and is considered as an "energy carrier" with a promising future. Production of hydrogen from protons and electrons are produced directly by bacteria with increasing electrochemical potential in the cathode. Bio-electrochemical system is an alternative technology using microorganisms as electrochemical catalyst. The most interesting part of the process of electrochemical is the occurrence of two simultaneous processes that produce hydrogen gas and electro - coagulation process. Microorganisms are capable of catalyzing the oxidation-reduction reaction at the anode and cathode electrodes in the Microbial Electrolysis Cell (MEC).

Keywords: bio-hydrogen, Clostridium sp., Microbial Electrolysis Cells (MECs)

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Bio-hydrogen production

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Abstract: Growing global energy demand leads to the need for new and sustainable renewable fuels solving problems related to greenhouse gas emissions leading to undesirable climate change. Thus, in recent years, hydrogen has been seen as an undisputed candidate in renewable energy agendas, where the production of bio-hydrogen is becoming increasingly. Hydrogen is perceived as a potential energy carrier of the future. Conventionally hydrogen is produced from natural gas by steam reforming. Other industrial methods are coal gasification and water electrolysis. Unfortunately, in both cases energy must be introduced and carbon dioxide is released. It is particularly valid for electrolysis, where the spent energy is more than the produced one by the obtained hydrogen. It is important to develop renewable hydrogen generation routes, like bio-hydrogen production. Hydrogen can be produced biologically by bio-photolysis (direct and indirect), photo-fermentation and dark-fermentation or by combination of these processes (such as integration of dark- and photo-fermentation (two-stage process), or biocatalyzed electrolysis, etc. In this review, biohydrogen production using organic waste materials through fermentation, biophotolysis, microbial electrolysis cell and gasification are discussed and analysed from technological perspective.

Keywords: bio-hydrogen, biophotolysis, microbial electrolytic cells (MECs). photo-fermentation, dark-fermentation

Acknowledgements: This work has received funding from the National Research Program "Low Carbon Energy for the Transport and Household (E^+)" granted by the Bulgarian Ministry of Education and Science.

Synthesis and characterization of photoactive titanium oxides by anodic oxidation

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Abstract: As part of an integral effort to produce titanium oxide catalysts for photoelectrochemical water splitting within the National Program E+, the synthesis and characterization of TiO_2 formed on Ti via barrier and breakdown anodic oxidation is reported. The oxides are formed in 0.11 M phosphate buffer solution (pH 7.0) with a current density of 5 mA cm^{-2} to 100 V (barrier anodization) and 40 mA cm^{-2} to 180 V (plasma, or breakdown, type of anodization) for 10-30 min. Subsequently the oxides are characterized by electrochemical impedance spectroscopy and high-frequency capacitance vs. potential measurements in the dark, as well as photoelectrochemical impedance and intensity modulated photocurrent spectroscopy (IMPS) under UV light (365 nm). Both ionic conduction in the dark and photoconductivity under irradiation are considerably larger for the oxides formed by breakdown anodization, which makes them prospective candidates for photo anodes. In the next stages of the project, modification of the oxides to enhance their visible light catalytic properties will be attempted.

Keywords: hydrogen generation, photoelectrochemical water splitting, titanium dioxide, breakdown anodization, electrochemical impedance spectroscopy

Hybrid supercapacitors with innovative binder - *ex-situ* structural and morphological studies

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Abstract: In this study are presented the results from ex-situ physicochemical analyzes of electrodes with synthesized poly(vinylidene fluoride-co-hexafluropropylene) (PVDF-co-HFP), used as binder in the active electrode mass of hybrid supercapacitors. The cells based on biogenic activated carbon, αβ-$Ni(OH)_2$ composite electrode, ionic liquid (1-ethyl-3-methylimidazolium tetrafluoroborate) as electrolyte and PVDF-co-HFP exhibit improved capacitive characteristics. The crystal structure of the electrodes is studied using X-ray diffraction analysis. The profiles of pristine $Ni(OH)_2$ electrode and this one after the electrochemical tests are similar, however, decreases in peak intensity were observed in (001) and (110) directions. In contrast, the peak intensity of (100) and (101) increased, suggesting the formation of more perfect crystals. The electrode morphology is visualized by SEM and AFM techniques.

Keywords: ecological hybrid supercapacitor, copolymer, binder, electrochemical tests, ex-situ analyzes

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Capture of CO_2 by mesoporous CeO_2/ZrO_2 materials

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Abstract: CO_2 is considered the main greenhouse gas because it is emitted in enormous amounts from anthropogenic activities. Recently, the targets for limiting CO_2 emissions into the atmosphere have driven the intensive development of innovative technological solutions. Therefore, carbon capture, utilization and storage (CCUS) technologies are among the most important environmental protection approaches aimed at mitigation of climate changes that are due to the environmental impact of greenhouse gases, specifically CO_2.

In this work mesoporous CeO_2-ZrO_2 adsorbent materials were obtained by hydrothermal template assisted method and studied in CO_2 capture. The physicochemical characteristics of the samples were studied by XRD, nitrogen phisisorption, UV Vis spectroscopy and TPR measurements. The adsorption capacity of CO_2 was measured for both the static and dynamic CO_2 adsorption regimes. The chemisorption of CO_2 forming different surface species was studied by FTIR spectroscopy. It was found that the mesoporous CeO_2/ZrO_2 materials show high capacity for CO_2 capture.

Keywords: Ceria/zirconia materials, CO_2 capture, static and dynamic adsorption, FTIR spectroscopy

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Organic acids and hydrogen production by a newly selected microbial consortium

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Abstract: Considering the present energy demand and industrial growth, finding a potential sustainable energy source is crucial and the H_2 is considered to be the primary choice.

The aim of this study is to propose a new microbial consortium for H_2 production, consisting of two microbial strains - Lactobacillus and Clostridium. Different media were used to carry out the fermentation. The selected consortium produces mainly lactic acid, with the type of medium having minimal effect on yield. 100% uptake of the substrate (glucose) was observed, with the resulting lactic acid being 6.63, 5.02 and 4.99 g/l, respectively, by mediums MRS, RCM and modified medium for the selected consortium.

The next step in the study is optimization of fermentation conditions especially the temperature, because of the difference in the optimal temperature for Clostridium and for Lactobacillus. It is interesting to study the possibility of the newly selected microbial consortium to use cheaper raw materials for efficient biological H_2 production. It will surely make it more competitive with the conventional H_2 generation processes in the near future.

Keywords: Hydrogen, Organic acid, Microbial consortium

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O-SS-9 Mg-Ca0.3 Electrochemical Activity Exposed to Hank's Physiological Solution and Properties of Ag-Nano-Particles Deposits

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Abstract: This work compares the degradation of Mg and Mg-Ca0.3 alloy when they are exposed for 14 days to Hank's solution at 37 °C. A combination of immersion test, electrochemical techniques (PDP, EIS, EN), and surface characterization methods (SEM-EDS, XRD, and XPS) were carried out. The pH change over time, the lower mass loss (≈20%), and the lower concentration of the released Mg2+ ions (≈3.6 times), as well as the lower level of the surface degradation, allowed to consider the positive effect of Ca, presenting Mg-Ca0.3 alloy with lower electrochemical activity than that of Mg. The positive effect of Ca may be due to the formed layer characteristics on the alloy surface, which impedes the cathodic hydrogen evolution and Mg-ions release. The electroless deposited Ag-nano-particles (Ag-NPs) on Mg-Ca0.3 surface were characterized by SEM-EDS, XRD, UV-Vis, and contact angle. The agar-diffusion test was used to compare the growth of Staphylococcus aureus and Escherichia coli bacteria on Mg-Ca0.3 in the presence of Ag-NPs deposits in different size. Zeta-potential of the bacteria was negative, with respect to pH of the Mueller-Hinton culture broth. The greater antibacterial effect of S. aureus was attributed to its more negative zeta-potential, attracting more released Ag+ ions.

Keywords: magnesium; Mg-Ca alloy; corrosion; Hank's solution; silver nano-particles; UV-Vis; bacteria zeta potential; antibacterial properties

Metal recovery from silver(I) dithiosulfate complex by Microbial Electrochemical Snorkel

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Abstract: Microbial electrochemical snorkel (MES) is a "short-circuited" microbial fuel cell (MFC), which cannot generate power but ensures the highest possible reaction rates in the system. In this study, we demonstrate the possibility of the MES for silver recovery from silver (I) dithiosulfate complex. For this purpose, MES setup with separation of the cathodic and anodic compartments by proton exchange membrane (PEM) was developed. Graphitized paper (GP) cathodes, immersed in $Na_3[Ag(S_2O_3)_2]$ solution containing 1 g Ag/L, were short-circuited with the bioanodes of sediment MFCs. The performance of thus constructed MES was monitored by measuring the current and potentials over time and compared with that of an MFC loaded by 510 Ω external resistance. The silver removal from the catholytes was followed up by spectrophotometrical analysis. The chemical composition of the deposited on the cathode coatings was examined by X-ray photoelectron spectroscopy. The obtained results are discussed and compared with those obtained for silver recovery from $AgNO_3$ aqueous solutions by the same experimental setup.

Keywords: Silver recovery, silver(I) dithiosulfate complex, Microbial Electrochemical Snorkel.

Acknowledgements: This study was supported by the Bulgarian National Science Fund through contract KP-06-H29/8/2018 and the National Scientific Program "EPLUS" (contract D01-214/2018).

Electrocatalytic activity of Ni- and Co-modified graphitized paper towards hydrogen evolution reaction in neutral electrolyte

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Abstract: The choice of the effective cathode materials for microbial electrolysis cell (MEC) is the main challenge for the practical implementation of this innovative technology for hydrogen production. In this study, nickel and cobalt catalysts, synthesized by direct selective grafting from acetilacetonate precursors, were deposited on graphitized paper (GP) and the electrocatalytic activity of the produced modified electrodes towards hydrogen evolution reaction (HER) in neutral electrolyte was examined. Magneli phase titanium sub-oxide powder was used as a catalytic carrier for the samples with particle size 60 to 100 nm. The metallic part in each of the catalyst was 40 wt.%. The prepared catalysts were applied on the GP by airbrush technique with purified air gas carrier. The electrochemical performance of the produced electrodes in neutral phosphate buffer solution was investigated by linear voltammetry, chronoamperometry, and electrochemical impedance spectroscopy. Both modified materials exhibit much higher electrocatalytic activity towards HER than that of the unmodified graphitized paper. The further evaluation of the produced materials as cathodes in MEC is in a progress.

Keywords: Ni- and Co-modified graphitized paper; Hydrogen evolution reaction, electrocatalytic activity, cathodes, Microbial Electrolysis Cells.

Acknowledgements: This study was supported by the Bulgarian National Science Fund through contract KP-06-H29/8/2018 and the National Scientific Program "EPLUS" (contract D01-214/2018).

POSTER SESSION

Influence of electrolyte additives on the performance of the positive plates of lead batteries

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Abstract: In this work, sodium dodecyl sulfate (SDS) and cetyltrimethylammonium bromide (CTAB) were used as electrolyte additives in test lead cells. Our recent study was focused on the elucidation of the basic effects of SDS or CTAB as electrolyte additives on the electrochemical reactions proceeding on a lead or lead alloy electrode immersed in 4.5M H_2SO_4 solution by applying linear sweep voltammetry measurements in the $PbSO_4$ / PbO_2 potential region [1]. In the present study flooded laboratory test cells with 2 positive plates (PbSb or PbCaSn grids) and 3 negative plates (PbCaSn grids) with different concentrations of SDS or CTAB in the electrolyte were subjected to initial C_{20} capacity tests and continuous cycling tests at 17.5% DoD for start-stop lead batteries. Control cells (Blank) with no additives in the electrolyte were also tested. The PbSb cells doped with the selected surfactants and the PbCaSn cell doped with 0.024% CTAB exhibit 20% improvement in cycle life performance vs. the control cell. The obtained experimental results demonstrate that the selected organic substances are promising for use as electrolyte additives for lead batteries operated under partial-state-of-charge conditions.

Keywords: lead, lead alloy, lead battery, positive active mass, surfactant

References

Matrakova M., Aleksandrova A, Nikolov P., Saoudi O., Zerroual L., Bulgarian Chemical Communications, Volume 52, Issue A (pp. 74-79) 2020 DOI: 10.34049/bcc.52.A.232.

Effect of Organic Electrolyte Additives on the Performance of Electrodes of Lead Battery

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Abstract: Wide range of inorganic and organic materials is used as additives to negative and positive electrodes of lead batteries in order to improve the electrical and electrochemical behavior of the batteries. The focus of present study is to elucidate the basic effect of commercially available products (Sigma-Aldrich) formic acid (HCOOH) and lactic acid ($C_2H_4OHCOOH$) on the electrochemical reactions proceeding on the negative and positive electrode of the lead cells. The preliminary results show that the addition of both, formic or lactic acid to the electrolyte has significant beneficial impact on the processes that take place on the negative electrode. In more detail, the evolution of the obtained current vs. potential curves in the $Pb/PbSO_4$ potential region demonstrates that addition of formic or lactic acid to the electrolyte supports the process of Pb oxidation to $PbSO_4$ and the reverse process of reduction to Pb. The change of concentration from 15ppm to 150ppm of lactic or formic acid in the electrolyte leads to increase of 75% in the anodic current and about 20% in the cathodic current. This effect suggests that the addition of formic or lactic acid to the electrolyte would increase the discharge capacity and cyclability of practical lead-acid negative electrodes.

Keywords: lead battery, electrolyte, additive, formic acid, lactic acid

Absorption – Adsorption Method for Gas Purification from SO_2 in Power Plants

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Abstract: Different companies propose methods and apparatuses for waste gases purification from SO_2 using two-phase absorbent ($CaCO_3$ suspension). The basic problem of the carbonate absorbents is that its chemical reaction with SO_2 lead to CO_2 emission (every molecule of SO_2 absorbed from the air is equivalent to a molecule of CO_2 emitted in the air), because the ecological problems (greenhouse effects) of SO_2 and CO_2 are similar. The large quantity of by-products is a problem, too. A method for waste gas purification is realized in two steps: physical absorption of SO_2 with water and chemical adsorption of HSO_3^- from the water solution by synthetic anionite particles. The adsorbent regeneration is made with NH_4OH solution. The obtained $(NH_4)_2SO_3$ (NH_4HSO_3) is used (after reaction with HNO_3) for production of concentrated SO_2 (gas) and NH_4NO_3 (solution). Convection-diffusion and average concentration models of the absorption and adsorption processes are presented.

Keywords: Absorption, adsorption, gas purification, SO_2, convection-diffusion model, average concentration model.

Acknowledgements: This work has received funding from the National Research Fund project No КП-06-Н37/11/ 06.12.2019 “Integrated absorption-adsorption process for waste free decontamination of gases from sulfur dioxide”.

CFD Modeling of Two-phase Flow in an Absorption-adsorption Column

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Abstract: Computational Fluid Dynamics (CFD) has been becoming one indispensable tool in solving and analysing problems that involve fluid flow. Bubble columns and tray columns are widely used for carrying out gas–liquid reactions in a variety of practical applications in industry. The subject of the present study is a new approach for purification of waste gasses from SO2. it includes a column with bubble-cap trays. As part of an extensive study of the bubble-cap tray hydrodynamics, the present work is aimed at the specific two-phase flow pattern on the novel tray proposed. A 3D model of a cylindrical compartment was composed with a diameter D=200mm and a height H=300 mm. The computational domain was discretized by a hexahedral grid of ca. 300 000 cells Air distribution by a coaxial bubble cap with a diameter d=80 mm and a height h=150 mm was provided for. The equations were solved using a CFD software ANSYS FLUENT (R13) based on the finite volume technique.

Keywords: Modeling, hydrodynamics, gas-liquid, bubble columns, tray columns

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Synthesis and characterization of electrode materials for supercapacitor systems

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Abstract: Current investigation presents some results of the synthesis of carbon xerogels and MnO_2 - based materials with predefined phase composition and surface for potential application as electrodes in supercapacitors. Carbon materials were prepared by polycondensation of resorcinol and formaldehyde. Two different methods were used for heat treatment of the previously obtained solution: microwave heating and thermal treatment in vacuum. The obtained materials are subsequently carbonized and activated in order to increase their specific surface. MnO_2-based materials were synthesized by chemical reduction in aqueous solution and hydrothermal synthesis. All synthesized samples were structurally and morphologically characterized. The results of the current analyzes demonstrate differences in the phase composition and structure of the obtained materials, reflecting on their surface properties. This creates prerequisites for in-depth study of the influence of the synthesis method, which will reflect on the electrochemical characteristics of the studied and the further tested supercapacitors.

Keywords: carbon xerogels, MnO_2, electrode materials, supercapacitors

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Butyric acid pertraction with and without carrier in the organic membrane. Parameter identification.

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Abstract: The use of liquid membrane is a potential approach to produce valuable products of high quality at reduced cost. It gives the opportunity to use less powerful but more selective liquid membranes than in the case of classical solvents extraction.
Butyric acid is a promising chemical for future energy needs as it can be converted to butanol through biological transformation.
Transport of butyric acid in a three-liquid-phase contactor (pertractor) was studied.
The objective of this work was to simulate the recovery of butyric acid by pertraction in a rotating disc contactor. The values of the parameters were determined based on experimental data and their importance was verified. The parameters identification problem for kinetic model was described on the base of least square function minimization.

Keywords: butyric acid, rotating disc pertraction, mass transfer, mathematical modeling, parameters identification

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Assessment methods for improving the Energy efficiency of Wastewater treatment plants

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Abstract: Environmental and climate change in recent years has required a reduction in the amount of greenhouse gases and the search for alternative energy sources. The topic of improving energy efficiency covers many production activities, but also pays attention to wastewater treatment plants (WWTP), whose activities are associated with high energy consumption. This requires looking for methods to improve energy efficiency in WWTPs, as well as opportunities to generate energy from waste products. In the present study, different approaches for modeling and optimization of WWTP facilities are presented, analyzing the possibilities for reducing energy consumption in wastewater treatment process.

Keywords: Energy efficiency, Optimization, Modeling, Wastewater treatment plants.

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Adsorption of Pd (II) on N- and S- modified silica sorbents

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Abstract: In this study two silica gel sorbents with different mobilization agents were applied for solid phase extraction of palladium(II) from 0.1–3 mol L-1 HCl. The first sorbent was prepared by immobilization of 4 - aminoantypyrine Schiff base (Schiff B-4-AAP) and the second one - by introduction of S-containing amino acid analog, N-Benzyloxycarbonyl-L-methionine (Z-Met-OH) on the silica gel surface through physical adsorption. Thus, the obtained two silica sorbents were functionalized with nitrogen (Sig ~ Schiff B-4-AAP) and nitrogen and sulfur (Sig ~ Z-Met-OH) chelating groups.

The role of various chemical parameters was studied for quantitative sorption of Pd(II) through batch adsorption experiments. It was found that the extraction efficiency of the newly prepared sorbents toward Pd(II) depends on the concentration of HCl in the sample solution and the contact time between Pd ions and the sorbents as well as on the type and concentration of the eluent. The optimal acid concentration for quantitative adsorption of Pd(II) was 1 mol L-1 HCl. The experiments showed that the coexisting ions - base metals exhibited little interference on the Pd(II) separation.

Keywords: SPE, Palladium,ICP-OES

Possibilities of increasing the detection power of ICP-OES

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Abstract: The efforts of modern chemical analysis are directed to determine more and more lower concentrations in samples with complex matrices, which additionally have a high degree of inhomogeneity. Depending on the analyte concentration, the purpose of the analysis may be to identify the major components, minor components, or to analyze trace elements. The analysis of traces from its side is divided into the analysis of micro trace, ultramicrotrace and submicrotrace components. The determination of such low concentration levels can be achieved by using techniques with low detection limits, high selectivity, as well as by introducing a preliminary step for separation and concentration of the analyte.

One of the most widely used methods in analytical chemistry for quantitative and qualitative analysis is ICP-OES. However, along with its advantages, the main limitations of the method are the matrix effects, which worsen the analytical characteristics, especially the detection limits. Various options for reducing or eliminating matrix effects and lowering ICP-OES detection limits have been discussed.

Keywords: ICP-OES, trace elements analysis, matrix effects

ICP-OES - analytical characteristics and application in chemical analysis

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Abstract: ICP-OES enters spectroanalytical laboratories all around the world and it is widely used for the analysis of samples with a different composition from waters to complex matrices, such as rocks, ores, and biological samples. The success of ICP-OES is due to its characteristics, such as low limits of detection (below 1 mg L^{-1}), good accuracy (RSD = 0.2-3%), wide dynamic concentration range (4-7 orders of magnitude), the possibility of determination of a large number of elements (> 75), plasma stability and low background level. The possibility of improving the analytical characteristics of the method consists in deepening the knowledge of the main processes that connect the analytical signal with the concentration, such as atoms and ions formation and characteristic photons emission. Capabilities and limitations of ICP-OES in PGE determination in diverse samples are discussed.

Keywords: ICP-OES, plasma techniques, analytical characteristics

Synthesis and biological activity of new *N*-dihydroxycinnamic acid hybrids

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Abstract: Recently, small molecules such as curcumin and others have been considered as one of the promising strategies for therapeutics of Alzheimer's disease (AD). Being "half" of the curcumin molecule, cinnamic acid derivatives are structurally similar to it. Therefore, we expect that our synthetically obtained N-cinnamoyl hybrids of memantine (the memantine uses as dugs for the treatment of the symptoms of AD) could provoke similar or pronounced neuroprotective effects. In addition AD pathology is consistent with increased oxidative stress of the brain. To overcome the oxidative stress, several levels could be affected, one of them is by increasing levels of endogenous and exogenous antioxidants. Since polyphenols, including hydroxycinnamic derivatives emerge as potent antioxidants, herein we evaluated in vitro the antioxidant activity of the obtained N-dihydroxycinnamic acid hybrids against DPPH• (1,1-diphenyl-2-picrylhydrazyl free radical). The results revealed that amongst the tested hybrids, N-caffeic acid amide demonstrated the highest radical scavenging activity (%RSA = 93.67± 2.73), which had no significant difference with caffeic acid (%RSA = 96.70± 2.28), used as reference. Moreover, the study of neuroprotection activities of the obtained memantine hybrids is in progress.

Keywords: Memantine, hydroxycinnamic derivatives, caffeic acid, Alzheimer's disease.

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Effect of the final thermal sealing on the performance of combined Ce-O-Al films formed on AA2024-T3 aircraft alloy

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Abstract: The present research represents results from corrosion tests, performed on combined Ce-O-Al coating primers, thermally sealed for 15 min. at 100 °C either in air or in boiling water medium. The coating primers were formed on A2024-T3 aircraft alloy substrates, according to the optimal conditions, described in previous works. Prior to the corrosion tests, their wettability and color characteristics were evaluated. The corrosion protective properties of the sealed films were assessed by means of Electrochemical Impedance Spectroscopy (EIS) and Linear Voltammetry (LVA) after 672 hours of exposure to a 3.5% NaCl model corrosive medium. The experimental results have shown that the sealing procedure in the water medium enhances the corrosion protective ability of the Ce-O-Al coating primer probably due to the formation of a hydrate monolayer, which suppresses the access of corrosive species to the substrate surface. This inference was additionally confirmed by the subsequent chemical analysis by means of X-Ray Photoelectron Spectroscopy (XPS).

Keywords: Cerium oxide, Corrosion tests, Aircraft aluminum alloy

Acknowledgements: This study was supported by the Bulgarian National Science Fund, contract No. ДН19/1.

Durability of Cu, Ni and Cu/Ni modified AAO layers, formed on AA2024-T3 aircraft alloy

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Abstract: The resistance of Cu-AAO, Ni-AAO, combined Cu/Ni-AAO and referent AAO layers was evaluated by performing electrochemical measurements using Electrochemical Impedance Spectroscopy (EIS) and Linear Sweep Voltammetry (LSV). The reported results are obtained after 168 hours of exposure to a model corrosive medium. The obtained EIS spectra were submitted to analysis by fitting to a suitable model equivalent circuit. The results have shown that the elaborated films are sufficiently durable and can be used as self-standing coatings for the protection of the AA2024-T3 aluminum alloy. Besides, the performed subsequent cross-sectional Scanning Electron Microscopy (SEM) and Energy Dispersive X-Ray Spectroscopy (EDX) analyses have shown that the film thickness does not change after the AC-assisted Cu, Ni and Cu/Ni modifications of the already formed AAO layers.

Keywords: AAO layers, Ni, Cu and Cu/Ni incorporation, Spectral characteristics, Barrier properties, Hydrophobicity

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Effect of the thermal sealing on Ce-O-Al coating primers in concentrated phosphate solutions

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Abstract: Four different phosphate compounds were used for phosphatization of Ce-O-Al coating primers deposited on preliminary anodized AA2024-T3 samples. The obtained primers were submitted to systematic evaluations in order to acquire data for their color characteristics, hydrophobicity and corrosion protection properties. Further, X-Ray Photoelectron Spectroscopy (XPS) was employed, in order to define a correlation between the film composition and their properties. The respective corrosion tests were performed by exposure to a 3.5% NaCl solution for as long as 672 hours. Data were acquired by means of Electrochemical Impedance Spectroscopy (EIS) and Potentiodynamic Scanning (PDS). These data have shown that the phosphate treatments in concentrated solutions have a definite detrimental effect on the already formed coating primers.

Keywords: Anodized AA2024T3 aircraft alloy, Cerium conversion coatings, Thermal finishing, Phosphoric compounds

Acknowledgements: This study was supported by the Bulgarian National Science Fund (contract No. КП-06-М38/1)

Factors, governing the metal affinity and selectivity towards HDAC8 enzyme active site

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Abstract: Histones, which are the basic structural element of chromatine, can be acetylated and deacetylated. Disruption of the balance of acetylation and deacetylation of histones is connected with one of the mechanisms of development of cancer diseases. Inhibitors of histone deacetylases influence and provoke malignant cell cycle arrest and subsequent apoptosis. A different type of hydroxamic acids are one of the most promising drugs for treatment of different types of lymphomas and other cancer diseases. As a Zn-dependent inhibitor of histone deacetylases (HDACi), hydroxamic acids coordinate to the active site of a HDAC8 enzyme. The physicochemical and metal binding properties of hydroxamic acids, however, are not well understood.

Using DFT- methods, in this work we investigate the affinity of several biogenic divalent metal ions (Zn^{2+}, Fe^{2+} и Mg^{2+}) to a series of different hydroxamic acids with a potential use in oncology. Hydroxamic acids were modeled in the active site of HDAC8 enzyme. The functional B3LYP and the basis set 6-31+G(d) were used. The metal selectivity of the HDAC8 enzyme was assessed.

Keywords: HDAC8 enzyme, DFT study, metal affinity, selectivity, histones

Synthesis and characterization of new deep eutectic solvents

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Abstract: In recent years, deep eutectic solvents (DES) have attracted a lot of attention as a substitute for current toxic organic solvents and can be applied in many chemical processes such as extraction and synthesis. Development of new deep eutectic solvents for use in the isolation of valuable biologically active substances with significant benefits for the health, the environment and others are being investigated with increasing scientific interest. Deep eutectic solvents were prepared using menthol as hydrogen bond donor and different tertiary amines as hydrogen bond acceptors by varying the ratio of the two constituents. The DES obtained were analyzed using viscosimetry, IR and NMR. The potential of the DES for extraction and reextraction is evaluated with water solution of lactic acid. Deep eutectic solvents based on menthol and DOA (2:1), TOA (2:1) and TDDA (1:2) show highest results. For example in the extraction step in case with DOA we reach 85% and in the reextraction – 78% recovery.

The DES obtained are suitable for extraction of biologically active substances.

Keywords: deep eutectic solvents, menthol, amines, lactic acid, extraction

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Effect of the ultrasound assisted mixing of Zn active mass with different content of BSCCO (2212) ceramics additives

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Abstract: In recent years the rechargeable alkaline nickel-zinc batteries are of special interest due to their good electrochemical characteristics.The battery life is largely determined by the zinc electrode and especially – by the life of the anode mass. In our previous studies the use of B(Pb)SCCO 2212 ceramic as additive to the zinc electrode mass was investigated and its positive effect on the improvement of the electrochemical properties was confirmed. The aim of the present work is to optimize the amount of B(Pb)SCCO 2212 additive, as well as the conditions of the ultrasonic treatment by 20kHz, 1200w ultrasonic lab sonicator, Hangzhou Dowell Ultrasonic Tech Co., Ltd. Its phase composition and morphology were characterized by scanning electron microscopy (SEM) and X-ray diffraction (XRD). Zinc electrodes prepared by inserting a zinc paste with a different amount of additive B(Pb)SCCO 2212 (5, 7 and 10 wt. %) into the copper foam matrix were used as a current collector and zinc mass carrier. The conductivity of Zn electrodes was examined by electrochemical impedance spectroscopy.

Keywords: nickel-zinc electrode, B(Pb)SCCO 2212 ceramic additive, ultrasonic treatment

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Possibility of measuring the angular characteristics of the primary and secondary tracks of relativistic nuclear fragmentation by the nuclear track emulsion method

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Abstract: In this study application of the nuclear track emulsion technique (NTE) in radioactivity and nuclear fission studies is used. As an example, some results for determining the angular characteristics of primary and secondary tracks of relativistic fragmentation of ^{28}Si nuclei with a momentum of 4.5 A GeV/c are presented. Angular measurements only for α fragments are performed. The invariant mass approach based on angular emission measurements of secondary fragments and approximation of the momentum conservation per nucleon of the parent nucleus is applied.

Keywords: nuclear track emulsion technique, relativistic fragmentation, angular measurements

Search for decays of the unstable nuclei in dissociation of relativistic nuclei ^{14}N

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Abstract: Analysis to determine contribution of decay of the unstable ^{8}Be and ^{9}B nuclei Hoyle 3α-state to dissociation of ^{14}N → 3He (+H) are presented. As the research material, layers of nuclear track emulsion longitudinally exposed to 2.9 A GeV/c ^{14}N nuclei with at the JINR Nuclotron. Under the assumption that the He and H fragments retain momentum per nucleon of the primary nucleus, these unstable states are identified by the invariant mass calculate from the emission angles of the fragment

Keywords: nuclear emulsion, relativistic nuclei, Hoyle state

Correlation in formation of ^{8}Be nuclei and α-particles in fragmentation of relativistic nuclei

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Abstract: In the events of peripheral dissociation of relativistic nuclei in the nuclear track emulsion, it is possible to study the emerging ensembles of He and H nuclei, including those from decays of unstable ^{8}Be and ^{9}B nuclei, as well as the Hoyle state. These extremely short-lived states are identified by invariant masses calculated from the angles in 2α-pairs, 2αp- and 3α-triplets in the approximation of conservation of momentum per nucleon of the primary nucleus. In the same approach, it is possible to search for more complex states. The correlation between the formation of ^{8}Be nuclei and the multiplicity of accompanying α-particles in the dissociation of relativistic ^{16}O, ^{22}Ne, ^{28}Si, and ^{197}Au nuclei are shown. On the above basis, estimates of this correlation are presented for the unstable ^{9}B nucleus and the Hoyle state. The enhancement in the ^{8}Be contribution to dissociation with the α-particle multiplicity has been found. Decays of ^{9}B nuclei and Hoyle states follow the same trend.

Keywords: nuclear track emulsion technique, unstable nuclei, α-particle multiplicity, Hoyle state

Influence of the beam power on the microstructure and mechanical properties of electron beam welded joints of copper and stainless steel

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Abstract: The electron beam welding (EBW) is one of the few technologies that allow welding of materials with quite different thermophysical characteristics. A problem during the welding of heterogeneous materials is the appearance of defects, which are due to the occurrence of intermetallic phases and lead to deterioration of the mechanical properties of the joint and deterioration of its performance.

This paper presents the results of the study of the crystallographic structure and the mechanical properties of electron beam welded samples of copper and stainless steel. The samples were made with different source power, changing the beam current. The specimens were examined by X-ray diffraction, an optical microscopy and a scanning electron microscopy. They are also subjected to mechanical tests, such as hardness and tensile strength measurement.

This work was supported by the Bulgarian National Scientific Fund under Grant КП 06-Н47/6.

Keywords: electron beam welding, dissimilar materials, intermetallic phases

Physicochemical and magnetic study of Dy-123 and Gd-123 bulk samples doped with nano Fe_3O_4

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Abstract: The $ReBa_2Cu_3O_{7-\beta}$ or Re-123 (Re = rare earth elements such as Y, Eu, Gd, Dy, Nd, Sm, Ho, Er) is material known as superconductor with high – Tc. In our study we synthesized bulk ceramic composite Gd123 and Dy123 by a solid-state reaction with starting stoichiometry of 1:2:3 (Gd:Ba:Cu) and 1:2:3 (Dy:Ba:Cu). The reagents were Gd_2O_3, Dy_2O_3, $BaCO_3$ and CuO with analytical grade purity and were mixed by grinding in an agate mortar. The resulting mixture was calcined at 900 ^oC in a flowing oxygen atmosphere for 21 h. The calcined powders were reground and sintered again at 940 ^oC for 21 h with additional annealing at 450 ^oC in an oxygen atmosphere for 2 h. Further, the powders obtained were reground, mixed with 2 wt. % of the nano Fe_3O_4 powder, homogenized and then pressed into tablets at 4 MPa. The bulk samples were sintered at 930 ^oC in a flowing oxygen atmosphere for 24 h and annealed at 450 ^oC in an oxygen atmosphere for 4 h. The magnetic properties of the samples were investigated.

Keywords: superconductors, nanoparticles, magnetite

Material and Optomechanical Characteristics of Polymers in Optical Design

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Abstract: Polymers are preferred materials not only in consumer but in high quality optics for their excellent transparency in visible and near-infrared region, much lower weight in comparison to glass, high impact resistance, configuration flexibility, safety and low production costs because of the injection molding technology. Most important optical characteristics of plastics are refractive indices and spectral transmission at selected wavelengths as well as the consequent dispersive parameters. Precise refractometric data of various types of polymers has been obtained by means of different measuring techniques at many wavelengths between 406 and 1320 nm and temperature influence has been studied.

In addition to the optical requirements, polymers should be selected in the design on basis of their material and mechanical properties. Rigidity of solids ensures their impact and shatter resistance and is a factor that determines safety in applications. Stress-strain analysis requires knowledge of elastic moduli at static or dynamic loading. In this report results of acoustic measurements of different types of polymers are presented. Dynamic Young's and shear moduli, as well as Poisson's ratio have been determined on base of ultrasonic investigations. Some optomechanical, thermo-optical, and thermo-mechanical parameters are calculated as deflection at constant thickness and constant mass, linear thermal expansion coefficients as well as thermal stress due to temperature differences. Presented results are compared to literature data for principal polymers.

Keywords: optical polymers, dynamic elastic moduli, optomechanical parameters, ultrasound velocities

Impedimetric response of phospholipid Langmuir-Blodgett films to methanol vapors

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Abstract: Aimed chemical biosensor applications, we have experimentally studied the impedimetric response of Langmuir-Blodgett (LB) nano-thin molecular monolayers of phospholipid dipalmitoyl-phosphatidyl-ethanolamine (DPPE) to methanol vapors. DPPE LB films were deposited from an aqueous subphase on planar interdigital electrodes of surface acoustic-wave resonator device. The ability of such sensing LB films with a thickness of about 3 nm to detect methanol vapors at ambient temperature was estimated by measurements with electrochemical impedance spectroscopy (EIS) in the frequency range 0.1 Hz – 100 KHz of the applied electric field. DPPE LB films were exposed to methanol vapors at concentration in the range from 50 to 200 mg/dm3. Being in contact with methanol vapors, a significant decrease in the resistance of the studied LB films was observed. This effect was reversible. The results show also a clear change in dielectric properties of the DPPE LB molecular monolayers upon methanol vapors.

Keywords: complex electrical impedance spectroscopy; gas detection; Langmuir-Blodgett films; methanol vapors; phospholipids keywords

New data on the pteromalid fauna (Hymenoptera: Pteromalidae) associated with foliage of the Norway spruce, *Picea abies* (L.) H. Karst., from Bulgaria

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Abstract: Having high economic and ecosystem value in forestry, Norway spruce, Picea abies, has been in the focus of many entomological studies. However, these investigations have dealt mostly with the spruce bark beetles and their parasitoids or fungal pathogens with no attention on the parasitoid communities inhabiting the tree crown. Here we present new data on the pteromalid fauna established by sampling in the foliage of P. abies growing in the Western Rodope Mts and Stara Planina Mts. The insects were swept from the lowest branches of the trees in forest stands situated between 1014 and 2155 m above sea level. We identified 16 species of family Pteromalidae belonging to six genera – Coelopisthia (one species), Cyrtogaster (one sp.), Mesopolobus (three spp.), Pachyneuron (two spp.), Stenomalina (two spp.), Trichomalus (seven spp.). Among them no one has been previously reported as Norway spruce associated. The relative abundance of these species in our samples and their possible trophic relation to the P. abies phytophagous inhabitants are presented and discussed.

Keywords: Norway spruce, Picea abies, Pteromalidae, foliage, Bulgaria.

Zoogeographical subdivision of Bulgaria based on the distribution of herpetofauna

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Abstract: The aim of the study was to propose a zoogeographical subdivision of the territory of Bulgaria based on the distribution of the amphibians (Amphibia) and reptiles (Reptilia). The following tasks have been performed: 1. An updated list of the taxonomic composition of the Bulgarian herpetofauna has been prepared. 2. Hundreds of new localities of amphibians and reptiles have been registered, which significantly expands the knowledge about the spread of certain taxa in Bulgaria. 3. A classification of Bulgarian herpetofauna based on the faunistic elements and sub-elements and a classification of ecological groups of fauna and faunistic copmlexes by using all taxa are proposed. 4. A comprehensive list of endemic and sub-endemic taxa in Bulgarian herpetofauna has been prepared. Specific role of endemic and relict species for the zoogeographical regionalization has been determined.

Based on the current spread of amphibians and reptiles in Bulgaria and following the principles and methods of biogeographical regionalization, a new zoogeographical subdivision and a new zoogeographical map of Bulgaria have been proposed. Five zoogeographical zones and 24 zoogeographical regions are distinguished. A specific ratio between the representatives of various faunistic complexes and certain indicator taxa of herpetofauna are distinctive for every zone and some of the regions.

Keywords: Amphibia, Reptilia, faunal elements

State and perspectives of citizen science for invasive alien species in Bulgaria

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Abstract: The article presents an analysis of the existing Citizen science (CS) initiatives related to invasive alien species (IAS) in Bulgaria, conducted in the framework of project KP-06-COST-14 funded by NSFB and COST Action CA 17122 (Alien CSI). Results show relatively poorly developed CS in Bulgaria. Despite the numerous projects dedicated to IAS, only three of them were related to IAS CS: "Danube-IASapp", "State and perspectives of citizen science for invasive alien species in Bulgaria" and "Increasing understanding of alien species through citizen science (Alien-CSI): Approaches to citizen science, data management and standards (Bulgaria)". Only one CS online platform "Citizen science for invasive alien species in Bulgaria" is available. Few others have a partial focus on alien species (Smartbirds, Ednodurvo, databases about flora, hunting, and fishing, etc.). The IAS awareness of the general public is at an unsatisfactory level. The possibilities for rising involvement of various stakeholders in the IAS SC initiatives in Bulgaria are discussed.

Keywords: biodiversity, awareness, projects, web platforms

Assessment of the motivation for participation in citizen science initiatives for invasive alien species in Bulgaria

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Abstract: The article presents an analysis of the motivation for participating in Citizen Science (CS) initiatives for invasive alien species (IAS) of professionals involved in the management and use of biological resources and general public. The motivation of the interviewees was assessed through a questionnaire containing questions about: Level of awareness of the existing opportunities for CS initiatives related to biodiversity in Bulgaria; Experience in initiatives for monitoring or registration of plants and animals; Reasons that would motivate or disappoint the respondents to participate in the CS; The most appropriate way for respondents to participate in CS initiatives, as well as the most appropriate form of raising their awareness of IAS. The results indicate that the main reasons for the failure to participate in CS initiatives was the lack of accessible information on the problems posed by the IAS and tools and initiatives for the IAS CS in Bulgaria. Possible measures and policies for involvement of various stakeholders in the IAS SC initiatives in Bulgaria are discussed.

Keywords: data analysis, biodiversity, invasive alien species, citizen science

Soil magnetic susceptibility properties as indicators of heavy metals pollution in Bobov dol Thermal Power Plant area

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Abstract: Bobov Dol TPP is located in the southwestern part of Bulgaria, near the town of Bobov Dol. It was commissioned in 1973 - 1975 with three 210 MW units. All the coal used in the power plant are mainly high ash coals, which consequently leads to the release of significant quantities of ash during their combustion. This cause a significant pressure on ecological status of the soil cover in the plant area. Recently has been proved that the magnetic susceptibility of polluted soils increases due to their enrichment with different metal oxides. Because of that the main goal of this research is to be analyzed the magnetic susceptibility values in the soils around Bobov dolo TPP as an indicators of heavy metals pollution. More than 60 measurements of the soil magnetic susceptibility were conducted around Bobov dol TP. This measurements were evenly distributed around the Power plan in accordance with the established grid network. The value of the magnetic susceptibility range between 1.9358x10-6si and 475.233x10-6si. The higher values of the magnetic susceptibility are observed around the Bobov Dol TPP and along the transport line that transport the waste from the burning process to the nearby dump site. Independent chemical analyses of selected samples from the study area were made to confirm the connection between the magnetic susceptibility values and the presents of heavy metals in the soils.

Keywords: magnetic susceptibility, heavy metals, contaminated soils.

Constructing of an optimal portfolio on the Bulgarian Stock Market using hybrid genetic algorithm for Pre and Post Covid-19 periods

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Abstract: In the aftermath of the Covid-19 pandemic, global financial markets have seen growing uncertainty and volatility and as a consequence, precise prediction of stock price trend has emerged to be extremely challenging. In this background, we propose two time frameworks wherein the Hybrid genetic algorithm are used to set up an optimal portfolio included ten stocks traded in Bulgarian stock market during pre and post Covid-19 periods. The fitness function value of constructed Hybrid genetic algorithm during pre and post Covid-19 periods were $-7.194e^{-04}$ and $-7.014e^{-04}$, respectively. The estimated nonzero portfolio weights during pre Covid-19 period were ALUM (0.025), HNVEK (0.253), HVAR (0.378), MSH (0.204), NEOH (0.038), and SFT (0.102) while during post Covid-19 period were AGR (0.003), ALUM (0.015), HNVEK (0.272), HVAR (0.460), MSH (0.142), NEOH (0.057), SFT (0.031), and SPH (0.021). The corresponding expected portfolio return and portfolio risk during pre Covid-19 period were $9.825e^{-03}$ and $7.163e^{-04}$ while during post Covid-19 period were $9.656e^{-03}$ and $6.895e^{-04}$, respectively.

Keywords: Hybrid genetic algorithm, portfolio optimization, stocks, Covid-19, Bulgaria

Air pollution during Covid-19 pandemic: Exploration in the Bulgarian city of Stara Zagora using interrupted time series ARMA model

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Abstract: The Covid-19 global pandemic has likely affected air quality due to extreme changes in human behavior. The aim of this paper is to explorate the consequence of the Covid-19 Pandemic on the air quality improvement in the Bulgarian City of Stara Zagora using Interrupted Time Series ARMA Model. After adjusting by meteorology and Sunday effect, the results confirm for positive and significant effect immediately after the state of emergency and negative and significant trend in the levels for $PM_{2.5}$ and O_3. For the remaining CO and NO series of data, the estimate of the time series slope, i.e. the expected change in the concentration associated with a time unit increase is positive and significant. The temporal dynamics for each time series are reported by the ARMA coefficients: an ARMA(2,3) structure is estimated for O_3 and NO, and an ARMA(1,1) is the best choice for CO while AR(5) for $PM_{2.5}$. Understanding howair pollution is affected during Covid-19 pandemic will provide important clues regarding health effects and control of emissions.

Keywords: ITS ARMA model, air pollution, Covid-19, Bulgaria

The Importance of Biological Databases in modeling of structure-activity relationship

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Abstract: Biological databases play a key role in bioinformatics research and applications. Many databases are known that contain different types of information: DNA, sequences of proteins, molecule structures and others. They give researchers access to large amount of biological data. The aim of the current research is to present a brief overview of major sequence databases and portals currently available and underlines open problems and future trends. The article presents examples from the use of various biological databases for the study of opioid and cannabinoid compounds. This investigation gives a brief description of the importance of biological databases and sequence analysis in bioinformatics research.

Keywords: biological databases, sequences of proteins, bioinformatics, computer modeling, structure-activity relationship

Acknowledgements. This work was supported by the project "Information and Communication Technologies for Unified Digital Market in Science, Education and Security" of the Scientific Research Center, NIS-3317, funded by the Ministry of Education and Science, Republic of Bulgaria.

Computer modeling and model selection in bioinformatics

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Abstract: Computer modeling and mathematical models are most frequency used tools in bioinformatics. They can be very useful in analysis of biological systems, predicts the outputs of biological processes, or to develop new experimental cases for some bioinformatics problem. The mathematical modelling in bioinformatics is concerned with the question of the best model choice. Model selection is a process of choosing a model from a set of candidate models, which will provide the best balance between goodness of fit of the data and complexity of the model. The aim of the presented work is to show the basic methods for modelling and criteria for model selection in bioinformatics, in order to develop a reliable approach for prediction of different relationships in bioinformatics. Also, we will briefly describe the application of computer modeling in analysis of biological structures, such as proteins.

Keywords: Bioinformatics, computer modeling, regression, model selection, proteins

Automatic Frequency Release Realized by Programmable Logic Controller UNITRONICS V1210

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Abstract: Automatic frequency release is one of the main automations against accidents in the electricity system of Bulgaria. The article presents an experimental methodology, through which is simulated automatic frequency release by using a programmable logic controller UNITRONICS V1210. The obtained experimental results and the formulated conclusions are presented in detail in the article. The developed experimental methodology is in accordance with the current regulations in the field of electricity in Bulgaria. The obtained results and conclusions can be used by the Electricity System Operator and for students' education in the field of electrical engineering.

Keywords: Automatic Frequency Release, Programmable Logic Controller, Electricity System.

An Android-based mobile application giving information for weather in real-time

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Abstract: Nowadays mobile devices are very popular in the work and life of people. Many software applications of various mobile operating systems like Android, Symbian and iPhone are available in online software stores. The most widely used mobile operating system is Android. It is a very popular open source system for mobile phone and tablet personal computer. The Android Studio Integrated Development Environment (IDE) is used for the development of the Android application. In the present work, we focus on designing a new smart Android-based mobile application giving information for weather in real-time. This application is expected to be useful for customers in terms of time and cost.

Keywords: Android, Mobile Operating system, Mobile device, iPhone, software

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Smart home automation based on Z-Wave technology

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Abstract: With the rapid expansion of the Internet of Things, more devices and objects are network connected. Many people want to have full control over their home communications and this leads to the growth of the home automation industry. Z-Wave is one of the most popular technology used to perform smart home and office automation services. It is uses a controller to manage and control all devices. The main purpose of this study is to design and investigate a Z-Wave home automation system. The smart home built with Z-Wave technology is useful for consumers because it will save energy - no lights or AC will be left on when they are not at home.

Keywords: Internet of Things, Home Automation, smart home, z-wave

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Optimization of the microbial production of 2,3-butanediol from glucose by *Bacillus licheniformis* 24

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Abstract: 2,3-Butanediol (2,3-BD) is a platform chemical with remarkable industrial applications in rubber and methacrylate synthesis, antifreeze and liquid fuel additive. The aim of the present investigation is to determine the capabilities of Bacillus licheniformis 24 as 2,3-BD producer, with intention of its industrial application. As non-pathogenic, having endocellulase activity, and converting high amounts of glucose and lignocellulose sugars to 2,3-BD, the strain appears as very promising. By applying Plackett-Burman design, and response surface methodology through central composite design (CCD), complex media and process parameter optimization was conducted. Thus, among ten studied factors of medium content, four components were evaluated with a significant positive effect on 2,3-BD formation. Their optimal values for 2,3-BD production (yeast extract - 13.38 g/L, tryptone - 6.41 g/L, K_2HPO_4 - 4.2 g/L, and $MgSO_4$ - 0.32 g/L), as well as the optimal temperature (37.8 °C), pH (6.23) and aeration rate (3.68 vvm), were predicted by CCD experiments and validated in a series of batch processes. Thus, in optimized batch fermentation of 200 g/L glucose was obtained 91.23 g/L 2,3-BD, with overall productivity of 1.94 g/L/h, and yield of 0.488 g/g. To revealed the maximum tolerance of B. licheniformis 24 to 2,3-BD, a fed-batch fermentation was carried out. The obtained 138.8 g/L 2,3-BD with yield of 0.479 g/g and productivity of 1.16 g/L/h ranks the strain among the best 2,3-BD producers.

Keywords: 2,3-Butanediol, Bacillus licheniformis 24, optimization.

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Results of the pedagogical observation and survey of students, teachers and students-future teachers who have participated in physics teaching with using modern educational technologies

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Abstract: The use of modern educational technologies in the physics teaching in the school education in Bulgaria is one of the current methodological problems. In the article are presented the results of the pedagogical observation and survey of students from 5th, 6th, 7th, 8th, 9th and 10th grade, teachers and students-future teachers who have participated in physics teaching with using modern educational technologies. The pedagogical observation and survey were conducted by the author of the article in the period 2015/2016 – 2019/2020 school year. The qualitative analysis of the results is presented in detail in the article. The formulated conclusions are also presented in the article. Modern educational technologies are an important innovative methodologically tool for improving the process of teaching and learning and for increasing the effectiveness of the physics teaching.

Keywords: Modern Educational Technologies, Physics Teaching, Pedagogical Observation and Survey.

Multimedia technologies in physics teaching

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Abstract: The use of multimedia technologies in the secondary school physics teaching is a new, relevant and significant trend in Bulgarian modern education. In the article are presented methodological possibilities for using multimedia technologies in the educational process in physics in the secondary school. The article gives specific, objective and reasoned answers to the methodological questions: When, where and how can be used multimedia technologies in the physics teaching? The multimedia technologies are innovative educational resources. The use of multimedia technologies complements, expands and diversifies the traditional methods and tools of physics teaching. Their application is related and aimed to increasing the effectiveness of the secondary school physics teaching.

Keywords: Multimedia Technologies, Physics Teaching, Secondary School.

An Integrated Approach to Teaching the Topic *Light and Colors* from the Seventh Grade Physics Syllabus

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Abstract: The paper analyzes the possibilities of integrating the knowledge about the physical nature of colors and the knowledge about the color as one of the basic artistic means in painting. The employment of real and virtual experiment provides the opportunity to introduce and compare on the qualitative level two different models of gaining color perception: 1) obtaining light in random color by mixing in different proportions the light beams of three primary colors: red, green and blue and 2) obtaining new colors by the mechanical mixing of paints, as in this model the three primary colors are red, yellow and blue. Specific attention is paid to the practical application of the discussed models. The importance of the integrated lessons for the formation of an overall world picture in the students' minds is underscored.

Keywords: physics education, painting, light, color, integrated approach

Cultivation, Isolation and Identification of Thermophilic Microorganisms and their Use for Redox Processes in Fuel Cells

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Abstract: Thermophilic microorganisms can survive at extremely high temperatures and natural thermal springs are one of their main habitats. Bulgaria is among the leaders in Europe in the number of thermal mineral waters with varying temperatures (from 45 to 100 °C) and pH. The rich thermophilic bacterial diversity of those springs has high potential for a variety of applications, including their usage for generation of electricity in microbial fuel cells (MFCs). The present investigation aims to apply thermophilic bacteria or bacterial consortia from the thermal spring "Rupite" in MFC for different redox processes. The study includes critical analysis of the methods for cultivation of microorganisms or microbial communities from their natural sources and a discussion of their potential application generating electricity in MFCs. Morphological, cultural, physiological, and biochemical tests for identification of the isolated microorganisms are also conducted.

Experiments using the cultivated microorganisms in MFC are carried out and the results are presented as well.

Keywords: Thermophilic microorganisms, Isolation, Identification, Cultivation, Microbial Fuel Cells

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Study of novel carbon materials for sulphur oxidation/reduction reactions

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Abstract: The current research work studies the oxidation of S^{2-} and SO_3^{2-} using novel electrocatalyst carbon materials. The electrocatalysts were characterized by phisicochemical studies (SEM, X-ray diffraction, XPS and BET) as well as electrochemical tests. The polarization curves were recorded of electrodes incorporating higher fullerenes and C_{60}/C_{70}. The experiments showed that higher fullerenes and C_{60}/C_{70} fullerene catalysts convert SO_3 to SO_4 electrochemically. The oxidation products do not poison the electrodes. It is ascertained that higher fullerenes play a major role in the synthesis of more effective catalysts. The electrodes built by incorporating catalysts containing higher fullerenes and manganese oxides are shown as most promising in the effective electrochemical decontamination of industrial and natural waste water.

Keywords: high fullerenes, C_{60}/C_{70}, DWCNTs

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Membraneless Fuel Cells for Remediation of Paper-pulp and Nitrate Wastewaters

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Abstract: Statistics show that each year the European pulp and paper industry generate approximately 11 million tonnes of waste, and the number increases every year. Nitrate-contaminated wastewaters – by-product from the agriculture industry and from the decomposition of organic wastes in the sewage systems of cities are another persistent pollutant that needs to be addressed. The ongiong search for reneable energy sources has lead to a rapid development of the fuel cells for environmental purposes that can give a solution to both problems – wastewater treatment and energy harvesting.
The present research is dedicated to recuperation of cellulose-paper and nitrate polluted fluxes in the anodic and cathodic compartments, respectively, in a membraneless fuel cell of our own design. The core of the fuel cell is a cylindrical tube of activated carbon, playing the role of both electrode and a membrane. Different preliminary hydrolysis processing of cellulose pulp wastewater from "Ekobulhart", Pazardzhik, Bulgaria were conducted with xylose being the main product of the process. The hydrolysates obtained were then used in abiotic and microbial fuel cells (MFC). Pseudomonas putida was chosen and used as microbial strain for organic decomposition in the MFC. Model solutions with xylose were also investigated and the results are compared with the actual pulp hydrolysates.

Keywords: Membraneless fuel cell, cellulose pulp wastewater, nitrates, Pseudomonas putida

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Structured Zirconium Catalyst for Electrochemical Oxidation of Sulfide Ion

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Abstract: Sulphide ions in industrial and natural effluents are toxic and disturb the ecological balance. The aim of the present research is to develop a structured ZrO_2 catalyst for their oxidation to sulphates, which are environmentally friendly products and present in a wide concentration range in natural waters. The surface of the catalyst was characterized by iodine adsorption and examined by XRD, BET and SEM. From the obtained catalytic mass are made bilaterally coated electrodes on a stainless steel conductor. The studied electrodes have a geometric area of 1 cm^2. Electrochemical studies were performed for oxidation of sulfide ions in a model electrolyte - 60 mg/l S^{2-} and 18 g/l NaCl. The electrodes have been designed and optimized in terms of the amount of catalyst and binder (PTFE). The electrodes were examined electrochemically by cyclic voltammetry, galvanostatic measurements and Tafel slopes. The electrodes containing 40 mg/cm^2 of the catalytic mass in the electrode showed a lower potential overvoltage in galvanostatic measurements.

Keywords: electrocatalytic oxidation, sulfide ions, zirconium catalyst

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Ab initio study on development of a BOD/COD biosensor

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Abstract: Microbial electrochemical systems utilize the electrochemical interaction between microorganisms and electrode surfaces to convert chemical energy into electrical energy, offering a promise as technologies for wastewater treatments. Recently, growing research attention has been devoted to the development of microbial electrochemical sensors as biosensing platforms. The aim of our study is to develop and optimize the design of microbial fuel cell (MFC), which provides stable and reproducible information about the organic load of wastewater (BOD and COD) in real time. From several carbon-based materials tested, carbon felt (CF) was selected as the most appropriate electrode material for formation of electroactive biofilm (EAB), required for the stable performance of the developed biosensors. New 3D-printed electrochemical cells were designed and long-term experiments for EAB formation on the selected CF electrodes were carried out at applied potential by using activated sludge and wastewater from Wastewater Treatment Plant. In parallel, a correlation between BOD standards and measured COD values was established. Construction of microbial fuel cell for BOD / COD tests is in a progress.

Keywords: Microbial Fuel Cell, biosensor, BOD, COD, wastewater

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NiW- and NiMo-modified graphitized paper as potential cathodes for Microbial Electrolysis Cells

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Abstract: Microbial electrolysis cell (MEC) has been recently recognized as an emerging technology for hydrogen production. Finding cost-effective cathode materials with high electocatalytic activity for the hydrogen evolution reaction (HER) at neutral pH is a key factor for the practical application of MEC. In this study, precious-metal-free cathodes were produced by electrodeposition of NiW and NiMo on a graphitized paper. The electrochemical performance of the produced materials in neutral phosphate buffer solution was investigated by Linear Sweep Voltammetry (LSV), Chronoamperometry (CA), and Electrochemical Impedance Spectroscopy (EIS). Both electrodeposits exhibit similar electrocatalytic activity towards HER, higher than that of the bared graphitized paper. This gives reason for further evaluation of the developed materials as cathodes in MECs.

Keywords: NiW and NiMo electrodeposits, HER, electrocatalytic activity, cathodes, Microbial Electrolysis Cell.

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Electrochemical performance of nanotube sodium titanate in post Li- ion cells

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Abstract: Lithium ion batteries are recognized as the most effective technology for energy storage with a variety of applications in different technological sectors. Irrespective of this achievement, they have some major disadvantages associated with their safety, cost and toxicity. The modern requirements for introducing more effective systems for energy storage require the searching of new approaches to develop safe batteries with higher energy density and lower costs. The present study provides the data on the electrochemical performance of nanotube sodium titanate as an anode material in Li- ion cells. The electrochemical performance of sodium titatane is first examined in half ion cells versus metallic Li anode and using two electrolyte compositions: lithium electrolyte ($LiPF_6$) including 1 M solution of $LiPF_6$ in PC:DMC and lithium electrolyte containing 0.5 M $Li(TFSI)_2$ in diglyme. The electrochemical activity of sodium titanate as an anode material is further tested in full hybrid ion cell. This cell is constructed by a pairing sodium titanate as an anode and Mn_5O_8 as a cathode.

Keywords: lithium ion batteries, sodium titanate

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Author Index

E

F

G

H

I

J

K

N

O

P

R

S

T

U

V

Y

Z