АКАДЕМИЈА НАУКА И УМЈЕТНОСТИ
РЕПУБЛИКЕ СРПСКЕ

СРПСКА АКАДЕМИЈА
НАУКА И УМЕТНОСТИ

ALMA MATER EUROPAEA
THE UNIVERSITY FOR LEADERSHIP

ТЕХНИЧЕСКИ УНИВЕРСИТЕТ
ГАБРОВО

United Nations
Educational, Scientific and
Cultural Organization

State Commission of
Bosnia and Herzegovina
for UNESCO

XVII МЕЂУНАРОДНИ НАУЧНИ СКУП

САВРЕМЕНИ МАТЕРИЈАЛИ 2024

ПРОГРАМ РАДА И
КЊИГА АПСТРАКАТА

XVII INTERNATIONAL SCIENTIFIC CONFERENCE

CONTEMPORARY MATERIALS 2024

PROGRAMME AND
THE BOOK OF ABSTRACTS

Бања Лука, 5–7. септембар 2024. године
Banja Luka, September 5th to 7th, 2024

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ОРГАНИЗАТОР НАУЧНОГ СКУПА

Академија наука и умјетности Републике Српске

СУОРГАНИЗАТОРИ

Српска академија наука и уметности
Alma Mater Europaea
Технички универзитет Габрово

ПОКРОВИТЕЉ НАУЧНОГ СКУПА

Министарство за научнотехнолошки развој, високо образовање и информационо друштво

ОДРЖАВАЊЕ СКУПА СУ ПОМОГЛИ

УНЕСКО
Универзитетски Клинички центар Републике Српске
Хемофарм Стада Група
Комора доктора медицине РС

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ORGANIZER OF THE CONFERENCE

Academy of Sciences and Arts of the Republic of Srpska

COORGANIZERS

Serbian Academy of Sciences and Arts
Alma Mater Europaea
Technical University of Gabrovo

UNDER THE PATRONAGE OF

Ministry for Scientific and Technological Development, Higher Education and Information Society

THE SCIENTIFIC CONFERENCE HAS BEEN SUPPORTED BY

UNESCO
University Clinical Center of Republic of Srpska
Hemofarm Stada Group
The Republic of Srpska Medical Association

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Prof. Pero Dugić, Ph.D. (Banja Luka)
Prof. Dubravka Marković, Ph.D. (Serbia)

ЧЕТВРТАК, 5. СЕПТЕМБАР 2024. ГОДИНЕ

- Долазак и смјештај пленарних предавача у хотелу „Босна” у Бањој Луци
- Долазак и смјештај учесника научног скупа који живе изван Бање Луке у хотелима по избору

ПЕТАК, 6. СЕПТЕМБАР 2024. ГОДИНЕ

08.30 Регистрација учесника научног скупа (АНУРС)
09.00 Отварање конференције
09.20 Пленарна предавања
13.30 Постер презентације
14.30 Дискусија
Затварање конференције

СУБОТА, 7. СЕПТЕМБАР 2024. ГОДИНЕ

УНЕСКО ПАРТИЦИПАЦИЈСКИ ПРОГРАМ 2024–2025

Пројекат *Регионална сарадња за изградњу равноправног, одрживог и зеленог друштва кроз оснивање лабораторије за испитивање ефикасности соларних електрана и семинари на тему околина, друштво и економски изазови*

Округли сто
„Утицај врсте соларних панела на енергетску ефикасност соларних електрана“

9.00–13.00 Презентација учесника из Словеније, Хрватске, Босне и Херцеговине и Црне Горе
13.00–14.30 Ручак
14.30–18.30 Презентације учесника из Србије, Бугарске и Сјеверне Македоније
19.00 Вечера

THURSDAY, SEPTEMBER 5, 2024.

- Arrival of the plenary speakers and accommodation in the hotel „Bosna" in Banja Luka
- Arrival of the participants and accommodation in the hotels optionally

FRIDAY, SEPTEMBER 6, 2024.

08.30 Registration of the participants in the ASARS
09.00 Opening of the Conference
09.20 Plenary session
13.30 Poster presentations
14.30 Discussion
Closing ceremony

SATURDAY, SEPTEMBER 7, 2024

UNESCO PARTICIPATION PROGRAMME 2024–2025

Project *Regional Cooperation for Building Equitable, Sustainable and Greeners Ocieties Through Establishing Laboratory for Measuring Solar Energy Efficiency and Seminars on Environmental, Social and Economic Challenge*

Round table
"The Impact of Type of Solar Panels on Energy Efficiency of Solar Plants"

9.00–13.00 Presentations of speakers from Slovenia, Croatia, Bosnia and Herzegovina and Montenegro
13.00–14.30 Lunch
14.30–18.30 Presentation of speakers from Serbia, Bulgaria and North Macedonia
19.00 Dinner

ПЕТАК, 6. СЕПТЕМБАР 2024. ГОДИНЕ

FRIDAY, SEPTEMBER 6, 2024

СВЕЧАНО ОТВАРАЊЕ СКУПА
OPENING CEREMONY
(09.00 – 09.20)

- Скуп ће отворити и учеснике поздравити академик Рајко Кузмановић, предсједник АНУРС-а

  Academician Rajko Kuzmanović, president of ASARS will give an opening speech

- Поздравни говор министра за научнотехнолошки развој, високо образовање и информационо друштво доц. др Жељка Будимира

  Welcome speechs – Minister of Scientific and Technological Development, Higher Education and Information Society, Željko Budimir, Ph.D.

- Поздравно обраћање гостију

  Welcome speeches of the guests

РАДНИ ДИО СКУПА
WORKING SESSION
(09.20 – 14.30)

ПЛЕНАРНА ПРЕДАВАЊА
PLENARY SESSION
(09.20 – 13.20)

9.20 – 9.40 Milan Damnjanović
Symmetry and Band Topology in Low-dimensional Crystals

9.40 – 10.00 Nenad Filipović
STRATIFYHF Platform: Artificial intelligence-based decision support system for risk stratification and early detection of heart failure in primary and secondary care

10.00 – 10.20 Spomenka Kobe
Sustainable Processing of Innovative Rare-Earth Magnets

10.20 – 10.40 Dragomir Vassilev, Plamen Tsankov
Climate Adaptation Activities for Higher Resilience in the Gabrovo Mountain Region

10.40 – 11.00 Zandra B. Rivera, Domenico Guida
Autonomous Mechatronic Platform AgriRover for Precision Agricultural Applications in Developing Countries

11.00 – 11.20 Coffee Break

11.20 – 11.40 Ljubomir Majdandžić
Synergy in Food and Energy Production - Agricultural Solar Power Plants

11.40 – 12.00 Duško Dudić
Depositing electricity in Zeolite/water/oil electrolytes

12.00 – 12.20 Sanja J. Armaković
Exploring the Role of Polymers in Water Purification: Experiments, Modeling, and Machine Learning

12.20 – 12.40 Nikolina Makivić
Reversible Proton-coupled Charge Storage in Nanostructured Amorphous and Anatase TiO_2

12.40 – 13.00 Dijana Jelić
Kinetics of Solid State Reactions: Software Approach and Application

13.00 – 13.20 Dušanka Marčetić
Linear Polymer as a First Step Toward Polymeric Material

ПОСТЕР ПРЕЗЕНТАЦИЈЕ
POSTER SESSION

(13.30–14.30)

1. Momir Đurović
   Is Future determined by Science and Research?

2. Ivanka Milošević, Zoran Popović, Milan Damnjanović
   Carbon Nanotubes as Thouless Charge Pumps

3. Zoran P. Popović, Milan Damnjanović, Ivanka Milošević
   Mechanical Deformation of Carbon Nanotubes
   Followed by Local Electron Transfer

4. Bogdan Milićević, Nenad Filipović
   Overview of the Electrophysiological
   Models for the Left Ventricle Simulations

5. Snježana Dupljanin, Olivera Šašić,
   Zoran Lj. Petrović, Dragoljub Mirjanić
   Cross Sections and Transport Characteristics
   of Electronsin Ammonia (Nh_3)

6. Ema Begović, Nevena Jokić, Gorana Mrđan,
   Suzana Apostolov, Đenđi Vaštag, Borko Matijević
   Study of Intermolecular Interactions of Selected Asymmetrical
   Thiocarbohydrazone Derivatives

7. Darko Janković, Martin Ochsenhofe, Marina Simović Pavlović, Katarina Nestorović, Svetlana Stojnović, Damir Jerković, Darko Vasiljević
   Impact Analisis of High-Speed Projectiles on Granular Material

8. Ivan Petronijević, Dragana Cerović, Slavica Maletić, Marija Šuljagić, Filip Marinković, Dušan Popović, Duško Dudić
   Dielectric Properties of IPP/Paraffin Wax Blends
   Treated In LICL Water solution

9. Bojan Gorančić, Marija Mitrović, Regina Fuchs-Godec, Milorad Tomić
The Inhibitive Effect of Thymus Serpyllum Extract on Corrosion of Steel in Chloride Rich Environment

10. Maria Savanović, Stevan Armaković, Andrijana Bilić, Svetlana Pelemiš, Sanja Armaković
Environmental Efficiency of UV-Activated TiO_2-Modified Acrylic Self-Cleaning Surfaces

11. Andrijana Bilić, Sanja J. Armaković, Svetlana Pelemiš, Maria M. Savanović, Stevan Armaković
Exploring the Adsorption Potential of Carbon Nanotubes as Efficient Adsorbers for Drug Molecules

12. Borislav N. Malinović, Milica Govedarica, Tijana Đuričić, Draženko Bjelić
Removal of Azo Dyes From Textile Industry Wastewater Using Electrooxidation and Electro-Fenton Processes

13. Jovan P. Šetrajčić, Nikola R. Vojnović
Energy Spectra and Spatial Distribution of States of Free Carriers in Ultra-Thin Crystalline Films

14. Jovan P. Šetrajčić, Dušan I. Ilić
The Possibility of Appearing of Localized States of Elementary Charges In Ultra-Thin Crystalline Films

15. Jovan P. Šetrajčić, Stevo K. Jaćimovski
Energy States of Elementary Charges in Crystalline Films

16. Stevo K. Jaćimovski, Jelena Lamovec, Jovan P. Šetrajčić,
Spectra and Charge Carrier States of Graphene Nanoribbons

17. Daliborka Ivanović, Ivan Srnka, Marija Vujović
Mineral Trioxide Aggregate Application in Non Surgical Endodontic Treatment of Right Canine in Mandibular Fracture Line - Case Report

18. Neđo Đurić, Marko Đurić
Analysis of Geotechnical Conditions of the Terrain at the Silo Construction Location in the "Molaris" Kozluk Mill Complex, Zvornik

19. Dušan Ješić, Pavel Kovač, Borislav Savković, Branko Štrbac, Ildiko Mankova, Dražen Sarjanović
Research on the Economic and Energy Aspects of the Tribological Properties of Austempered Ductile Iron

20. Ljiljana Trumbulović, Snežana Aksentijević, Ivana Čeković, Branko Drndarević
Application of Cordierite Ceramics in Casting Technology

21. Željana Lojpur, Vladan Mićić, Nebojša Vasiljević, Mirko Petković
Examination of the Possibility of Obtaining Biodiesel from Unrefined Sunflower Oil

22. Marko Stajčić, Vladan Mićić, Nebojša Vasiljević, Mirko Petković, Svetlana Pelemiš
Examination of the Possibility of Obtaining Biodiesel From Sunflower Oil and Various Waste Edible Oils

23. Dragana Kostić, Mitar Perušić, Ljubiša Balanović, Srećko Stopić, Duško Kostić, Vladimir Damjanović, Dragana Kešelj, Slavko Smiljanić, Radislav Filipović
Analysis and Initial Qualitative Assessment of Red Mud in the Bayer ProcesS

24. Dragana Malivuk Gak, Zoran Rajilić
Correlation Analysis of Force Parameters Assigned to Time Series Data

25. Sara Srebrenkoska, Vineta Srebrenkoska, Svetlana Risteska
Thermoplastic Unidirectional Laminates Based on Carbon Fibers: Automated Production and Mechanical Characterization

26. Branka Ružičić, Dragana Grujić, Blanka Škipina, Biljana Pećanin, Ana Velemir, Slavica Maletić, Sandra Dedijer
Spectrophotometric Characteristics of Printed Nonwoven Textile

27. Slavica Maletić, Ivan Petronijević, Dragana Cerović
Optical Properties and Effects of Effective Voltages on Dielectric Properties of Ferroelectric $LiNbO_3$

28. Nikola Cekić
Titanium Material on Facades of Frank Gehry

29. Vojkan Zorić, Radovan Radovanović
A New Approach to Determining Forgery of Documents use of Physical-Chemical Methods

30. Zoran Govedar
Criteria and Indicators of Forest Management in the Republic of Srpska

31. Biljana Pećanin, Branka Ružičić,Slavica Maletić, Dragana Cerović, Ivan Petronijević, Dragana Grujić, Blanka Škipina
Effect of Modified Bentonite on Permittivity and Dielectric Loss Tangent of Nonwoven Textiles

32. Valentina Novičić, Radislav Filipović, Mitar Perušić, Zoran Obrenović, Duško Kostić, Vladimir Damjanović, Vladislav Sekulić, Nebojša Vasiljević
Influence of Process Parameters on the Sorption Characteristics of Aluminum Hydroxide

33. Dušan Ješić, Pavel Kovač, Borislav Savković, A. Kekić, B. Nedić, B. Dudić, Mile Stoiljković, Dražen Sarjanović
The Study of the Influence of Lubricating Oil on the Tribomechanical System

34. Marina Simović Pavlović, Tijana Maksimović, Jelena Maksimović, Aleksandra Radulović, Darko Janković, Maja Panjako
Defining Phosphate Tungsten Bronze Structure Through the Fractal Dimension

35. Dušanka Marčetić, Dragoljub Mirjanić, Bojan Kovačević, Dijana Đukić, Svetlana Pelemiš, Darko Divnić
The Map of Solar Radiation for Five Municipalities Located in the Southeastern and Eastern Part of the Republic of Srpska

36. Milan Pantić
Excitation Spectrum in the Anisotropic XXZ Triangular Antiferromagnetic Model: Application To $Ba_3CoSb_2O_9$

37. Božidarka Arsenović
Some Issues of the Development and Application of Sustainable Aviation Fuel, Saf From the Aspect of Co_2 Emission Reduction

38. Jovan Škundrić, Darko Knežević, Indir Mujanić, Danilo Đurica, Marko Lazarević, Saša Laloš,
Analysis of Flow Phenomena Impact on Heat Exchange in an Air-Cooled Condenser

39. Vladislav Zdravković, Aleksandar Lovrić, Neda Sokolović, Nenad Šekularac
Adhesive Type Influence on the Compressive Strength of Beech LVL Reinforced with Carbon Fiber Fabric

40. Jana Prodanova, Aleksandra Kanevce, Ljupčo Kocarev
Understanding Public Sentiment and Topic Dynamics on Waste Management in the Balkans

41. Dragana Kešelj, Kika Stevanović, Milenko Aćimović, Ljubica Vasiljević, Marko Ivanović
Determination of Acetaldehyde Adsorption on Synthetic Zeolites and Characterization of Samples by FTIR Method

42. Srđan Vuković, Danijela Rajić, Aleksandar Vuković, Svetlana Pelemiš, Dragoljub Mirjanić
Capacity and Potential of Solar Power Plants in Bosnia and Herzegovina

43. Srđan Vuković, Danijela Rajić, Aleksandar Vuković, Svetlana Pelemiš, Dragoljub Mirjanić
Solar Energy and Sustainable Development

44. Aleksandra Janićijević, Fathya Shabek, Aco Janićijević
The Rate of Chemical Etching of the Polymer Detector LR115 as an Important Factor for the Detection of Ionizing Radiation

45. Valentina Lulić, Dušan Golubović, Borislav Savković, Pavel Kovač, Dušan Ješić, Branislav Dudić,
Research of Energy Efficiency of Heat Pumps for Heating

46. Darko Divnić, Dragoljub Mirjanić, Esad Jakupović, Zoran Ž. Avramović, Ivana Radonjić Mitić
Performance Degradation of Solar Photovoltaic Modules

47. Ivana Radonjić Mitić, Milutin Petronijević, Leonid Stoimenov, Dragoljub Mirjanić, Lana Pantić, Darko Divnić
Possibility of Producing Photovoltaic Electricity on Balcony Fence in Pirot, Serbia

48. Milesa Srećković, Aleksandra Janićijević, Aco Janićijević, Aleksandar Bugarinović, Milovan Janićijević, Srđan Milanović, Aleksandar Wells Hough
Interaction of Elion Radiation with Materials and Modeling of Materials Properties and Geometric Shapes

49. Đorđe Mirjanić, Milesa Srećković, Vladan Mirjanić, Svetlana Pelemiš, Aleksandar Bugarinović, Radovan Gospavić
Interaction of Laser Beams with Materials of Interest to Dentistry: History, Praxis and Trends

50. Jelena Đorđević, Strahinja Milenković, Nenad Grujović, Fatima Živić
Collagen-based biomaterials and their application in reproductive medicine

51. Milena Radenković Stošić, Sanja Stojanović, Stevo Najman
Different Models of Implantation in the Study of Biomaterials for Bone Tissue Engineering Applications

52. Ivan Stevović
Water Management and Environmental Issue in Correlation to Food or Energy Production

53. Zoran Ćurguz, Dragoljub Mirjanić, Srđan Vuković
Indoor Radon Survey in Republic of Srpska and Dose Assessment

54. Ljubiša Petrov
Toxicity of Nanodimensional Materials as a Factor of Usability in Biomedical Engineering

55. Valentina Veselinović, Nataša Trtić, Olivera Dolić, Tijana Latinčić, Saša Marin, Aleksandra Đeri, Nataša Knežević, Vladan Mirjanić
The Influence of the Addition of TiO_2 Nanoparticles on Antimicrobial Activity and Surface Properties of Denture Base Polymethyl Methacrylate Material

56. Tatjana Ignjić, Goran Kolarević, Petar Janjić, Bojan Pavičar
Rapid Plan in Prostate Cancer Treatment Planning

57. Darija Knežević Ratković, Irena Kasagić-Vujanović
ION-Exchange Retention Models in the Analysis of Retention Mechanisms of Amitriptyline Hydrochloride and its Impurities in Hydrophilic Interaction Liquid Chromatography

58. Ana Micić, Aleksandra Delić, Ema Aleksić, Jasmina Milić, Jovana Milutinović
Orthodontic Treatment with Fixed Appliances and its Influence on the Periodontal Health

59. Bojan Pavičar, Andrej Milosavljević, Milomir Milaković, Tatjana Ignjić, Petar Janjić, Mihajlo Tovilović, Goran Kolarević, Dragoljub Mirjanić
Comparison of Image-Based Three-Dimensional Treatment Planning Using Acurostm bv and TG-43 Algorithm for Intracavitary Brachytherapy of Carcinoma Cervix

60. Zorana Stamenković, Vanja Stojić, Nemanja Marinković, Jovan Marković, Ivan Arsić, Nenad Nedeljković, Vladan Mirjanić
Combined Orthodontic - Surgical Treatment of Severe Skeletal Class III Maloclussion – Case Report

61. Jelena Najdanović, Vladimir Cvetković, Sanja Stojanović, Milena Radenković, Jelena Živković, Stevo Najman
The Influence of Mice Adipose-Derived Mesenchymal Stem Cells, Platelet-Rich Plasma and Bone Mineral Matrix on Ectopic Osteogenic Process

62. Zorana Stamenković, Jovan Marković, Ivan Arsić, Vanja Stojić, Nemanja Marinković, Nenad Nedeljković, Vladan Mirjanić
Therapy of Skeletal Open Bite and Skeletal Class III Using Bionator According to Balters Type III (Case Report)

63. Nataša Trtić, Saša Marin, Valentina Veselinović, Sanja Jovičić, Maja Barudžija, Nina Zubović, Marko Bulajić, Ivana Dujaković, Nikolina Spasojević, Branislav Stančević
Bone Animal Segment - Model for Human Bone Regeneration

64. Josipa Karij Trivunović, Vladan Mirjanić, Sanja Gnjato
Golden Ratio in Assessment of Facial Aesthetics

65. Josipa Karij Trivunović, Vladan Mirjanić, Sanja Gnjato
Stem Cells in Dental Medicine

66. Ognjenka Janković, Smiljana Paraš, Radmila Arbutina, Nataša Knežević, Sanja Ilić, Tijana Adamović, Sanja Gnjato, Sanja Subotić, Verica Protić Berić, Vladan Mirjanić
Clinical Evaluation of Three Different Self-Adhering Materials in Class I Restorations

67. Velibor Andrić, Nikola Marković, Maja Gajić-Kvasčev, Olivera Klisurić
Pattern Recognition Supported EDXRF Analysis of the Medieval Glass

68. Jovan Dašić, Predrag Dašić, Violeta Đorđević, Zvonko Petrović
Application of 3D/4D Printing for the Processing of Composites Materials

69. Predrag Dašić, Esad Jakupović
The Role of Artificial Intelligence Systems in the New Education of Engineers

70. Jelena Erić Obućina, Marina Karić
Maintenance of the Hydraulic System Regarding the Materials from Which its Components are Made

71. Marina Karić, Predrag Dašić, Jelena Erić Obućina
Experimental Identification of the Drying Process of Biomaterials using a Factorial Design of the Experiment

72. Radmila Lišanin, Mitar Lutovac, Jelena Medić, Danka Nišavić
Statistical Analysis of the Participation of Micropollutants in Wastewater in Serbia

73. Predrag Pravdić, Violeta Dorđević, Jelena Erić-Obućina, Vladan Obućina
Modern Materials and Renewable Energy Sources

74. Predrag Pravdić, Violeta Dorđević, Jelena Erić-Obućina, Vladan Obućina
Reliability and Stability of Advanced Technical Systems

75. Snežana Topalović, Radmila Lišanin, Aleksandar Marić
Analysis of the Quality of Food Materials Based on the HACCP Standard

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A B S T R A C T S

PLENARY PRESENTATIONS

SYMMETRY AND BAND TOPOLOGY IN LOW-DIMENSIONAL CRYSTALS

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Abstract: During past several years topological band theory is rapidly developing, becoming most propulsive theoretical field in condensed matter. It combines different mathematical techniques to analyse and apply symmetry: besides group theory, graph and K-theory are normally employed. In contrast from the three-dimensional crystals, Q1D and Q2D systems are less elaborated. Hence, in this lecture we give an overview of the subject, and then present some new results about the low-dimensional systems.

A consequence of the crystal periodicity along Þ (Þ=1,2,3) directions is that symmetry group of crystal has translational Þ-dimensional subgroup (lattice). Combining the other Euclidean symmetry with this subgroup, one gets line, layer and space groups. Each of these groups stratify Euclidean space into orbits with various stabilizers (group fixing a particular point), being a point groups. Collection of the orbits with the same stabilizers is called stratum. Different orbits, and therefore different strata exhaust the space. Taking a point from each orbit one gets fundamental domain, a finite part of space, while typical representative of each stratum is called Wyckoff position, and it may be understood as a contraction of each stratum to a point. Adding the arrows from special to more general neighbouring strata, one gets fundamental domain graph (FDG). This transforms the set of strata into the partially ordered set, with the corresponding stabilizers ordered by super-to-subgroup relation.

In general, a system consists of the ions positioned in the points $\boldsymbol{r}^{Pp}$ of the orbits P of the symmetry group. For each point a finite-dimensional space $V^{Pp}$is associated, determined by a set of orbitals defining quantum tight-binding space. The only physical condition is that such space is invariant under the corresponding stabilizer group, i.e. that the stabilizer action is a representation $\delta^P(F^P)$ of the stabilizer in this orbit space. Using this, an induced representation $D^P(G)=\delta^P(F^P)G$ can be formed, and generally for the whole system $D(G)=\sum_p D^P(G)$. All such representations have important property when restricted to translational subgroup $T^Þ$: each irreducible representation $\Delta^{(k)}(T^Þ)$ of the translational group $T^Þ$ occurs the same number of times (frequency number $f=f^k$); wave vector k takes values from the Brillouin zone, which is p-dimensional torus.

This is the very origin of the Bloch theory: to each point k of the torus, vector subspace V_k of the dimension f is associated. Hamiltonian reduces within each of them, and the eigenvalues and eigenvectors van be found separatel, givin the spectrum of Hamiltonian in the form of energy bands over Brillouin zone.

The action of the group in the Brillouin zone is such that translations fix each point, meaning that the stratification (similar to the case of Euclidean space) gives infinite stabilizers F_k (with full T^b as their subgroup), while the orbits are finite. Stratification gives irreducible domain (instead of fundamental domain) with different strata partially ordered by connectivity, equivalent to super-to-subgroup relation of stabilizers. Eventually, contraction of strata to points gives the irreducible domain graph. Induction procedure, from the (allowed) irreducible representations of stabilizers results in the complete set unitary irreducible representations of G.

Finally, we can combine results related to Euclidean space (band representations) and Brillouin zone (bands and irreducible representations). While each representation is in a unique way (unique frequency numbers) decomposed onto irreducible components, band representations are a subset which can be generated by integer combination of a finite number of them, elementary band representation (EBR). These are those which are induced from the irreducible representations of the maximal stabilizers. Indeed, it can be shown that such set generates all other band representations. Still, there may be cases of the *exceptional* representations, when different maximal strata give the same EBR. This is generalized to arbitrary *exceptional band representation*, which can be induced from two different Wyckoff positions. These situations indicate that the Wannier centers of the electrons is not clearly defined, i.e. that the centers depend on the model Hamiltonian, and may be between ions (in contrast to the expectation).

Also, there are situations of pairs A and B of band representations which when subtracted (A-B) is a representation itself (the frequency numbers are non-negative), but cannot be induced from any stabilizer. This is indication of fragile topology (in accordance with K-theory).

Finally, the obvious restrictions on the band representations (equal dimension of spaces in each k-point, compatibility and monodromy relations) leave a band structures space of the dimension BS. On the other hand, elementary band representations form an (invariant abelian) subgroup of this space, with atomic limits (AI). The corresponding factor group is called group of symmetry indicators, SI=BS/AI. Their cosets are spanned by stable topological structures.

Generally, all these quantities are calculated for 3D crystals (including time reversal symmetry). We discuss here Q1D and Q2D structures. For Q2D and layer groups result are partly known, and here we discuss their completition. For Q1D systems and line groups there are only few results in literature. It is known that group of symmetry indicators is trivial, so there is no stable not fragile topological bands. Only in the context of Wannier localization there are new results: complete list of exceptional band representations, indicating all the cases of possible obstructed atomic limits.

Keywords: band topology, low-dimensional crystals.

STRATIFYHF PLATFORM: ARTIFICIAL INTELLIGENCE-BASED DECISION SUPPORT SYSTEM FOR RISK STRATIFICATION AND EARLY DETECTION OF HEART FAILURE IN PRIMARY AND SECONDARY CARE

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Abstract: Heart failure is a multifaceted clinical syndrome that impacts over 15 million individuals throughout Europe. It is closely linked with diminished quality of life for patients and substantial healthcare expenditures. Consequently, pioneering AI tools can expedite the initiation of preventive and therapeutic approaches. The EU-funded STRATIFYHF project will develop, validate and implement an AI-driven decision support system through server and mobile-app. This system will serve the purpose of risk stratification, early detection and evaluation of disease progression, effectively addressing the clinical requirements of both primary and secondary care settings. By amalgamating patient-specific demographic and clinical information through state-of-the-art technologies, the system will employ advanced machine learning and computational modeling techniques to formulate AI-powered instruments for precise risk stratification and accurate prognosis.

In this platform fluid-structure coupling for left ventricle was introduced. A nonlinear material model for heart wall using constitutive curves which include the stress-strain relationship was presented.

Three important innovations are presented in this project:

1) patient-specific data i.e. demographic, clinical, genetic, lifestyle and socio-economic
2) AI-based digital patient library and algorithms for risk stratification, early diagnosis, and disease progression
3) Multifunctional AI- and computational modelling-based DSS and mobile app for informing a patient-centred, personalised, prevention and treatment strategies

Computational platform like STRATIFYHF for sure will open a new avenue for new diagnostic and therapeutic tools for risk stratification and early detection of heart failure in primary and secondary care.

Keywords: artificial intelligence-based, decision support system, early detection, heart failure.

Acknowledgments: *This paper is supported by the STRATIFYHF project that has received funding from the European Union's Horizon Europe research and innovation programme under Grant agreement No 101080905. This article reflects only the author's view. The Commission is not responsible for any use that may be made of the information it contains*

SUSTAINABLE PROCESSING OF INNOVATIVE RARE-EARTH MAGNETS

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Abstract: The European Union has set itself the goal of achieving climate neutrality by 2050, a milestone that depends on the continent's ability to develop and implement clean energy and mobility solutions in a way that is both economically viable and environmentally sustainable. The amount of critical raw materials (CRM) needed to facilitate this energy transition is significant. In addition, industrial and household appliances will need to meet stringent energy efficiency standards to support this transition. The most energy-efficient electric motors and generators contain rare earth permanent magnets. While EU companies are world leaders in the production of electric motors, they are completely dependent on imports for the entire value chain of rare earth magnet materials. (Bernd Schaferet.al, A Report of the Rare Earth Magnets and Motors Cluster, Berlin 2021).

Rare earth elements (REEs) are essential components of these permanent magnets, which are critical for many applications that are vital to Europe's future. It is well known that REEs from China have been the main source for Europe, that supplies are uncertain, and that the Chinese production chain is generally unsustainable. At the same time, the demand for REEs for the production of new PMs is expected to double in 15 years.

In light of this data, our work focuses on the collection of EOL magnets and the sustainable recycling and reprocessing of PM from sources, concentrating on the most common and readily available source of economically recyclable electric motors: domestic appliances. We are developing new dismantling and recovery processes for PM on high-availability scrap and reprocessing lines. In HPMS (Hydrogen Processing of Magnetic Scrap)[1,2] we use an already established method of hydrogenation followed by grinding, degassing, and coating of sensitive powders. The HDDR (Hydrogenation-Disproportionation-Desorption-Regeneration)[3] process has been implemented to simplify and minimize the steps in the recycling process.

Initial, ongoing pilot trials for the production of sintered and bonded magnets from recycled magnets confirm the waste-free, economic processing and future independence from unstable REE sources. For the production of sintered magnets, a new sustainable process of rapid consolidation is used, while for bonded magnets the most sensitive part to protect the reactive powders is the coating with a few mon-

olayers of chemically bound coating precursor. In addition to magnetic measurements, various analytical techniques (SEM, HRTEM, XPS) are used to characterize the powders obtained by HPMS and HDDR processes, as well as the final magnets.

**This work is part of the "INSPIRES" project financed by EIT RawMaterials, Proposal Number 20090 (project website: https://eitrawmaterials.eu/project/inspires/).*

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Keywords: Rare-Earth Magnets, HDDR.

CLIMATE ADAPTATION ACTIVITIES FOR HIGHER RESILIENCE IN THE GABROVO MOUNTAIN REGION

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Abstract: Mountains, which cover 35% of Europe and are home to 17% of the EU population, are disproportionately affected by climate change, experiencing faster warming and significant ecosystem disruptions. The Gabrovo Mountain Region, located in Bulgaria's Balkan Mountains, experiences climate-related challenges with risks such as floods, droughts, and forest fires threatening biodiversity, agriculture, and local livelihoods, imposing urgent adaptation measures for enhanced resilience.

The paper presents part of the main tasks under the Horizon Europe project MountResilience (mountresilience.eu), with the aim of accelerating the climate-resistant transformation of the mountain regions of 9 EU countries, in which Gabrovo is one of the Regional Demonstration Sites. Two key demonstrator project activities, which are designed by scientists and researchers from Technical University of Gabrovo, support these goals:

1. Innovative solutions for Green Infrastructure (GI): This pilot project integrates technological and social innovations. The current Green Infrastructure (GI) Strategy of Gabrovo ends in 2023. The objective is to develop a new GI Strategy, placing the focus on the sustainable use of natural resources and innovative NBS so as to adapt to CC. The new GI Strategy will focus on semi-natural spaces in Gabrovo, such as public parks and gardens, as well as green areas between residential and public buildings. The elaboration of GI Strategy will go through three main stages:

Mapping of the urban green environment and identification of needs for further development/improvement of the green infrastructure (expert-based), GI concept development, incl. pre- investment studies.

Co-development of the GI Strategy with the inclusion of representatives of all relevant stakeholders in Gabrovo, incl. citizens (social innovation), with an Action Plan with concrete measures/projects;

Implementation of a pilot project focused on improving/expanding the urban green infrastructure through rainwater harvesting for maintaining urban green areas (technological innovation), complemented by tree planting and increasing of permeable green surfaces.

2. Early-Warning and Monitoring System (EWMS): Early-Warning and Monitoring System: complements demo project 1 and is focused on the development of an Early-Warning and Monitoring System (EWMS) for Risk Management. The ambition of the Municipality of Gabrovo is to establish an effective EWMS for different natural hazards, namely floods, hurricanes and forest fires. Awareness-raising measures and public engagement will be integral elements of this pilot project. EWMS will allow for: real-time measurements through several monitoring stations, announcement of events in real-time, collaboration with the population through a mobile application for data collection/exchange and addressing inquiries in real-time (the list of functionalities is not exhaustive). The implementation will go through three stages: pre-investment studies and conceptualizing the EWMS; design of the three components of EWMS - for floods, hurricanes and forest fires, and awareness raising of the general population and capacity building of the municipal administration.

Keywords: Mountain resilience, climate adaptation, green infrastructure, early-warning systems, climate neutrality, biodiversity protection, natural hazards.

AUTONOMOUS MECHATRONIC PLATFORM AGRIROVER FOR PRECISION AGRICULTURAL APPLICATIONS IN DEVELOPING COUNTRIES

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Abstract*:* This research outlines the design of a versatile AgriRover tailored to the needs of small-scale and traditional agricultural applications in developing countries, where infrastructure is limited and trained personnel are scarce. The proposed AgriRover is engineered to be assembled using readily available technologies, making it cost-effective and accessible. By leveraging easily obtainable sensors, actuators, microcontrollers, communication devices, and open-source components, the rover is designed for autonomous operation with minimal maintenance requirements. Key features of the AgriRover include autonomous navigation, either by following the agricultural applications or executing pre-determined routes based on specific tasks, and high operational availability ensured through autonomous return-to-base functionality for battery recharging. The design process also considered the unique terrain characteristics of the target regions, focusing on optimizing the interaction between the rover's wheels and the soil to ensure reliable performance. In this paper is presents a multifunctional mobile mechatronic platform AgriRover for precision agricultural applications with potential applications in developing countries.

Keywords: multi-body design, small-scale agricultural monitoring, autonomous vehicle, low-cost design (LCD), developing countries, terrain adaptation.

SYNERGY IN FOOD AND ENERGY PRODUCTION - AGRICULTURAL SOLAR POWER PLANTS

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Abstract: For farmers, protecting their crops is the most important goal. Many of them have already seen their crops wither for the second or third time because there was too much sun and too little water in the summer. That's why the shading provided by an Agri PV system is the most important argument. The innovative Agri PV intelligently combines agriculture with renewable power generation. Solar modules are installed above and between agricultural land to generate electricity so that it can continue to be farmed profitably. A real win-win situation that not only benefits the climate and security of supply, but also farmers: The "double harvest" enables income diversification and thus contributes to the sustainable strengthening of agricultural businesses and rural areas.

Keywords: agriculture, agrosolars, solar energy, climate and energy.

DEPOSITING ELECTRICITY IN ZEOLITE/WATER/OIL ELECTROLYTES

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Abstract: In order to find a cheap and environmentally friendly solution for storing electricity, it is necessary to test a large number of physical-chemical formulations of battery-capacitive systems. This presentation describes the idea of depositing electrical energy in a zeolite electrolyte, where the type of electrodes does not matter. In contrast to classical electrolytic capacitors, where no significant interactions between electrolyte and ions are expected, the main aspect of this study is precisely the examination of the influence of that interaction on the energy balance of such systems. The possibility that the application of an electric field breaks the coordination bonds between ions and zeolite structures could be used for the deposition of electrical energy. Preliminary results of the examination of the described phenomenon are presented.

Keywords: Despositing electricity, zeolite/water/oil electrolytes.

EXPLORING THE ROLE OF POLYMERS IN WATER PURIFICATION: EXPERIMENTS, MODELING, AND MACHINE LEARNING

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Abstract: The topic will cover the innovative application of polymers in water purification, integrating experimental methods, modeling, and machine learning to enhance efficiency and effectiveness. Polymers offer unique properties that can be used to remove contaminants from water, presenting a promising solution to global water quality challenges. The study involves a comprehensive approach, beginning with the synthesis and characterization of various polymers adjusted for water purification. Furthermore, the results of the experimental tests of the performance of these polymers in removing specific contaminants, such as pharmaceuticals, dyes, and pesticides, will be analyzed. Computational simulations of the interactions between polymers and contaminants, providing insights into the mechanisms of interaction, will be analyzed in detail. These models help optimize polymer structures and conditions, reducing the need for extensive trial-and-error experiments. In parallel, machine learning techniques will analyze experimental data, identify patterns, and predict polymer performance under different conditions. The integration of experiments, modeling, and machine learning not only advances the understanding of polymer-based water purification but also establishes a framework for future research in the field. The literature results highlight the potential of polymers as versatile and efficient agents for improving water quality, addressing both current and emerging contaminants.

Keywords: Contaminant removal, sustainable water resources, advanced materials, predictive modeling.

REVERSIBLE PROTON-COUPLED CHARGE STORAGE IN NANOSTRUCTURED AMORPHOUS AND ANATASE TIO_2

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Abstract: To enable higher input of renewable energy into our grid system, increase in gird storage capacity is urgently needed. One way to reach this goal is through development of an aqueous rechargeable proton "rocking chair" battery, relying on proton as a small size and light weight charge carrier, enabling fast charge/discharge and long cycling, as well as aqueous electrolytes to ensure safety, high ionic conductivity and eco-friendliness.

In the present work, titanium dioxide (TiO_2) has been investigated as possible candidate for proton insertion anode material in aqueous electrolytes, using well-defined and highly reproducible nanostructured electrodes made of the pure material as model electrodes. The reversible proton-coupled charge storage occurring at such nanostructured electrodes was thoroughly investigated as function of both intrinsic parameters, such as the TiO_2 crystallinity, as well as extrinsic parameters, notably the electrolyte composition and pH. First, the influence of the electrolyte composition and pH has been studied at amorphous TiO_2 electrodes by comparing reversible proton insertion in buffered and unbuffered aqueous electrolytes. This study revealed the pH-dependence of the proton-coupled charge storage process over the entire pH-range of water as well as the benefit of buffered electrolytes to stabilize the insertion/disinsertion potential and reduce potential hysteresis upon cycling. Next, the influence of the active material crystallinity was investigated by comparing proton-coupled charge storage at amorphous and anatase TiO_2 electrodes. Reversible proton insertion was demonstrated to be a bulk charge storage process at both electrodes, with the crystallinity of the material only influencing the energetic but not the dynamic aspects of the process. Besides, reversible proton insertion was evidenced much faster than lithium-ion.

Still, we conclude that TiO_2 is not the ideal anode material for a rocking chair proton battery, due to side reactions such as competitive hydrogen evolution as well as acid dissolution. However, the fundamental knowledge gained from the present study remains of primary interest by providing a comprehensive framework for investigation of reversible proton insertion over a wide range of active materials.

Keywords: Proton-coupled charge storage, TiO_2, reversible proton insertion, buffered electrolytes, unbuffered electrolytes, anatase TiO_2, amorphous TiO_2, lithium insertion in anatase TiO_2, GLAD-TiO_2, lithium vs proton insertion in aqueous media.

KINETICS OF SOLID STATE REACTIONS: SOFTWARE APPROACH AND APPLICATION

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Abstract: Countless inorganic, organic and polymeric materials are in the form of solids. Understanding and controlling the mechanism of the solid-state degradation or solid/gas reactions is crucial for designing reactions for new contemporary materials. For such systems kinetics of solid state reactions is very applicable since it explains the mechanism of the thermally stimulated processes and gives information on thermal decomposition, phase transformations, crystallization etc., important for the optimization of the chemical processes. Using useful tool called kinetic triplet (KT): activation energy (Ea), pre-exponential factor (A) and reaction model (f (α)), obtained by Kinetics 2015 software package, we get valuable insight into physico-chemical significance of results. The Kinetics 2015 software program supports thermal analysis methods (TGA, DTA and DSC) and works in non-isothermal conditions. The presentation will cover wide range of different materials starting from metallic nanocomposites, through polymers and pharmaceuticals for which by using software approach we get information regarding thermal stability and its decomposition. A special case of thermal degradation of catalyst copper oxide yielding to copper will be discussed in paper in details.

Keywords: kinetics, solid state, Kinetics 2015 software, drugs, nanocomposite, copper oxide reduction.

LINEAR POLYMER AS A FIRST STEP TOWARD POLYMERIC MATERIAL

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Abstract: Polymers are a class of materials that are ubiquitous in our daily lives. They have found their application in packaging, construction, clothing, transport and electric industry, electronics, medicine etc. Natural polymers have been in use since ancient times, but it is only in the 19th century that, by applying some specific treatments, their properties began to be modified fruitfully. At the beginning of the 20th century the first completely synthetic polymer was produced, and after that, particularly during the Second World War, the mass-production and creation began. Nowadays, more than 400 millions of metric tons of plastics is produced annually in the world, and the problem of accumulated waste has been taking its toll. In this presentation we will first deal with polymers in general, then we will give short review of synthetic polymers development and future trends, and then mostly focus, from the physicists point of view, on the properties of single linear polymer as the building block of polymeric material.

Keywords: polymer classification, linear polymer, physics.

POSTER PRESENTATIONS

IS FUTURE DETERMINED BY SCIENCE AND RESEARCH?

Momir Đurović

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Abstract: Our civilization is faced with many problems among which issues related to climate change, energy, water, demographic changes, food, environment, AI, sustainability, are the most problematic. To overcome most of the problems related to those issues there are needed political decisions based on scientific knowledge and research. It is obvious that, in this process, sscience and technology should provide answers such to enable prosperity and economic growth based on sustainable development. That should involve competitive research characterized by national and international cooperation. Certainly, this process will be based on many different prediction–hypothesis within science based forecasts. It is the most important when talking on future to appreciate difference between hypothesis and prediction– science fiction vs. short term and long term forecasts.

It is the duty of scientific community to establish good communication and collaboration with the representatives of the society, the politicians, convincing them that basic research should contribute to the development of a country. Obviously, there cannot be development without basic research. It has to be realised that basic research is source of knowledge, being powerful educational tool in training highly qualified human capital, and source of prestige for nations, institutions and individuals-

Certainly, the technologies are strongly related to scientific research- There are many new emerging technologies among which the most promising, **that will redefine the future and the world we live in,** are :Artificial Intelligence, The Growth Rate of Self-Driving Cars, Advanced Robotics, Smart Clothes, Space Travel, Cloud Computing, Augmented Reality, Smart Glasses and some more-

It should be stressed that scientific research involves systematic and organized examination of phenomenon, often involving experimental research. Certainly, it is the big question can science and technology be predicted, appreciating that basic research is source of a new knowledge? One has to appreciate that basic research is not needed only to rich countries, but equaly for a country with limited economic resources

Keywords: challenges of the future, science and research, predicted science and technology.

CARBON NANOTUBES AS THOULESS CHARGE PUMPS

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Milan Damnjanović

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Abstract: Mechanically induced topological phase transitions in single-wall carbon nanotubes (SWCNTs) are theoretically and numerically studied. The discontinuous change of the Z-topological invariant (when the band gap closes and the number of edge states changes) at certain critical amplitudes of induced homogeneous mechanical deformations is obtained. In this way, singular points (in the parameter configuration space) for each of the SWCNTs are found. These data are then used to design adiabatic quantum charge pumping cycles (through the SWCNTs) by simultaneously exciting two selected phonon modes and finely tuning their frequency ratio by applying elastic deformations. The Wilson operator eigenspectra are calculated, and the Wannier charge centers' flow through the (insulating) bulk is evidenced.

Keywords: thouless charge pump, berry phase, modern theory of polarization, carbon naotubes, topological quantized charge transport.

MECHANICAL DEFORMATION OF CARBON NANOTUBES FOLLOWED BY LOCAL ELECTRON TRANSFER

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Abstract: Structure and geometry, modelling of carbon nanotubes enable to generate whole system from a single representative atom, by symmetry transformation. Hence, symmetry can be used to reduce calculations and prediction of electronics and wide range other relevant physical properties. Homogeneous mechanical deformation, that preserves symmetry, causes Hamiltonian reparameterization that influences change of energy bands change. For semiconducting carbon nanotubes, the most significant changes occur around Fermi level, where the process involves conducting and valence bands with the same angular quantum number. Deformations can be varied until bands come close to each other. Inside Brillouin zone bands approach always in two points symmetrical with respect to gamma point during homogeneous deformation of carbon nanotube. In accordance with the non-crossing rule, valence and conducted states never intersect if they have all quantum numbers the same, even in the moment they take cone-like shape when it comes to the change of Berry phase. This is interpreted as the change of average positions of two electrons simultaneously by tunneling from the onsite position toward the intermediate position between two neighbor sites or vice versa, despite that nanotube is semiconductor.

Keywords: carbon nanotube; symmetry; Berry phase; deformations.

OVERVIEW OF THE ELECTROPHYSIOLOGICAL MODELS FOR THE LEFT VENTRICLE SIMULATIONS

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Abstract: Electrophysiological models play a crucial role in understanding the complex dynamics of the heart, particularly the left ventricle. These models provide insights into the mechanisms underlying cardiac function and are essential for developing treatments for cardiac diseases. This paper presents an overview of various electrophysiological models used for simulating the left ventricle, including the van der Pol oscillator, the FitzHugh-Nagumo model, the Luo-Rudy model, and the O'Hara-Rudy model. By exploring the historical development, applications, and future directions of these models, this paper aims to highlight their significance and potential in advancing cardiac research and clinical practice.

Keywords: electrophysiology, cardiac cycle, left ventricle, action potentials.

CROSS SECTIONS AND TRANSPORT CHARACTERISTICS OF ELECTRONS IN AMMONIA (NH_3)

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Abstract: The sets of cross sections for electron scattering on ammonia (NH_3) molecules are presented and discussed. Several sets recommended by different groups of researchers were compared with each other and used as input parameters for the calculation of transport coefficients: drift velocity (W), reduced ionization coefficient (α/N), and reduced attachment coefficient (η/N). The calculations were performed with the Bolsig+ code in the range of reduced electric field (E/N) from 0 to 3000 Td (1 Td = 10^{-21} Vm^2). Significant deviations were observed between different sets of cross sections for e-/NH_3 interactions, as well as deviations between calculated and measured values of transport coefficients.

Keywords: cross sections, transport coefficients, ammonia.

STUDY OF INTERMOLECULAR INTERACTIONS OF SELECTED ASYMMETRICAL THIOCARBOHYDRAZONE DERIVATIVES

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Abstract: Thiocarbohydrazone derivatives belong to the class of biologically active compounds. Many compounds tested so far have proven to be good antioxidant, antimicrobial, anti-inflammatory, and antitumor agents. Compounds based on thiocarbohydrazide are divided into mono- and bisubstituted derivatives, while bisubstituted derivatives can be symmetrical and asymmetrical. In this paper, the intermolecular interactions of eight newly synthesized asymmetric thiocarbohydrazones in twelve solvents of different properties were investigated using Kamlet-Taft's solvatochromic model. Also, the influence of the type of the substituent present on shifts in the absorption spectra was examined by applying Hammett's equation. Definition of the type, intensity, and dominance of the interactions that occur between the dissolved substance and the surrounding medium is of great importance when it comes to the physicochemical characterization of newly synthesized derivatives, and can also provide information on the potential biological activity of the tested compounds.

Keywords: Hammett's equation, intermolecular interactions, Kamlet-Taft's solvatochromic model, thiocarbohydrazones

IMPACT ANALYSIS OF HIGH-SPEED PROJECTILES ON GRANULAR MATERIAL

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Abstract: To enhance ballistic protection, this paper explores the benefits of granular materials compared to traditional materials used in this field. Currently, ballistic protection employs various materials either individually or in combination, such as armored steels, ceramic layers, composite materials, and granular structures. This study investigates the interaction of projectiles with each type of material, as well as the effects of combining different material layers. Granular materials consist of macroscopic particles, each with its own degrees of freedom. Collisions between these particles transfer energy from the solid body to individual particles, leading to energy dissipation that can halt the motion of particles within the granular material. The primary objective of this research is to analyze the results of projectile impacts on various material obstacles using a mathematical model for image processing.

Keywords: Granular materials, ballistic protection, optical methods, energy dissipation, obstacle, projectile.

DIELECTRIC PROPERTIES OF IPP/PARAFFIN WAX BLENDS TREATED IN LICL WATER SOLUTION

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Abstract: Nowadays demands towards electrical energy storage demands are great. However, present batteries have many disadvantages. Tendencies in science and technology are to overcome these problems by the application of new materials for this purpose. Blends of iPP/paraffin wax (80/20 and 90/10 weight ratio) were processed by plastograph and then foils were obtained by compression molding. Blend and neat iPP foils are treated for (24, 72, and 168) hours in a saturated water solution of LiCl at room temperature and the +4kV DC potential. Dielectric spectroscopy measurements are conducted. Specific conductivity, loss tangent, and relative dielectric constant are studied. It is noticed that blend samples with 10% and 20% paraffin wax have higher specific conductivity in comparison with iPP samples in a whole measured frequency range. The higher percentage of wax greatly influences specific conductivity rise by order of magnitude comparing treated iPP with 80/20 treated blend. All untreated samples (0, 10, 20) wax percentage has lower specific conductivity values compared to treated ones (0, 10, 20) in the whole frequency range, probably due to the incorporation of ions into samples during the treatment. Loss tangent has similar trends which are expected due to leakage currents observed by specific conductivity spectrums. Time of treatment has shown no significant changes or trends of dielectric parameters. Relative dielectric constant showed that treatment with positive DC potential influenced its value since treated samples had significant changes compared to untreated ones especially the 80/20 iPP/paraffine wax blend sample, considering that the value relative dielectric constant of paraffine wax is similar or lower than the value of iPP. Also, relaxation on this spectrum is clearly visible.

Keywords: isotactic polypropylene, paraffine wax, dielectric spectroscopy, LiCl, salt water solution treatment, DC potential.

THE INHIBITIVE EFFECT OF *THYMUS SERPYLLUM* EXTRACT ON CORROSION OF STEEL

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Abstract: The study examined the inhibitive effect of thyme extract as a green inhibitor on the corrosion of two steel types, DC01 and X5 CrNi 18-10, in a 3% NaCl solution. Four test solutions were used: 1) blank 3% NaCl, 2) 3% NaCl + 0.5 g/L thyme extract, 3) 3% NaCl + 1.0 g/L thyme extract, and 4) 3% NaCl + 1.5 g/L thyme extract. Steel samples (3x3x0.2 cm) underwent chemical treatment before being exposed to the non-inhibited and inhibited solutions. Weight loss and electrochemical techniques, i.e. electrochemical impedance spectroscopy, were employed to investigate the corrosion rate and the inhibitive effect of thyme extract. All experiments were obtain on room temperature. After chemical treatment samples were immersed in blank and inhibited solutions for 2h, 4h, 6h, 8h, 24h, 48h и 168h. Based on the weight loss in steel samples for the time spent in prepared solutions, negative mass index of corrosion, K_m^- (g/m^2h), depth corrosion indicator, π (mm/year), and degree of efficiency, protection factor, z (%), were calculated. The results of the gravimetric and electrochemical measurements showed that thyme extract had an inhibitive effect on the corrosion of the tested steels, but not sufficient to be recommended for commercial application. The average corrosion inhibition efficiency of thyme extract was below 60% for both steel types. For steel 1, the protection factor was above 80% only in solution 4 after 48h and 168h, while for steel 2, the protection factor was greater than 80% for all three inhibited solutions only after 168h. These findings suggest a very slow adsorption of phytochemicals from thyme extract on the surface of the tested steels.

Keywords: corrosion, green inhibitors, thyme extract, weight loss, electrochemical techniques.

ENVIRONMENTAL EFFICIENCY OF UV-ACTIVATED TIO_2-MODIFIED ACRYLIC SELF-CLEANING SURFACES

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Abstract: Raising awareness of the importance of protecting the environment generates ever-increasing efforts of chemists and material scientists who seek new chemical compounds, production methods, and new types of surfaces and materials with self-cleaning abilities. Taking into consideration the data on increasing pollutant levels in the environment, materials that degrade pollutants could be an acceptable, sustainable solution to improve self-cleaning materials, especially when functionalizing large surfaces characteristic of building materials. The development of building materials that degrade polluting chemicals and carry out the mineralization of pollutant loads has now become a necessity. This work aimed to analyze the environmental performance of TiO_2-modified acrylic surfaces under UV–LED irradiation through the oxidative processes taking place on the illuminated surfaces. The simple approach of synthesis yielded highly affordable self-cleaning surfaces. The self-cleaning properties of these surfaces were tested against three frequently used textile dyes, rhodamine B, methylene blue, and methyl orange. It was demonstrated that rhodamine B was still present after 10 h of irradiation, while methylene blue and methyl orange were successfully self-cleaned after 3 h and 5 h, respectively.

Keywords: dyes, self-cleaning surfaces, environmental pollution, photocatalysis.

EXPLORING THE ADSORPTION POTENTIAL OF CARBON NANOTUBES AS EFFICIENT ADSORBERS FOR DRUG MOLECULES

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Abstract: This research observed the interaction between carbon nanotubes (CTs) and ephedrine (EH) molecules through a comprehensive utilization of density functional theory (DFT) and density functional tight-binding (DFTB) calculations applied to both periodic and isolated structures. EH, as a prevalent pharmaceutical pollutant, interacts with CTs and prominent organic nanostructures, prompting a meticulous examination of CTs' potential as EH adsorbents. Multiple models of CTs were systematically scrutinized to elucidate their interaction with EH in detail. Given the substantial complexity of systems involving 122-187 atoms, the DFTB methodology was used for geometric optimizations. DFT computations were subsequently employed to procure accurate total energies, enabling the precise evaluation of binding energies between EH and nanotubes. The outcomes underscore the propensity of CTs to adsorb EH molecules with notable binding energies, striking a balance between robust adhesion and facilitation of desorption under plausible experimental conditions. These findings not only shed light on the fundamental mechanisms governing the CT-EH interaction but also offer promising insights for the practical application of CTs in environmental remediation strategies targeting pharmaceutical pollutants.

Keywords: pharmaceuticals, DFT, binding energies, environmental remediation.

REMOVAL OF AZO DYES FROM TEXTILE INDUSTRY WASTEWATER USING ELECTROOXIDATION AND ELECTRO-FENTON PROCESSES

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Abstract: Wastewaters from the textile industry have a high content of organic matter, high coloration, various minerals and metals, and often toxic and carcinogenic substances. Azo dyes are the most common used dyes in the textile industry. Due to their complex structure, the removal of azo dyes from wastewater is challenging. In this study, electrooxidation and the electro-Fenton process, as one of the most effective Electrochemical Advanced Oxidation Processes (EAOPs) for the removal of organic pollutants in wastewater, were used for the treatment of synthetic wastewater containing "Bemacid Red" dye as a pollutant. Several process parameters affecting the efficiency of OH. formation and dye degradation were examined. Stainless steel (SS) was used as the cathode material, and the anodes used were mixed metal oxides (MMO) - Ru mixed oxide (titanium substrate coated with 6g Ru/m^2) and Ru-Ir mixed oxide (titanium substrate coated with 6g Ru- Ir/m^2). The results showed that the Ru:SS electrode pair is more efficient comapred to the Ru-Ir:SS pair, and that the electro-Fenton process is more efficient compared to electrooxidation.

Keywords: textile industry, wastewater, treatment efficiency.

ENERGY SPECTRA AND SPATIAL DISTRIBUTION OF STATES OF FREE CARRIERS IN ULTRA-THIN CRYSTALLINE FILMS

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Abstract: The translational symmetry of the distribution system of atoms (ions) and charge carriers (electrons or holes) is broken by scattering (doping) and due to the existence of two boundary surfaces. This is a model of high-temperature superconductors in which the observed symmetry breaking orthogonal to the CuO plane is treated as a perturbation. Single-particle fermionic wave functions and possible charge carrier energies were determined. The competing existence of superconducting and normal regions in such a sample is shown in agreement with experimental data. The conditions for the formation of superconducting states and limiting values of current density in planes parallel to the boundary surfaces (in CuO planes) were obtained and considered.

Keywords: High-temperature superconductivity, copper-oxide ceramics, charge carriers, dispersion law, energy states, critical temperature.

THE POSSIBILITY OF APPEARING OF LOCALIZED STATES OF ELEMENTARY CHARGES IN ULTRA-THIN CRYSTALLINE FILMS

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Abstract: The dispersion law of elementary charges (electrons or holes, hereinafter: electrons) in perturbed nanodimensional crystal film-structures (with variable boundary parameters) was analyzed by the method of two-time and temperature-dependent Green's functions. In contrast to unbounded structures, the energy spectrum of charges in the film has two gaps, and the range of charge energies is strictly discrete and narrower, and highly dependent on the boundary conditions of the film. The paper found and discussed the conditions for the appearance and existence of localized electron states as a function of the size of the boundary parameters.

Keywords: Crystals, ultrathin films, electrons, dispersion law, localized states.

ENERGY STATES OF ELEMENTARY CHARGES IN CRYSTALLINE FILMS

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Abstract: The spectrum of energy states of elementary charges (eg electrons or holes, hereinafter: electrons) in crystalline thin-layer structures was investigated by the method of two-time, temperature-dependent Green's functions. In contrast to unbounded (bulk) crystal structures, the energy spectrum has two gaps, and the zone of allowed electron energies is narrower and discrete. The size of the gaps and the width of the zone depend on the thickness of the film: the gaps decrease sharply, and the width of the zone increases sharply with its increase. The effective mass of electrons in the film, compared to the bulk structure of the same physicochemical and crystallographic characteristics, remains unchanged, which means that the presence of boundaries does not affect the fundamental properties of electrons.

Keywords: Crystals, thin films, electrons, spectrum of energy states, effective mass of charge carriers.

SPECTRA AND CHARGE CARRIER STATES OF GRAPHENE NANORIBBONS

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Abstract: By the calculation of wave functions, the paper analyzes the spectra of charge carriers in graphene nanoribbons with different ends. Two extreme edge cases are considered: zigzag and armchair type, which correspond to chiral angles of 0º and 30º, respectively. Such edge disturbances can significantly change the properties of edge charge states and can lead to Anderson localization, anomalies in the quantum Hall effect, Coulomb blocking, etc. It is shown that surface states appear at zigzag edges, and for long strip lengths surface states have zero energy at the Fermi level. With armchair-type edges, surface states do not occur. It is shown that surface states appear at zigzag edges, and for long strip lengths surface states have zero energy at the Fermi level. With armchair-type edges, surface states do not occur.

Keywords: Graphene, nanoribbons, electrons, energy spectrum, localized charge states.

MINERAL TRIOXIDE AGGREGATE APPLICATION IN NON SURGICAL ENDODONTIC TREATMENT OF RIGHT CANINE IN MANDIBULAR FRACTURE LINE - CASE REPORT

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Abstract: Mineral trioxide aggregate (MTA) is a dental material hydrophilic and biocompatible endodontic cement, with properties to stimulate healing and osteogenesis. MTA was developed for endodontic treatment in use to create apical plugs during apexification, for treatment of internal root resorption, repairing root perforations during root canal therapy, and pulp capping. Cement is formulated from Portland cement, combined with bismuth oxide powder for radiopacity. In base of this cement is powder of tricalcium-oxide, silicon- oxide and bismuth-oxide and other hydrophilic particles (tricalcium silicate and tricalcium aluminate) responsible for physical and chemical properties of this aggregate (Ph 12,5, antibacterial good hardens and good consistency unlike $Ca(Oh)_2$. Patient 14-year-old male child receives a blow in the area of right side of mandibula. After manual reposition of fractures fragments and intermaxillary immobilization and dental follow-up for canine who is on fractures line is performed. Radiological and clinical follow up on 7, 14, 20 and 90 days. After this period it is determined that the clinical and radiological parameters indicate pulp necrosis and endodontic treatmen of the canine was performed. After irrigation with ethylenediaminetetraacetic acid 17% and 2% of NaOCl endodontic canal root sealing is performed with MTA and gutta-percha point. This case report describes a non-surgical management of a mandibular canine with open apex and necrotic pulp which is located on the fracture line of the mandibula. Using biocompatible material such as MTA in this case leads to satisfactory results in apexification and successful apical and canal root system sealing.

Keywords: dental material, Portland cement, root canal sealing, mineral trioxide aggregate, osteogenesis.

ANALYSIS OF GEOTECHNICAL CONDITIONS OF THE TERRAIN AT THE SILO CONSTRUCTION LOCATION IN THE "MOLARIS" KOZLUK MILL COMPLEX, ZVORNIK

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Apstract: The planned construction of the facilities is related to the terrain of complex geological structure, built of semi-stony rocks. A more significant presence of tectonic movements has developed relatively regular folded forms, which complicate the foundation of planned buildings in the research area. The facilities are of the type of modern silos made of metal structures and do not require a deep foundation.

The terrain is morphologically developed, and the location is located at the foot of the slope. For the previously built facilities at the foot of the slope, a wider plateau was created, which in the hinterland was manifested by a subvertical notch about 6.0 m high. Investigations were carried out with boreholes in the axis of the silo, and the data were correlated with the data on the open terrain profile. By analyzing the layers in more detail, six geological environments were singled out, three of which were analyzed for building foundations.

The calculation results obtained using the form three method, which are most often applied today, are quite consistent. They were analyzed according to the rock classifications of different authors and show that they are within the limits of the permissible bearing capacity of the rocks for the given loads. They were also analyzed in the RocLab system, where the rock massif was observed as a whole. For the analysis of the physical-mechanical characteristics and rating of the state of the rock mass, the lower values of the laboratory tests were chosen, and for the rock mass the data were taken from the RocLab program package.

Keywords: geotechnical environment, geotechnical conditions, rock characteristics, RocLab.

RESEARCH ON THE ECONOMIC AND ENERGY ASPECTS OF THE TRIBOLOGICAL PROPERTIES OF AUSTEMPERED DUCTILE IRON

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Abstract: Tribological properties of austempered ductile irons, as well as of the other materials, are being determined by measuring the friction force in tribo-mechanical systems (energetic aspect) and by measuring wear parameters (economic aspects). Tribological properties two sort of austempered ductile irons arc presented with both aspects. Experimental programme is realized on tribometer “Pin on Disk". PQ index is used as wear parameter for wear intensity determination.

Keywords: energy aspect, economic aspect, tribometer, ductile iron.

APPLICATION OF CORDIERITE CERAMICS IN CASTING TECHNOLOGY

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Abstract: Standard raw materials, kaolin and talc, were used in the synthesis of cordierite ceramics. The cordierite composition corresponded to 2 MgO - 2 Al_2O_3 - 5 SiO_2. Sintered cordierite was used as a refractory filler in the ceramic coating for evaporative polystyrene patterns in the new casting technology known as the Lost Foam process. Cordierite characterization was carried out by means of X-ray structure analysis. The characteristic temperatures for carrying out solid-state reactions in the three-component system of 2 MgO - 2 Al_2O_3 - 5 SiO_2 were determined differentially by thermal analysis in the range from ambient temperature to 1200°C. The obtained ceramic coatings were applied using the "full mold" casting method. For realistic evaluation of possible cordierite application in the production of evaporative pattern ceramic coatings, concurrent analyses with talc-based coatings were carried out. While cordierite has wide applications in the electrothermic, electronics, and engineering industries, it has not yet been used in casting.

Keywords: cordierite ceramics, lost foam process, ceramic coating.

EXAMINATION OF THE POSSIBILITY OF OBTAINING BIODIESEL FROM UNREFINED SUNFLOWER OIL

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Abstract: The paper examines the possibility of obtaining biodiesel from unrefined sunflower oil, with the aim of evaluating its potential as a sustainable and renewable energy source. The transesterification process was used to convert unrefined oil into biodiesel, using potassium methoxide as a catalyst. Glycerol was obtained as a by-product in the process of transesterification of unrefined sunflower oil. The physico-chemical characteristics of the input oil and the obtained biodiesel were performed for the purpose of characterization. The results were compared with biodiesel standards in order to assess the quality of the final biodiesel product obtained

Keywords: biodiesel, unrefined sunflower oil, renewable fuels, transesterification.

EXAMINATION OF THE POSSIBILITY OF OBTAINING BIODIESEL FROM SUNFLOWER OIL AND VARIOUS WASTE EDIBLE OILS

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Abstract: Due to limited oil supplies and high procurement costs, there is a growing interest in alternative fuels. Biodiesel, produced from renewable sources such as vegetable oils, animal fats and used edible oils, is a sustainable alternative to diesel.

Biodiesel can be used in diesel engines, providing environmental benefits such as reducing land, water and air pollution, and reducing carbon dioxide emissions, which helps reduce the greenhouse effect. This paper investigates the production of biodiesel from sunflower oil and waste edible oils. The transesterification process was used to convert these oils into biodiesel, using a homogeneous catalyst. Physico-chemical analyzes were carried out on input oil samples and obtained biodiesel. The results showed that from both oils can produce biodiesel that meets international quality standards for biodisel.

Keywords: biodiesel, biofuel, sunflower oil, waste edible oils.

ANALYSIS AND INITIAL QUALITATIVE ASSESSMENT OF RED MUD IN THE BAYER PROCESS

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Abstract: In the research, the residues from the leaching of bauxite in the Bayer process, are the so-called red mud samples. The samples were subjected to chemical methods to determine the concentrations of components in red mud, such as SiO_2, Fe_2O_3, Al_2O_3, CaO and TiO_2. Spectrophotometric and gravimetric methods were used. X-ray diffraction (XRD) analysis provided results regarding the identification of crystal structure in red mud, specifically the compounds comprising its composition. Additionally, analysis of red mud using scanning electron microscopy (SEM and EDS) revealed the microscopic appearance of red mud at high magnification.

Based on the experimental data, it was concluded that the red mud contains the most mineral forms of iron, with over 50%, followed by aluminium, then silicon, calcium and the particularly interesting mineral forms of titanium, respectively. Titanium mineral form constitutes the smallest proportion, among those examined, approximately 5.5%. XRD analysis identified compounds present in red mud, including hematite (Fe_2O_3), hydro-granate ($Ca_3Al_{3,5}H_{9,785}O_{12}$), perovskite ($CaTiO_3$), cancrinite ($Na_4Al_3Si_3O_{14,35}$), diaspore (AlOOH) и boehmite (AlOOH).

Keywords: Bayer process, bauxite, chemical analysis, red mud, titanium (Ti).

CORRELATION ANALYSIS OF FORCE PARAMETERS ASSIGNED TO TIME SERIES DATA

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Abstract In a complex system, determinism without chaos, determinism with chaos, and stochasticity are intertwined, making the behavior of such a system difficult to predict. In this model, time series data are linked to time-dependent force parameters using Newton's second law. The correlations between these force parameters are calculated, and a correlation matrix is created. The values of the determinants of the correlation matrix are then computed. The relationship between the determinant values and the prediction of the behavior of the complex system is considered. This type of rough forecasting model can be valuable for studying earthquakes, movements in stock markets and stock indices, as well as predicting fluctuations in daily and monthly temperatures.

Keywords: Newton's second law, correlation matrix, complex systems.

THERMOPLASTIC UNIDIRECTIONAL LAMINATES BASED ON CARBON FIBERS: AUTOMATED PRODUCTION AND MECHANICAL CHARACTERIZATION

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Abstract: Thermoplastic composites are ideal materials for aerospace, automotive and other industries where the use of high-performance advanced materials directly enhances their capability. Automated manufacturing is widely used to manufacture advanced composite laminates from unidirectional prepregs. Unidirectional (UD) continuous fiber reinforced tapes with high fiber content are used as semi-finished material. These tapes are usually fully impregnated and consolidated. Within the thermoplastic tape placement process, tapes are melted by a heat source like, laser beam, infrared light, hot gas torch, and bonded to laminates by compaction force induced by a consolidation roller. During consolidation step, the tapes are cooled down to tool temperature. In this study, we have produced unidirectional laminates from carbon UD thermoplastic tapes with different matrices: PEEK, PPS, PEKK and by using of laser assisted automate tape laying process (LATL).

Automated Fiber Placement (AFP) and Automated Tape Laying (ATL) are the two main technologies that are used to make composite parts. Both processes use robotic system to lay one or several layers of uunidirectional prepreg tape onto a tool to manufacture a part. Each layer can be laid with different orientation, which benefits a structure capable to carry load in their required direction. Each tape is pressed to the mould by a roller for proper compaction. LATL consists of three main steps: impregnation, consolidation and crystallinity. Impregnation is a parameter that cannot be controlled by automatic fiber/tape laying while consolidation and crystallinity can be controlled. Consolidation consists of two sub-processes: intimate contact and autohesion. To achieve better final characteristics of the thermoplastic composite it is necessary to achieve a good degree of intimate contact and good self-connection.

This paper examines the impact of compaction roller on several types of thermoplastic matrices that have different flows after melting. The aim is to reduce the percentage of pores in the lamina that is present in the material itself, because process parameters cannot reduce the voids in the tape that has the raw material itself. The results show that the compaction roller in the LATP process for given materials reduces the percentage of pores present in the laminate of the raw material. This is another reason that the impregnation of the prepreg used in this technology is a key part of the final product.

After a good selection of technological processes, the composite laminates were manufactured using LATL (in-situ laser assisted tape laying). The carbon fiber volume fraction was 60% in the CF/PPS laminate/ CF/PEEK laminate and CF/PEKK laminate. Then the composite laminates were cut into a specimen by a water-cooled diamond saw, for mechanical characterisation. In this study, flexural strength tests were used to determine the bonding strength of tape with laser. For all three types of laminate plates, it has been found that the processing temperature and the compact pressure of the roller significantly influence on the flexural strength of the laminate plates. This research will present and discuss some of laser control system variables and final properties of flat panel specimens, manufactured with conventional LATL process. Following the experiments, the damage and fracture morphologies of composite specimens after failure were examined by scanning electron microscope (SEM).

Keywords: thermoplastic prepreg, automated tape laying, automated fiber placement, interlaminated bonding, flexural strength, scanning microscopy.

SPECTROPHOTOMETRIC CHARACTERISTICS OF PRINTED NONWOVEN TEXTILE

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Abstract: In this study, the spectrophotometric characteristics of samples screen-printed with alginate paste (CHT-NV) and modified bentonites on nonwoven textiles were examined. Sodium bentonite was modified with $CuSO_4 \cdot 5H_2O$ and $ZnSO_4 \cdot 7H_2O$ in different percentages. An alcoholic extract of Picea omorika (conc. 100 mg/mL) was added to all printing pastes. Color coordinates and spectral reflectance curves in the visible region were measured. The color difference (ΔE) and color strength (K/S) were analyzed. The sample with added sodium bentonite showed an unnoticable color difference compared to the sample printed with the extract alone. However, this difference became noticeable with the addition of further modified bentonites in the paste. When sodium bentonite modified with $ZnSO_4 \cdot 7H_2O$ was used, an increase in $ZnSO_4 \cdot 7H_2O$ percentage resulted in a linear decrease in color difference. The most intense coloring was observed in the sample with bentonite modified with copper ions and the lowest percentage of zinc ions. As the percentage of zinc ions increased, the color intensity decreased. Consequently, the sample with sodium bentonite modified only with $ZnSO_4 \cdot 7H_2O$ showed the smallest K/S value.

Keywords: Bentonite, plant extracts, spectrophotometric characteristics, color strenght, printed textiles, nonwoven textile.

OPTICAL PROPERTIES AND EFFECTS OF EFFECTIVE VOLTAGES ON DIELECTRIC PROPERTIES OF FERROELECTRIC $LINBO_3$

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Abstract: Lithium niobate is a ferroelectric material suitable for a variety of applications. Its versatility is made possible by the excellent electro-optic, nonlinear, and piezoelectric properties of the intrinsic material. It is also used as a substrate for crystal growth, so it is very important to know the response of the material to the applied electric field.The dielectric and optical properties of lithium niobate single crystal were tested, and the effects of different effective voltages on dielectric permittivity, dielectric loss and conductivity were analyzed. The frequency dependence of the dielectric permittivity, dielectric loss, and ac conductivity have been examined in frequency (20 Hz–200 kHz) range. The optical properties were studied on the basis of the absorption spectra in the UV-Vis region.

Keywords: lithium niobate, dielectric properties, absorption.

TITANIUM MATERIAL ON FACADES OF FRANK GEHRY

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Abstract: At the beginning of the 1960s, a powerful urban creator, the Canadian-American architect Frank Gehry, appeared in the world of architecture, whose designs of public buildings, with complex spatial geometry, moved the previous conventional norms and created icono-architectural, artistically attractive forms in space. The designed facades of the buildings, featured titanium concave curves, light-reflecting polygonal brushed steel sheets produced by the company "A. Zahner" in Kansas City. With them, he achieved charming, attractive looks of volume in the space, suppressing the old artefact forms. With his unique, captivating vision and fantastic synthetic approach, he permanently changed the cultural-aesthetic and design view of new materially contemporary urban transformations. Steel-titanium sheets with excellent properties: high resistance to corrosion, and physical-mechanical resistance to air, energy and chemical impacts at high and low temperatures, brought an innovation of historical urban planning significance. By implementing complex spatial geometry, defying the laws of gravity and established conventional norms in urban architecture, resulted in unique visual sculptural-artistic possessed only by the most famous structures in the world. In chronological order, the paper presents a combination of ten of Gehry's most famous archi-sculptural buildings, which at the end of the previous century and the beginning of the present century pushed the boundaries of planning and design.

Keywords: titanium material, facade panels, concave curves, archisculpturality, complex geometry.

A NEW APPROACH TO DETERMINING FORGERY OF DOCUMENTS USE OF PHYSICAL-CHEMICAL METHODS

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Abstract: The development of new materials and their very rapid application in science and technology, as well as in everyday life, is accompanied by the development of criminal activities of groups and individuals. The application of physico-chemical methods in the current way of determining forgery of documents is usable in cases where the written text on the printer, the signature and the impression of the seal had points of contact, i.e. touched with some of their elements (letters of the printed text with the beginning or end of the signature, as well as with with a stamp). In a large number of cases, with a high degree of certainty, a skilled expert was able to show whether it was a forged or genuine document. The newly created situation was followed by criminal circles, who began to pay attention to the falsification of documents. There are more and more falsified documents on which there are no points of contact with the elements on them. In this paper, a new approach to determining the forgery of documents, in which there are no points of contact with their elements (letters of the printed text, signatures, seal impression), using the method of polarization and electron microscopy, is processed.

Keywords: Forged document, forensics, polarization, electronic microcopy.

CRITERIA AND INDICATORS OF FOREST MANAGEMENT IN THE REPUBLIC OF SRPSKA

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Abstract: Successful monitoring of forest management is based on criteria and indicators of the quality of forest ecosystems. In this sense, methods of comparing specific forests with reference models or with the remaining old forest communities are used. A number of parameters are used as indicators (quantity and quality of volume and volume increment, health status, degree of renewal, origin and method of establishment of forests, etc.). The indicators provide feedback on the basis of which decisions can be made on future activities in order to improve the general condition and functions of forests. For the implementation of the strategic goals of sustainable development of the European Union's forestry, criteria are used that enable the adoption of forestry policy, forest management plans and the development of cross-sectoral cooperation. At the level of the European Union, six pan-European criteria have been defined, and due to the specifics of forestry and the regional character of the forests of the Republic of Srpska, their harmonization has been carried out on the basis of 40 sub-criteria and 70 indicators have been defined. This paper includes quantitative indicators related to the silvicultural quality of stands.

Keywords: Criteria, indicators, forest management, sustainable development, stand quality.

EFFECT OF MODIFIED BENTONITE ON PERMITTIVITY AND DIELECTRIC LOSS TANGENT OF NONWOVEN TEXTILES

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Abstract: In this paper the dielectric properties, such as permittivity and loss tangent, of the printed nonwoven textile were studied in detail. The samples were screen printed using alginate paste (CHT-NV) with bentonite modified with sodium, copper and zinc ions in different percentages. Conductance and susceptance were measured in a broad frequency range and at temperature 298 K. It was analyzed how the addition of the previously mentioned bentonites affected the dielectric properties. A possible relationship between the concentration of copper and zinc in the samples and the value of the dielectric permittivity was considered. The sample with the highest concentration of zinc in the paste has shown the highest permittivity over the entire frequency range, while the dielectric loss tangent has very low values for all tested samples. The dependence of conductivity on frequency for these samples was also considered. Although this dependence was qualitatively the same for all samples, a certain change in the conductivity values can be observed.

Keywords: Nonwoven textile, bentonite, permittivity, dielectric properties, AC conductivity, printed textiles.

INFLUENCE OF PROCESS PARAMETERS ON THE SORPTION CHARACTERISTICS OF ALUMINUM HYDROXIDE

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Abstract: In this work, the influence of process parameters on the sorption characteristics of aluminum hydroxide is investigated. The starting materials used to obtain finely precipitated hydrate were aluminate solution and seed crystals of aluminum hydroxide. The effect of caustic modulus of aluminate solution at constant temperature was examined, followed by the influence of specific surface area of seed crystals on crystallization, as well as the effect of sulfate in aluminate solution on the formation of particles of finely precipitated aluminum hydroxide and on the resulting slurry. Samples were analyzed for particle size distribution, specific surface area, and slurry sorption. Additionally, scanning electron microscope (SEM) results showed differences in particle morphology of the obtained finely precipitated hydrate.

Based on experimental data, it was concluded that reducing the caustic modulus results in finer particles of finely precipitated hydrate, thereby enhancing specific surface area and intensifying slurry sorption.

Keywords: aluminate solution, aluminum hydroxide, crystallization, sorption.

THE STUDY OF THE INFLUENCE OF LUBRICATING OIL ON THE TRIBOMECHANICAL SYSTEM

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Abstract: The movement of the elements of machine systems with the least possible loss of energy and prevention of their damage is the goal of diesel engine manufacturers. In this paper, an analysis of the application of semi - synthetic motor oil is presented. Physical and chemical analyzes of engine oil used in agricultural machinery, i.e. in tractors CASE 9220, John Deere 8320 and John Deere 6820, were performed. Conclusions are given regarding the application of engine oils in diesel engines from the aspect of degradation, i.e. the impact on the elements that are exposed to the wear process.

Keywords: motor oil; contamination; friction coefficient; time of interrogation of oil.

DEFINING PHOSPHATE TUNGSTEN BRONZE STRUCTURE THROUGH THE FRACTAL DIMENSION

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Abstract: The investigation of layered material named phosphate tungsten bronzes (PWBs) was done. Those are materials with pentagonal and hexagonal tunnels obtained by thermal collapsing of Keggin's structure. These orderly-arranged structures are interesting for numerous applications due to their different chemical, optical, electrical and mechanical features. Here, the results of fractal analysis of those structures were presented. This is important for defining the patterning in PWBs structures as well repeating these paterns whithin the structure.

Keywords: PWBs, fractal dimension, material structure.

THE MAP OF SOLAR RADIATION FOR FIVE MUNICIPALITIES LOCATED IN THE SOUTHEASTERN AND EASTERN PART OF THE REPUBLIC OF SRPSKA

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Abstract: The world's transition process to renewable energy sources emerged as its commitment to limit global warming, mainly caused by the greenhouse gas emissions. Solar energy drives most of the processes on the planet, and it can be directly converted into electricity by using photovoltaic technologies. This way of electricity generation proves to be one of the most promising in the achieving the aforementioned goal. Among all renewables, Bosnia and Herzegovina mostly exploits hydropower, whereas its solar potential is almost untouched. In this paper, we produce the map of solar radiation for five municipalities located in the southeastern and eastern part of the Republic of Srpska. The map is obtained by using the Photovoltaic Geographical Information System (PVGIS) database. For selected towns, we present average daily irradiation, average monthly and yearly global horizontal irradiation, direct normal irradiation, global irradiation at optimum angle as well as diffuse to global ratio and average temperature. Besides, we give estimates of electricity that could be generated by solar power plants of 5kWp nominal power, installed on the rooftops of households or buildings. These estimates may guide householders in their decisions to harvest solar energy as independent energy producers.

Keywords: renewable energy sources, solar radiation, photovoltaic technologies, solar power plants.

EXCITATION SPECTRUM IN THE ANISOTROPIC XXZ TRIANGULAR ANTIFERROMAGNETIC MODEL: APPLICATION TO $BA_3COSB_2O_9$

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Abstract: We investigate the excitation spectrum of the antiferromagnetic Heisenberg XXZ triangular lattice model using the method of two-time spin Green's functions. The single-magnon spectrum was calculated in the approximation of random phases, for all values of the anisotropy parameter in the range $0 < J_z < J_1$. We tested our model on the concrete compound $Ba_3CoSb_2O_9$. The obtained theoretical results show a good agreement with the experimental measurements for the mentioned compound. Also, the excitation continuum that is generally present in two-dimensional frustrated spin systems such as this compound is clearly manifested.

Keywords: excitation spectar, spin anisotropy, anisotropic antiferromagnetic Heisenberg model.

SOME ISSUES OF THE DEVELOPMENT AND APPLICATION OF SUSTAINABLE AVIATION FUEL, SAF FROM THE ASPECT OF CO_2 EMISSION REDUCTION

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Abstract: Sustainable Aviation SAF is the main name used by the aviation industry to represent non-conventional aviation fuel. Aviation has always been, and remains, a training ground for the demonstration of national, economic, scientific, technological and military prestige in the world. In the last decades of the twentieth century, the development and use of sustainable alternative jet fuels emerged as a key factor in reducing aviation-related CO_2 emissions. "Refuel Aviation" is an initiative that promotes the use of sustainable fuels, the so-called of SAFs (sustainable aviation fuels) for the decarbonization of air traffic, and represents the obligation of suppliers to increasingly sell sustainable fuels at all airports within the EU. Compared to the CO_2 emission produced during the flight of an aircraft with conventional hydrocarbon fuel, kerosene, JET A-1, the use of alternative jet fuels can reduce this emission by up to 80%, depending on the type of raw material used and the method of sustainable fuel production. Alternative fuels for air traffic were developed (and are being developed) in response to the growing emission of harmful substances that is a consequence of the increasing growth of this type of traffic. The paper gives a brief overview of some of the goals and obligations of the use of alternative jet fuels from the perspective of progress criteria and further predictions in aviation.

Keywords: alternative JET fuels - SAF, aviation, development.

ANALYSIS OF FLOW PHENOMENA IMPACT ON HEAT EXCHANGE IN AN AIR-COOLED CONDENSER

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Abstract: Air-cooled condensers have become increasingly prevalent in large thermal power plants in recent years. The primary advantage of such a system for water vapor condensation is the absence of the need for water (such as a river or lake) at the power plant site, which is typically necessary for conventional water-cooled condensers. Consequently, a thermal power plant employing an air-based condensation system can be located near a mine site regardless of the terrain. However, using ambient air as a cooling medium presents numerous challenges including low density, low specific heat capacity, relatively high temperatures, and often unpredictable meteorological parameters, particularly wind speed and direction, as well as ambient air temperature that can significantly impact the operation of this type of condenser. Moreover, as air-cooled condensers have been implemented in large power plants relatively recently, there exists a range of physical phenomena and dependencies that remain insufficiently explored but substantially affect plant operational stability. Hence, this study conducts an analysis of how changes in the air velocity entering the condenser cell affect the amount of heat removed from the condensing steam and the temperature gradient in the vicinity of the heat exchange surface of the condenser. The research was conducted at the "Stanari" Thermal Power Plant in the Republic of Srpska, currently the only large thermal power plant in Eastern Europe utilizing this type of condensation system at the time of writing.

Keywords: Air-cooled condenser, thermal power plant, power generation facility, condensation, heat exchange.

ADHESIVE TYPE INFLUENCE ON THE COMPRESSIVE STRENGTH OF BEECH LVL REINFORCED WITH CARBON FIBER FABRIC

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Apstract: In this research, nine-layer reinforced laminated veneer lumber (RLVL) was produced using beech veneer by inserting woven carbon fibers between the veneer sheets. Panels were made in industrial circumstances with two types of adhesives - phenol-formaldehyde (PF) and polyurethane adhesive (PUR). The research aims to determine the influence of adhesives on the compressive strength in two directions of beech LVL reinforced with woven carbon fibers and its potential for use in load-bearing building structures. The experimental data was verified by the ANOVA model. Reinforced LVL produced using PF adhesive was stronger than those produced using PUR adhesive by 17.88% in longitudinal direction and by 31.89% in transverse direction. This research is part of an effort to encourage the implementation of hardwoods, especially beech, as renewable and ecologically sustainable material with long term use in load-bearing building structures.

Keywords: beech laminated veneer lumber, CFRP, reinforcement, polyurethane adhesive, phenol-formaldehyde adhesive, compressive strength.

UNDERSTANDING PUBLIC SENTIMENT AND TOPIC DYNAMICS ON WASTE MANAGEMENT IN THE BALKANS

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Apstract: This study will explore the dynamics of public opinion in Macedonia and the Balkans about the waste management situation, through a comprehensive analysis of X (former Twitter) data collected over the past ten months. By employing Natural Language Processing techniques, we aim to understand the sentiment and emotions expressed in tweets and identify the main topics of discussion related to the problem of waste collection, recycling, treatment, landfills and similar issues regarding waste management matters.

Our methodology will involve several key steps. First, we will perform sentiment analysis to classify tweets as positive, negative, or neutral, which will provide an overarching view of the general sentiment in the region. Next, we will employ topic modelling techniques to uncover the primary topics discussed on X. This will help us identify the key issues and concerns around waste among users in Macedonia and the Balkans. Furthermore, we will perform a geographical analysis to explore regional variations in topics and sentiments, providing insights into the local dynamics of public opinion across different areas within the Balkans.

Our findings will offer a detailed view of the public perceptions in Macedonia and the Balkans, highlighting the interaction between sentiments, events, and topical discussions on social media. This study will contribute to understanding regional social dynamics and provide a framework for analysing public opinion in other sociopolitical contexts using similar methodologies.

Keywords: waste management, analysis of X, natural language processing techniques.

DETERMINATION OF ACETALDEHYDE ADSORPTION ON SYNTHETIC ZEOLITES AND CHARACTERIZATION OF SAMPLES BY FTIR METHOD

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Abstract: Acetaldehyde is one of the most common carcinogenic organic compounds (pollutants) that can be found in the air in urban and industrial areas, as well as in indoor spaces. Generally, the most efficient method for removing pollutants from the air is adsorption with suitable adsorbents. To choose a suitable adsorbent, it is necessary to know its characteristics, the most significant of which is the adsorption capacity, i.e., the maximum amount of adsorbed substance per gram of adsorbent under given conditions. Nowadays, there is still a search for an adequate method that would provide an answer to how much and which organic substances are adsorbed on adsorbents. This paper presents the possibility of applying the FTIR analysis method for the identification and detection of adsorbed acetaldehyde on different types of zeolites. Adsorption of acetaldehyde from the gaseous phase was performed on ZSM zeolite (ZEOflair 100, ZEOflair 110), NaA zeolite (ZEOflair 1000), and the Na-form of mordenite (ZEOflair 800). Initial concentrations of acetaldehyde in the air ranged from 0.071 mol/m³ to 1.239 mol/m³, and the adsorption was carried out at atmospheric pressure, T=25 °C, and relative humidity (rH) 65%. On the FTIR spectra of the examined samples after adsorption, peaks were observed at a wavelength of 1700 cm^{-1}, which are characteristic of the carbonyl group of acetaldehyde. It was observed that the peak areas were proportional to the amounts of adsorbed acetaldehyde, which were very small and ranged from 0.107 mmol/g to 2.98 mmol/g of zeolite. Based on the obtained results, it can be concluded that FTIR spectroscopy, as a rapid and non-destructive method, can be used to determine the adsorption of acetaldehyde on different types of zeolites at very low concentrations.

Keywords: zeolites, acetaldehyde, adsorption, FTIR.

CAPACITY AND POTENTIAL OF SOLAR POWER PLANTS IN BOSNIA AND HERZEGOVINA

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Abstract: Solar energy, as a renewable energy source, can significantly contribute to the energy stability and sustainable development of Bosnia and Herzegovina. It is an inexhaustible, environmentally friendly resource that reduces dependence on fossil fuels and the emission of harmful gases.

The first photovoltaic (PV) power plant in BiH was built in 2012 in Kalesija, with a capacity of 120 kW. By the end of 2017, a total of 180 PV plants with a total capacity of 18.6 MW were built in BiH, representing only 0.37% of the country's total electricity capacity.

Potential locations for PV plants include residential rooftops, water surfaces of accumulation lakes, protective belts along highways, and non-perspective agricultural lands. It is predicted that the capacity of solar power plants in BiH will reach 705 MW by 2025, which would account for 14% of the total installed capacity in the country.

BiH is obligated to encourage energy production from renewable sources within the framework of the European Energy Community. The legislative framework at the entity level includes incentives such as guaranteed purchase prices for energy producers from renewable sources. However, there are limitations on the size of plants that can receive incentives, which restricts larger investments in solar plants.

Bosnia and Herzegovina has significant potential for the development of solar power plants, which is currently underutilized. Increasing installed PV capacities and adequate incentive measures can significantly contribute to the energy transition and sustainable development of the country. It is necessary to work on creating a more favorable legislative framework and incentive environment for investments in solar technologies.

Keywords: Solar energy, energy stability, potential locations, photovoltaic plants.

SOLAR ENERGY AND SUSTAINABLE DEVELOPMENT

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Abstract: Solar energy represents a significant solution for achieving sustainable development due to its environmental friendliness and unlimited supply. Technologies such as Concentrated Solar Power (CSP) and Photovoltaic (PV) systems are continuously evolving to meet growing energy needs. Their application reduces dependence on fossil fuels, which are major sources of pollution and greenhouse gas emissions.

Globally, the installed capacity of solar systems has significantly increased over the last decade. Solar energy has a broad range of applications, including electricity generation, water desalination, heating, and more. PV systems can be used commercially or installed in smaller groups for mini-grids or individual use. It has beneficial in rural areas and developing countries with abundant solar energy. CSP systems use mirrors to focus sunlight and produce steam that drives turbines for electricity generation.

One of the key aspects of solar energy is its contribution to sustainable development through job creation. Renewable energy technologies have created over 12 million jobs worldwide, with PV applications contributing over 3 million jobs. The number of employees in the renewable energy sector is expected to exceed 40 million by 2050.

Solar energy also plays a significant role in environmental protection by reducing carbon dioxide and other harmful gas emissions. According to the Paris Agreement of 2015, goals have been set to reduce global warming and achieve net-zero carbon emissions by 2050. These initiatives support the transition to sustainable energy systems that utilize renewable energy sources.

Solar energy is a key factor in achieving a sustainable future. Its application not only contributes to energy security but also enhances economic and social development through job creation and environmental protection. Further technological advancements and increased investments in solar projects are crucial for achieving global sustainable development goals.

Keywords: solar energy, sustainable development, opening new jobs, environment

THE RATE OF CHEMICAL ETCHING OF THE POLYMER DETECTOR LR115 AS AN IMPORTANT FACTOR FOR THE DETECTION OF IONIZING RADIATION

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Abstract: Solid State Nuclear Track Detectors (SSNTDs) are well known for the detection of ionizing radiation through track formation of heavy ionizing particles. The LR-115 detector is a commonly used SSNTD for the detection and measurement of Rn222 and its progeny. Various characteristics of these detectors, such as: energy "window", critical angle and calibration coefficient, which are relevant for the detection of ionizing radiation and above all α-particles, are the subject of a large number of studies. Several techniques of track revelation are known but, the chemical etching technique is the most frequently used in which tracks can be made visible under an optical microscope after chemical amplification via etching. So the surface chemical etching behavior of LR-115 polymer is an important parameter in the study of ionizing radiation. The surface chemical behavior is studied by etching process. The parameter studied is the thickness of polymeric sample for different time intervals at different temperatures and normality. The results are indicated in terms of bulk etch rate of LR115 detector is determined with very precision device Form Talysurf.

Keywords: Keywords: LR 115 Type 2, chemical etching, removed layer, bulk etching rate.

RESEARCH OF ENERGY EFFICIENCY OF HEAT PUMPS FOR HEATING

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Abstract: This article presents the components of heat pumps, cooling cycles, an example of heat pump application and its economy. The emphasis in the article is to show the energy efficiency of the heat pump in relation to the corresponding boiler plants. An economic analysis of individual solutions was performed according to economic criteria on the basis of which the proposed variants can be selected. Those analyzes assume technical concepts that directly determine the degree of profitability of the selected system. Such analyzes have usually never been done for classic energy systems, so since we were forced to do them without preparation, the transition to new technological concepts of obtaining heat energy was and still is slowed down.

Keywords: heat pumps, energy, efficiency, economy, boiler plants.

PERFORMANCE DEGRADATION OF SOLAR PHOTOVOLTAIC MODULES

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Abstract: Long-term reliability assessment of solar photovoltaic (PV) modules is very important to ensure the economic viability of the PV system. A number of factors that affect the degree of useful effect, performance and lifetime causes degradation of solar PV modules. One of the main reasons that contribute to the decline of solar PV performance is the problem of aging, so accordingly, the main causes, shortcomings, problems and challenges that affect it are identified, addressed and investigated as part of research and commercial purposes.

This paper analyzes many factors that affect degradation-aging of solar PV modules including: exposure to sunlight, temperature, moisture, dust, discoloration, cracks, and delamination. In addition, the effects of aging factors on solar PV modules performance are investigated, including lifetime, useful performance, material degradation, overheating, and misalignment from both visual and electrical characterization points of view. Degradation rates are determined by the ratio of module performance, temperature losses and energy yield, and visual inspection and electrical characterization are a fundamental part of the PV system evaluation process.

Electrical characterization methodologies for measuring the degradation rate of PV technologies are listed, where the accuracy of each method depends on the measuring equipment, data qualifications and filtering criteria, metrics and statistical data calculation methods.

Finally, directions for future research, best practices and recommendations for overcoming aging issues and achieving sustainable management and operation of solar energy systems are provided. For PV engineers, manufacturers and investors, the critical analysis, evaluation and research directions of this work can be very useful, because getting to know and conducting additional research and development on this aging issue would enable greater benefits with an increase in the lifespan of solar PV systems.

Keywords. Degradation models, loss of performance, solar photovoltaic (PV) modules, PV systems, aging, service life prediction.

POSSIBILITY OF PRODUCING PHOTOVOLTAIC ELECTRICITY ON BALCONY FENCE IN PIROT, SERBIA

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Abstract: In urban environments, PV panels are usually affixed on available buildings, but they can also be included in the initial architectural design of the constructions. PV panels mounting on/as balcony fences become frequent solution for creating PV systems in buildings. The idea of decentralized production and storage of electricity very close to the point of use represents an additional benefit. In this paper, the possibility of using PV panels in urban conditions, within the home installations of individual residential consumers with the placing of panels on the balcony fence, is analyzed. A detailed simulation of the complete PV system in the PVSYST software was used for the analysis of different mounting options for PV panels on the balcony fence. For an individual consumer from the "Household type 3" category with an annual consumption of about 6000 kWh, the installation of PV panels with a total power of 1650 Wp was analyzed. Different variants of installation of PV panels were simulated for the case of two different tilt angles (0^o (vertical position) and 60^o) and three different azimuthal orientations (south, east and west). Self-consumption is modeled through typical daily profiles, taking into account seasonal variation for a given type of consumer. The obtained results show that in the investigated PV system, photovoltaic energy can cover from 15.84% to 29.48% of considered household's self-consumption, depending on the tilt angle of the PV panels on the balcony fence and their azimuthal orientation.

Keywords: PV panel, balcony fence, electricity production, electricity consumption, household

INTERACTION OF ELION RADIATION WITH MATERIALS AND MODELING OF MATERIALS PROPERTIES AND GEOMETRIC SHAPES

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Abstract: The influence of electromagnetic radiation in various ranges, plasma, acoustic and nuclear radiation with its characteristic areas of energy density and power is an area that has been applied for years, according to the historical practice of certain categories of materials, implemented in the field of metrology as the measuring component of detector (track detectors LR-115 i CR-39) process monitoring systems and transmission lines. In the scale of influence, a source of elionic type is needed, which ranges from a slight modulation of material properties (changes in optical, thermal, electrical and other properties), up to destruction. Depending on the selected material, i.e. its application, it will influence its main role in the application and improvement of the properties, compared to non-irradiated materials in a broader sense. Related to the application, it concerns, for example, increasing the detection efficiency, changing the electrical properties, changing the atenuation coefficient or adjusting the impedance, higher microhardness, etc. In this paper, several different material types (wood, types of textiles, polymers) obtained from mechanical components, clothing or nuclear detectors, as part of the references, will be analyzed in terms of changes in properties, shapes, etc. in case of several specific conditions of exposure to coherent radiation by simulation, prediction of achieved temperature distributions for output assessment, i.e. the area in which there is a change in the aggregate state of the material, i.e. destruction. For several samples of the mentioned materials, experimental exposures will be performed by commercial laser systems for material processing, and the duration of some operations that can be achieved with various techniques, will be analyzed, as well as equipment for finding the parameters of a laser beam that would be suitable for given operations (contour cutting...).

Keywords: Keywords: Elion radiation, modeling of material properties, detector systems, efficiency.

INTERACTION OF LASER BEAMS WITH MATERIALS OF INTEREST TO DENTISTRY:HISTORY, PRAXIS AND TRENDS

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Abstract: In the era of coherent optics and its application in the diagnosis and modification of tissue-equiv avalent materials, there are many potentially interesting directions of development. However, depending on the problem, it is likely that a lot of time will be spent on the development to the degree that is allowed for a certain country, on the administrative side,for introduction of some new technique, which for various reasons shows a potentialfor development into a standard one.

The paper analyzes some of the diagnostic/measuring methods, which are of potential interest for a more complete understanding of a certain pathological condition and differences in relation to "normal" properties/parameters of biomaterials. On the other hand, considering the importance of the prosthetic material, in the current state of development, it is simple to manufacture, but there are some complex issues in case of biocompatibility. In general, material compatibility is still a problem. Especially, in the field of diagnostics, many possibilities for treatment, surgery and others have appeared.

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Keywords: lasers, dentistry, meterials.

COLLAGEN-BASED BIOMATERIALS AND THEIR APPLICATION IN REPRODUCTIVE MEDICINE

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Abstract: Collagen, as the most abundant protein in mammals and the main component of the extracellular matrix (ECM), is widely used in the preparation of biomaterials and the treatment of various diseases. High biocompatibility makes collagen the perfect biomaterial for implantable medical products and scaffolds. In recent years, the application of collagen-based biomaterials in reproductive medicine has attracted increasing attention, providing innovative approaches in the treatment and regeneration of reproductive organs. Furthermore, collagen-based biomaterials such as collagen hydrogels, decellularized extracellular matrix (dECM), and bioengineering techniques, including collagen-based three-dimensional (3D) bioprinting, facilitate reproductive tissue engineering. Taking all this into account, the aim of this review was to highlight the recent progress and possibilities of collagen-based biomaterials for reproductive tissue engineering as well as their application in reproductive medicine. The integration of collagen-based biomaterials in reproductive medicine is promising, opening the way to more effective treatments, reducing complications and improving the quality of life of reproductive health patients.

Keywords: collagen, collagen-based biomaterials, reproductive medicine.

DIFFERENT MODELS OF IMPLANTATION IN THE STUDY OF BIOMATERIALS FOR BONE TISSUE ENGINEERING APPLICATIONS

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Abstract: There are numerous different *in vivo* testing models used for preclinical assessment of biomaterial biocompatibility and for studying tissue regeneration. The ectopic subcutaneous implantation model in mice and rats is one of the most widely used models for preclinical testing of tissue response to biomaterials. Bone tissue injuries are often studied using orthotopic models of artificial bone defects. The aim of this study is to provide a comparative overview of different animal implantation models used to evaluate the biocompatibility of biomaterials intended for bone tissue engineering applications. The ectopic subcutaneous implantation model can provide information on biomaterial biocompatibility, tissue response, the ability to induce angiogenesis and osteogenesis, as well as the level and time of bioresorption of the biomaterials. Ectopic implantation models of bone substitutes provide a simple approach for assessing tissue integration and biomaterial biocompatibility in the physiological environment, but they lack the biological influences of bone factors from the bone which could modulate the osteogenic process. On the other hand, studies of orthotopic implantation models of calvaria, jawbones, and long bones (most commonly tibia or femur) defects allow the examination of biomaterials under the mechanical and biological conditions that exist in bone tissue. In calvaria defects, the biomaterial comes into contact with a poorly developed vascular network of bone, while in defects made to full depth in long bones, the biomaterial has direct contact with the bone marrow. The mentioned differences in these models suggest that the pattern of tissue integration of biomaterials cannot be assessed through just one tissue engineering approach and one implantation model. There is a need for comparation and consolidation the results obtained from different implantation models in order to investigate the specific aspects of tissue response to biomaterials under various conditions and to evaluate biocompatibility, biofunctionality and effectiveness of biomaterial application.

Keywords: animal models, *in vivo,* biomaterials, bone tissue engineering, ectopic implantation models, orthotopic implantation models.

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WATER MANAGEMENT AND ENVIRONMENTAL ISSUE IN CORRELATION TO FOOD OR ENERGY PRODUCTION

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Abstract: Water resources management is a particularly complex research area. Water is the basic substance on earth, which provides life. It is the living environment, the source of health and life. Every living being is mostly made up of water. Although man strives for the development of eco-materials and eco-technologies within his activities, many of his activities nevertheless threaten and reduce the amount of clean water on planet Earth. At the same time, water is necessary for food production. The construction of hydrotechnical facilities, such as dams and canals for irrigation and drainage, introduces into research the question of whether a cubic meter of water will be used for food production, or for the production of renewable energy, which is also necessary as electricity – paradigm of contemporary survival. Water makes and gives health and life, but it can also threaten it with its enormous destructive power. This research encompasses correlation within the water, food, energy and environment nexus. The main cause-and-effect relationships will be analyzed. Examples of positive practice from around the world will be given, as well as risk events in which water has endangered people and the environment, and vice versa, examples of human-made water pollution, with a discussion of remediation methods.

Keywords: water, environment, food production, energy production, management.

INDOOR RADON SURVEY IN REPUBLIC OF SRPSKA AND DOSE ASSESSMENT

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Abstract: Indoor radon and its decay products are the primary sources of the population's exposure to background ionizing radiation. Radon decay products are one of the leading causes of lung cancer, with a higher lung cancer risk for smokers due to the synergistic effects of radon decay products and cigarette smoking. Radon measurements in the Republic of Srpska have been conducted over the past 15 years. The results indicate significantly elevated concentrations in some cities of Srpska, which necessitates consideration of the doses received by the population from natural radiation sources. This paper presents the results of radon measurements in seven cities of Srpska, calculates the average doses, and compares them with effective dose results measured globally which amounts to 1.3 mSv due to inhalation of radon in indoor environments. Cost-efficient mitigation methods exist to reduce radon in existing buildings, and to prevent radon entry into new buildings.

Keywords: radon, effective dose, concentration.

TOXICITY OF NANODIMENSIONAL MATERIALS AS A FACTOR OF USABILITY IN BIOMEDICAL ENGINEERING

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Abstract: In biomedical sciences, the interaction between the materials used during the most diverse medical procedures and the tissues of a living organism is a basic prerequisite in terms of the usability of the used materials. The interaction between these two worlds depends on many factors, and the basic task of biomaterials science is to establish the possible conditions under which a harmful effect of materials on tissue can occur. This paper deals with issues of toxicity of nanodimensional materials as an elementary factor for determining its usability in medicine, from the aspect of understanding and measuring its biocompatibility. It can be considered that nanotoxicology is a separate scientific discipline, which has the task of determining whether and to what extent the properties of nanodimensional materials pose a danger to the organism, the individual health and the environment in which the individual is surrounded.

Keywords: nanotechnology, biomedicine, toxicity, biocompatibility.

THE INFLUENCE OF THE ADDITION OF TIO_2 NANOPARTICLES ON ANTIMICROBIAL ACTIVITY AND SURFACE PROPERTIES OF DENTURE BASE POLYMETHYL METHACRYLATE MATERIAL

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Abstract: Introduction: Polymethyl methacrylate (PMMA) represents the gold standard in the production of mobile prosthetic restorations. From a biological point of view, the main drawback of PMMA is its susceptibility to dental plaque accumulation and resistant microbial biofilm formation. One of the most frequently present microorganisms in the oral cavity, which has a tendency to form a resistant biofilm and cause an inflammatory response of prosthesis supporting soft tissues, is Candidae albicans.

Purpose: The purpose of this work is to determine the influence of prosthesis base modification TiO_2 nanoparticles on surface characteristics and Candidae albicans antimicrobial activity.

Material and method: The evaluation surface characteristics and their relationship with the intensity of biofilm accumulation was observed through surface roughness, contact angle and zeta potential. Antimicrobial potential was observed through inhibition degree of Candidae albicans biofilm formation.

Results: The addition of TiO_2 nanoparticles leads to a decrease in roughness, while the contact angle is registered between hydrophobic and hydrophilic values. The addition of TiO_2 particles causes an increase in the zeta potential. Modification of the prosthesis base with the addition of TiO_2 nanoparticles reduces the accumulation of CandidaeAlbicans biofilm.

Keywords: polymethyl methacrylate, TiO_2 nanoparticles, antimicrobial activity, Candidae albicans, surface roughness, zeta potential, contact angle.

RAPID PLAN IN PROSTATE CANCER TREATMENT PLANNING

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Abstract: 52 prostate cancer plans have been prepared. CTV is defined as the prostate bed, prostate or prostate + seminal vesicles. Delineated organs at risk (OAR) are bladder, rectum, femoral heads, penilebulb, colon and smallbowel. Each plan used for training model was planned manually by experienced physicist with one full arc (30 degrees collimator), in Eclipse treatment planning system (TPS), version 15.6 . Treatment energy was 6X. These plans were used to train the KBP model using Varian RapidPlan. Goodness of fit statistics is checked for each structure in training log. Outliers were identified and their removal from the model was considered. According to training log data, coefficient of determination for each OAR is higher than 0,7 (R^2>0,7). Chi square is close to 1, except for penile bulb (χ^2≈1,2). Also, other statistical parameters are within the thresholds.

Keywords: knowledge based planning, RapidPlan, prostate, VMAT.

ION-EXCHANGE RETENTION MODELS IN THE ANALYSIS OF RETENTION MECHANISMS OF AMITRIPTYLINE HYDROCHLORIDE AND ITS IMPURITIES IN HYDROPHILIC INTERACTION LIQUID CHROMATOGRAPHY

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Abstract: Hydrophilic interaction liquid chromatography (HILIC) is used for analyzing small polar molecules, especially in pharmaceutical field sciences. Retention mechanisms in HILIC are complex, with interactions between the surface of the stationary phase and analytes in the mobile phase being crucial for separation. The retention mechanism varies with different mobile and stationary phase pairs and depends on the type and ionic state of analytes. Therefore, this paper aimed to evaluate the contribution of anion-exchange and cation-exchange retention mechanisms to the overall retention of amitriptyline hydrochloride and its impurities denoted as A, B, C, D, F, and G on amino and silica stationary phases in HILIC, respectively. High R^2 values (> 0.995) indicate a significant cation exchange contribution to the retention of charged analytes in the silica stationary phase (non-ionized analytes – impurities A and G, did not exhibit ion-exchange retention). Basic analytes show longer retention at lower buffer ionic strength due to reduced competition with buffer ions. Higher pH increases retention of charged analytes by ionizing the surface of the silica stationary phase, especially for highly hydrophilic analytes like impurity F. On the other hand, higher buffer ionic strength promotes the retention of basic analytes on the amino stationary phase due to reduced electrostatic repulsion between the analytes and the surface of the stationary phase. However, R^2 values point to cation exchange contributing more to overall retention in the silica stationary phase than anion exchange in the amino stationary phase.

Keywords: cation-exchange, anion-exchange, retention mechanisms, hydrophilic interaction liquid chromatography, amitriptyline.

ORTHODONTIC TREATMENT WITH FIXED APPLIANCES AND ITS INFLUENCE ON THE PERIODONTAL HEALTH

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Abstract: Periodontal tissues are exposed to the challenges of orthodontic forces generated by tooth movements. During tooth movement, all periodontal structures, including the gingiva, periodontal ligament, and alveolar bone, are subjected to constant mechanical stress, which, in conjunction with an increased bacterial challenge caused by poor oral hygiene, creates highly favorable conditions for periodontal disease. Therefore, it is essential to have a good understanding of the existing etiology of periodontal disease and risk factors for proper diagnosis and treatment planning for patients undergoing orthodontic treatment. During the active orthodontic phase, the periodontal status of patients should be carefully monitored, compared with their initial clinical and radiographic measurements, and treated as needed. Patient compliance with the proposed home oral hygiene regimen should be carefully assessed and reinforced. The aim of this study was to measure the periodontal status of patients undergoing fixed orthodontic appliance therapy. The sample for this study included 50 patients of both genders, with an average age of 17, who were treated with fixed orthodontic appliances, had complete permanent dentition, and denied systemic diseases. During the study, a clinical examination was performed, and each patient answered questions posed in a questionnaire. The questionnaire included questions about the frequency of tooth brushing, brushing technique, and the presence of poor oral habits. The clinical examination involved measuring the width of keratinized gingiva in millimeters, determining the gingival biotype, assessing the presence and location of recessions, Plaque Index by Silness-Löe (PI), Bleeding on Probing Index (BOP), and Gingival Index by Löe-Silness (GI). The measurements revealed that 80% of patients had a GI of 1.1-3.0, while 75% of patients had a PI ≥1. No effect of fixed orthodontic therapy on gingival thickness, width of keratinized gingiva, or an increase in periodontal indices due to the length of orthodontic therapy was found. Fixed orthodontic appliance therapy can lead to an increase in periodontal indices and create more challenging conditions for maintaining oral hygiene.

Keywords: fixed appliance, parodontium.

COMPARISON OF IMAGE-BASED THREE-DIMENSIONAL TREATMENT PLANNING USING ACUROSTM BV AND TG-43 ALGORITHM FOR INTRACAVITARY BRACHYTHERAPY OF CARCINOMA CERVIX

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Abstract: This study compares the dosimetric effects of the American Association of Physicists in Medicine (AAPM) TG-43 dose formalism and the Acuros BV (grid-based Boltzmann solver, GBBS) formalism on high-dose-rate (HDR) brachytherapy planning for cervical cancer patients treated with a tandem and ring applicator. Ten cervical cancer patients were included in the study. The high-risk clinical target volume (HR-CTV) and organs at risk (OARs) were delineated using computed tomography (CT) imaging and manual contouring methods. The doses to HR-CTV were assessed using D50%, D90%, and D98% metrics, while for OARs, D2cc doses were compared.

For HR-CTV, the dose differences between TG-43 and Acuros BV were as follows: D50% (1.9%), D90% (2.6%), and D98% (3.4%). For OARs, the D2cc dose differences were: bladder (3.0%), rectum (2.6%), small bowel (2.8%), and sigmoid colon (2.9%).

Overall, the study demonstrates that while both TG-43 and Acuros BV formalisms provide comparable dosimetric outcomes for HDR brachytherapy of cervical cancer, Acuros BV offers slight dose reductions across HR-CTV and OARs. The differences in dosimetric parameters between TG-43 and Acuros BV are statistically significant (p=0.05), but their clinical significance has yet to be examined.

Keywords: HDR Brachytherapy, cervical cancer, TG-43 algorithm, acuros BV, dosimetry.

COMBINED ORTHODONTIC - SURGICAL TREATMENT OF SEVERE SKELETAL CLASS III MALOCLUSSION – CASE REPORT

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Abstract: Severe skeletal Class III caused by mandibular prognathism often requires a combined orthodontic and surgical treatment to ensure a stable therapeutic outcome. This case presents the therapeutic approach for a male patient who had a ½ Class III malocclusion, an anterior open bite of 3 mm, anterior crossbite and a concave profile before initiating orthodontic treatment. The initial lateral cephalogram indicated mandibular prognathism (SNB 83°), a skeletal Class III (ANB -1°) with a tendency towards an open bite (B 31°), proclination of the upper incisors (I/SpP 59°), and retroclination of the lower incisors (i/MP 92°). Additionally, an increased mandibular corpus length of 4 mm was observed. The second lateral cephalogram, taken immediately before surgical intervention indicated a skeletal Class III (ANB -3°), an increased mandibular corpus by 5.85 mm, and corrected inclinations of the upper and lower incisors. Presurgical treatment with fixed appliances lasted 36 months, followed by bimaxillary surgery. Postsurgical orthodontic treatment lasted 8 months, during which the patient wore vertical intermaxillary elastics to establish a stable occlusion. At the end of the treatment, Class I occlusion was achieved with proper overbite and overjet, and a harmonious facial profile. The post-surgical lateral cephalogram showed correction from Class III to Class I skeletal relationship, proper inclination of the upper and lower incisors, and corrected mandibular corpus length. Combined orthodontic - surgical treatment can effectively correct severe skeletal discrepancies caused by mandibular overdevelopment.

Keywords: mandibular prognathism, Class III malocclusion, orthodontic - surgical treatment, lateral cephalogram.

THE INFLUENCE OF MICE ADIPOSE-DERIVED MESENCHYMAL STEM CELLS, PLATELET-RICH PLASMA AND BONE MINERAL MATRIX ON ECTOPIC OSTEOGENIC PROCESS

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Abstract: Novel approaches to bone tissue repair and regeneration frequently include the application of bone tissue engineering (BTE) methods. BTE methods involve the construction of implants composed of bone substitute biomaterials, source of growth factors and cells, in orthopic and ectopic models. The advantage of ectopic over orthopic models is that they exclude the influence of bone tissue components and also enable evaluation of the implants' components on osteogenic process. The aim of this research was to examine the influence of implants composed of mice adipose-derived mesenchymal stem cells (ADSCs), platelet-rich plasma (PRP) and bone mineral matrix on ectopic osteogenic process. Two types of implants were prepared. The first type of implants contained *in vitro* cultivated, uninduced mice ADSCs, combined with PRP and loaded onto bone substitute biomaterial (bone mineral matrix – BMM) that was used as a carrier. The second type of implants contained only BMM (control group). The implantations were ectopic, subcutaneous. The implants were extracted after one early and one late post-implantation period in order to analyze the expression of osteogenic markers. The relative expression of gene that encodes osteopontin (gene *Spp1*) and immunoexpression of protein osteocalcin were examined. The *Spp1* gene expression and osteocalcin immunoexpression were both significantly higher in the implants that contained cells and growth factors in comparison with the implants from control group. It was concluded that there is a promising potential for the application of implants constructed of *in vitro* cultivated, uninduced ADSCs, PRP and BMM in bone tissue regeneration.

Keywords: adipose-derived mesenchymal stem cells, platelet-rich plasma, bone mineral matrix, ectopic osteogenic process, bone tissue regeneration.

THERAPY OF SKELETAL OPEN BITE AND SKELETAL CLASS III USING BIONATOR ACCORDING TO BALTERS TYPE III (CASE REPORT)

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Abstract: In the period of puberty growth spurt, functional therapy can be successfully performed using the Bionator according to Balters. This case report aims to show the successful treatment of a skeletally open bite and overbite in a 13-year-old girl. The clinical examination revealed an enlarged lower third of the face, an open bite in the area of the frontal teeth (1.5 mm), and occlusion of ½ class III. Analyzing the initial profile teleradiograph, she was diagnosed with skeletal class III (ANB= -2°), skeletal open bite (B= 31°)), increased corpus of the mandible (by 8 mm), and a tendency towards a vertical type of facial growth (Bjork=400°). Balters type III bionator was indicated. The active phase of therapy lasted 19 months. During this period, the patient wore the appliance continuously during the day and night. Control examinations were performed every 6 weeks. After finishing the active phase of therapy, the value of the ANB angle on the control profile teleradiograph was 1°, with the presence of a vertical growth tendency (Bjork= 402°) and an enlarged body of the mandible of 3.3 mm. Clinical examination revealed a stable Class I occlusion and a flap depth of 2 mm. A bionator according to Balters, is a tooth-worn functional appliance, that gives a successful therapeutic result by affecting the change in the position and activity of the tongue while suppressing the excessive sagittal growth of the lower jaw.

Keywords: bionator according to Balters, functional therapy, skeletal open bite, class III.

BONE ANIMAL SEGMENT - MODEL FOR HUMAN BONE REGENERATION

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Abstract: The population of people in our region is faced with the problem of total or partial toothless alveolar ridge in a large percentage. Tooth loss, for any reason, consequently leads to a decrease in the vertical dimension of the teeth in the human population, which later creates a problem in stomatoprosthetic reconstruction. The aim of this work is to examine to what extent animal alveolar bone can serve as a model for testing different materials that have potential for alveolar bone regeneration, as well as to what extent synthetic bone substitute exhibits regenerative potential. The animal model in this paper will be a sheep. Methodology. Periodontal part of the experiment. Experimental periodontitis will be caused by the formation of defects around the root of the tooth, on both sides. In order to access the alveolar bone, it is necessary to perform a flap operation in the indicated region. A hydroxyapatite-polylactide-co-glycolide bone substitute will be placed in the defects formed on one operative side, while a synthetic bone substitute based on pure hydroxyapatite will be placed on the opposite side. After the application of bone substitutes in the experimentally induced defects, the flap will be repositioned and fixed with resorbable sutures. Plaque non-absorbable surgical sutures will be used. Oral surgical part of the experiment. Immediately after tooth extraction, bone substitutes will be applied to the available socket, on one

side hydroxyapatite combined with polylactide-co-glycolide, and on the other side, pure hydroxyapatite will be placed in the alveolar socket. The operative region will be fixed with sutures so that the applied bone substitutes remain in place. Sutures will be fixed with resorbable surgical sutures. Six months after, the euthanasia of the animals and the separation of the bone segments in which the bone substitutes were placed will begin. Histomorphometric analyzes will be performed on the bone segments in order to determine the condition of the animal bone, as well as what reaction the applied bone substitutes caused on the animal alveolar bone. With this research, we expect to obtain a reaction of animal bone in the form of regeneration at the site of applied bone substitutes in both the periodontal and oral surgical parts of the experiment. Also, it will be examined to what extent which bone substitute caused the regeneration of animal alveolar bone.

Keywords: animal model, bone segment, bone substitute, alveolar bone regeneration.

GOLDEN RATIO IN ASSESSMENT OF FACIAL AESTHETICS

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Abstract: The "Golden Ratio," golden proportion, or mathematical golden section/division speaks to the relationship between two ratios: the larger part to the smaller is in the same proportion as the whole to the larger part. The length and width of someone's face are first measured, and the result is divided. First, it is necessary to measure the width and length of the face to gather data on symmetry, from chin to hairline, and measure the width at the widest part of the face (likely the cheekbones). Now, divide the length by the width. The ideal result is 1.618, meaning that a beautiful person's face is about 1 ½ times longer than it is wide. Measurements are further made in segments: from the forehead (hairline) to the point on the nose between the eyes, from that point to the edge of the nose, and from the edge of the nose to the end of the chin. A person is considered more beautiful if the numbers are equal. Attention is then focused on the symmetry and proportion of the face, and according to this golden ratio, to be declared beautiful, the length of the ear must be equal to the length of the nose, and the length of the eye should be equal to the distance between the eyes.

In dentistry, the concept of the golden section represents significant aid in achieving aesthetic and functional perfection. Through the application of mathematical principles and harmonious proportions, the golden section is used as a guideline for shaping a smile that is harmonious and aesthetically appealing. Although individual variations may influence the final result, the principle of the golden section remains a key element in achieving optimal aesthetics and proportions in dental practice. This concept enables the attainment of a high level of patient satisfaction through precise planning and execution of aesthetic dental treatments.

Keywords: golden section, facial ratios, aesthetics, measurement segments, symmetry and proportion of the face.

STEM CELLS IN DENTAL MEDICINE

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Apstract: Stem cells are unspecialized cells that can undergo unlimited self-renewal and differentiate into more mature cells with specialized functions. They have the following characteristics: pluripotency, high migratory potential, and the ability of immune tolerance.

The stem cell undergoes asymmetric division, resulting in its duplicate and a copy with differentiation potential. The duplicate plays a role in renewing the original stem cell, while the other copy further divides to create progenitor cells that enter the process of division and differentiation, leading to the formation of precursor cells directed towards development in a precisely determined direction. Through further differentiation, terminal differentiated cells are formed, capable of building new tissues or replacing previously damaged ones. After terminal differentiation, the newly formed cells assume the function of the previously damaged or destroyed ones, thus aiding in tissue defect repair.

They are more accessible compared to other stem cells in the body. Until today, many orofacial stem cells have been isolated, such as DPSCs, SHED, PDLSCs, DFPCs, SCAPs, OMSCs, and ASCs. Numerous scientific studies have confirmed that dental cells are indeed stem cells.

Keywords: stem cells, pluripotency, migratory potential, immune tolerance, cell division.

CLINICAL EVALUATION OF THREE DIFFERENT SELF-ADHERING MATERIALS IN CLASS I RESTORATIONS

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Abstract: Introduction: Self-adhering flowable composite (Vertise Flow, Kerr, USA) simplified the long-lasting restorative procedure and opened a new chapter in conservative dentistry. This study aimed to evaluate the clinical effect of VF in comparison with resin-modified glass ionomer (Fuji II LC, GC, Japan) and glass carbomer (Glass Fill, GCP Dental, Vianen, Netherlands) in cavities of I class.

Material and methods: Thirty patients with initial occlusal caries lesions were recruited in the study. For each patient, three restorations of I class were placed, one each with each examined material. All materials were applied according to the manufacturer's instructions. The restoration was evaluated after one month and after 6 months using the modified United States Public Health Service criteria measuring (retention, postoperative sensitivity, color match, marginal adaptation, and marginal discoloration). For statistical analysis, Fisher's test, Student's test, Mann-Whitney, and Chi-square test were used to investigate changes in the follow-up periods.

Results: After one month and after 6 months, there was no statistically significant difference between the three materials for all the parameters tested ($p<0.05$).

Conclusion: VF showed a clinical effect similar to resin-modified glass ionomer (Fuji II LC, GC, Japan) and glass carbomer (Glass Fill, GCP Dental, Vianen, Netherlands) in cavities of I class after 6- months of follow-up.

Keywords: Clinical evaluation, self-adhering materials, flowable composite, glass carbomer.

PATTERN RECOGNITION SUPPORTED EDXRF ANALYSIS OF THE MEDIEVAL GLASS

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Abstract: The glass samples from three archaeological sites in Serbia (Resava (Manasija) monastery, monastery of St. Archangel Michael, better known as Valjevska Gračanica, and Valjevo–Stadion) were analyzed. Resava monastery was built in 1418. by despot Stefan Lazarević, and it is widely considered one of the most important medieval monuments in the Morava architectural style. The Valjevska Gračanica monastery was probably built in the mid 15 c. on top of an older structure, and the monastery is noted for its unusual architecture in the form of a clover-shaped foundation. The Valjevo–Stadion site was a focus of archaeological conservation, where afterward, a stadium in the town of Valjevo was built. The elemental analysis results should reveal information regarding the provenance of glass objects and production technology since no local manufacturing site was known to archaeologists. The samples can be dated to the 15-16 c by style and stratigraphy. Their provenance is probably Adriatic, Venetian, or possibly Ragusan, though all glass from Venice was imported to modern-day Serbia through Ragusa (Dubrovnik). The samples are roughly equally split by type between vessels and oculi (round windowpanes).

A total of 72 pieces of glass samples were analyzed using energy-dispersive X-ray fluorescence (EDXRF) spectrometry analysis. An in-house developed portable EDXRF spectrometer was used for non-invasive elemental composition analysis. The excitation source was an air-cooled X-ray tube with Rh anode (maximum voltage 50 kV, maximum current 1 mA) with a pin-hole collimator. For the detection, the X-123 Complete X-Ray spectrometer (Amptek Inc.) with Si-PIN detector (6 mm^2/500 m, Be window 12.5 m thickness, with an energy resolution of 160 eV at 5.89 keV) and DP5 digital signal processor for spectra acquisition, was used. ADMCA software (Amptek Inc.) was used for spectra acquisition. The following parameters, X-ray tube voltage of 40 kV and 800 μA current, were used and kept constant during all measurements. The measuring time was 60 s.

The unsupervised multi-analytical technique has been chosen to explore the dataset (89x2048 dimensions) structure and reveal potential differences among analyzed pieces. The three different groups are separated in the PC1-PC2 space of maximal variance. The glass pieces from Manasia monastery have the most coherent chemical composition, while the two other groups are less coherent but still different in composition. Either the EDXRF is not the fully informative analytical technic in the glass study, but supported by pattern recognition techniques, can gain informative classification models.

Keywords: medieval glass, EDXRF analysis, PCA.

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APPLICATION OF 3D/4D PRINTING FOR THE PROCESSING OF COMPOSITES MATERIALS

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Abstract: 3D and 4D printing (3DP/4DP) are modern additive manufacturing (AM) technologies used to produce a wide range of products with complex geometries from three-dimensional (3D) and four-dimensional (4D) model data, retrospectively. The 3D/4D printing process consists of printing successive very thin layers of material that are formed on top of each other. It is used as one of the ten main technologies in the concept of a new generation of digitized factories called ”Industry 4.0”. This is a new and very interesting field, as evidenced by the large number of 3D/4D printers produced and used in production facilities, as well as the large number of products made using this technology, the large number of publications in well-known global citation databases, and the large number of reported and accepted applications of patents. 3D and 4D printing (3DP/4DP), compared to traditional production processes, has several advantages, such as: production of complex product geometry with high precision, maximum material savings, flexibility in design, etc. So, as of 2019, they represent the most dominant production processes in all industrial sectors. 3D and 4D printing involves different processing methods, materials and equipment. The wide range of materials currently used in 3D and 4D printing includes all three main groups of composite materials based on ceramics or abbreviated CMC (Ceramic Matrix Composites), metal or MMC (Metal Matrix Composites) and polymers or PMC (Polymer Matrix Composites). The paper provides an analysis of the application of 3D and 4D printing of composite materials with special reference to the types of CMC, MMC and/or PMC materials that are processed and the recommended parameters for their processing.

Keywords: 3D printing (3DP), 4D printing (4DP), additive manufacturing (AM), industry 4.0 (I4.0), composite materials.

THE ROLE OF ARTIFICIAL INTELLIGENCE SYSTEMS IN THE NEW EDUCATION OF ENGINEERS

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Abstract: In the new real world, everything is becoming digital and smart with a large admixture of different artificial intelligence (AI) technologies. In part of the educational process, students have already widely started to use modern software systems based on artificial intelligence (AI) for writing seminar, diploma and master theses (a large group of software systems called LLM), for making presentations (such as BeautifulAI), for solving mathematical problems (PhotoMath) and etc. In contrast, the teaching staff still uses outdated teaching methods. Currently, the big problem for both is how to harmonize these two diametrically opposed directions of the educational process. For students how to properly use unfamiliar software systems, and in contrast for teaching staff how to introduce new software systems into curricula and how to find solutions for new knowledge assessment methodology and, also, how to start using software systems for plagiarism detection (software for plagiarism) in the mentioned works of students. Large Language Models (LLM) are language models that can recognize, summarize, translate, predict and generate content using very large data sets. They consist of neural networks with many parameters (typically billions of weights or more), trained on large amounts of unlabeled text using self-supervised learning or semi-supervised learning. LLMs are more recent, and the first of this group of software BERT and GPT-1 appeared in 2018. Examples of LLM are: BERT, GPT (GPT-1, GPT-2, GPT-3 and GPT-4), LaMDA, BLOOM, ChatGPT, LLaMA etc. All of the above examples of developed LLM systems are widely used in education in the field of engineering sciences, which is the aim of this paper.

Keywords: education, knowledge, software, artificial intelligence (AI), large language models (LLM).

MAINTENANCE OF THE HYDRAULIC SYSTEM REGARDING THE MATERIALS FROM WHICH ITS COMPONENTS ARE MADE

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Abstract: In this paper, the application of new materials for hydraulic components that build a hydraulic system for various applications is analyzed. Regardless of the construction, installation and quality of the hydraulic components, the time and conditions of exploitation, when using almost any hydraulic system, malfunctions or failures occur from time to time. Hydraulic system failure refers to the state of the system when it is not possible to perform any work function. New constructions in which components made of new, higher-quality materials with a higher degree of controlled and automatic operation are installed, and which are themselves with elements processed with improved or new technologies, with lower energy consumption, higher reliability in operation, more profitable production, better environmental protection and other advantages are at an advantage. New, more modern materials, in addition to general trends, must also contain specific trends in the development of the construction of hydraulic components and systems: greater accuracy of work, increased reliability in work, better energy and volume coefficient of utilization, higher degree of regulation of work and characteristics, higher flows and working pressures, greater power, longer service life and a wider area of application.

Keywords: maintenance of hydraulic components and systems, new and better materials for making components of hydraulic systems.

EXPERIMENTAL IDENTIFICATION OF THE DRYING PROCESS OF BIOMATERIALS USING A FACTORIAL DESIGN OF THE EXPERIMENT

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Abstract: Drying of biomaterials takes place during complex and interdependent processes of matter transfer and heat exchange, which are accompanied by a phase change between the wet material and the drying agent, resulting in dehydration of the wet material. The multiplicity and complexity of factors (controlled and uncontrolled) that influence the drying process as well as their interactions make this preservation process extremely complex and difficult to study, which makes its theoretical analysis (modeling) difficult. For the aforementioned reasons, the research is based on experimental results, and the obtained mathematical models refer to the exact material for the experimental space determined by the limit values of the input parameters. In a laboratory convective-condensation dryer, apples of the "red delicious" variety were dried at defined combinations of process parameters: temperature, relative humidity and speed of the drying agent; analyzed the quality of finished dried products (content of total acids and total sugars) and processed the obtained results, ie defined empirical model of the drying process in a convective-condensation dryer. The relevance of certain factors and their influence on the quality parameters of dried products were determined by the method of a planned experiment. The goal of applying the procedure of factorial plans of experiments is to obtain mathematical models and graphic representations of the influence of process parameters on the change of the measured property of the starting-tested material.

Keywords: drying, biomaterials, design of experiment (DoE), statistical analysis, mathematical model.

STATISTICAL ANALYSIS OF THE PARTICIPATION OF MICROPOLLUTANTS IN WASTEWATER IN SERBIA

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Abstract: The current situation in the field of municipal and industrial waste water management in the Republic of Serbia is not adequate. Based on the report of the Serbian Environmental Protection Agency (SEPA) for the year 2021, the percentage of the population connected to urban wastewater treatment with at least secondary treatment is approximately 15.2%, which indicates bad consequences for the state of the environment and sustainable development. The latest published data from the SEPA agency show that wastewater contains large amounts of harmful zinc, copper, chromium, arsenic, lead, nickel and their compounds. The technologies applied to treat micropollutants in water depend on the physical, chemical and biological properties of the compounds present in the water. On the basis of existing scientific knowledge, the expert public in the field of wastewater treatment, in addition to the standard mechanical procedure of previous treatment and conventional physical and chemical procedures, proposes four complementary procedures for the removal of micropollutants: Treatment of micropollutants by biological decomposition; Treatment of micropollutants by adsorption; Oxidation of micropollutants by physical-thermal techniques; Membrane separation for retention of micropollutants. In this paper is presents a statistical analysis of the participation of different types of micropollutants in wastewater in Serbia.

Keywords: wastewater, micropollutants, Serbian Environmental Protection Agency (SEPA), statistical analysis.

MODERN MATERIALS AND RENEWABLE ENERGY SOURCES

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Abstract: As the energy transition gains momentum, attention is turning from renewable energy sources (RES) to the materials from which they are made as a way to boost decarbonization efforts. Incorporating sustainable materials into clean energy solutions helps reduce their environmental impact and can potentially improve their performance or efficiency. In today's technologically advanced society, there is no longer an area of the real world where reliability predictions are not used to achieve the necessary system security. The importance of reliability analysis and the monitoring of partial reliability properties is increasing, and therefore the requirements for reliability analyzes are increasing. This particularly applies to systems for renewable energy sources (RES). The paper presents an overview of modern materials for the development of systems for renewable energy sources (RES), as well as an analysis of the reliability of those systems.

Keywords: materials, renewable energy sources (RES), reliability, security system.

RELIABILITY AND STABILITY OF ADVANCED TECHNICAL SYSTEMS

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Abstract: The issues of ensuring and maintaining high reliability and stability throughout the lifetime of a technical system, i.e. determining the requirements, design, research, development, production, installation, operation, and disposal of the product, are given special attention in companies for several reasons. The assessed technical systems usually consist of different components that can be considered as a tree structure according to their relationship with the content. An important element in ensuring reliability and stability is the management and leadership approach of the company that is responsible for the production of the technical system. The reliability of objects can be understood as their ability to fulfil the required functions within the specified time while observing the operational parameters given by the technical conditions. In paper is presents an analysis of the reliability of a complex system composed of standard components and several critical components that cause the failure of the entire system.

Keywords: technical system, product life cycle (PLC), reliability, stability.

ANALYSIS OF THE QUALITY OF FOOD MATERIALS BASED ON THE HACCP STANDARD

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Abstract: Quality and safety are certainly the most important aspects in food production and distribution. The quality of food largely depends on the raw material from which it is made and other possible hazards during its handling, production, distribution and consumption of the final product. Food quality is controlled according to the recommendations of the HACCP (Hazard Analysis and Critical Control Points) standard, which is a flexible system for identification, evaluation and control of potential biological/micro-biological, chemical and physical hazards that are significant for food safety. The HACCP standard is based on the analysis and control of potential hazards along the entire food chain and defines requirements that enable organizations to control food safety risks along the entire food chain. The paper provides a analysis of the quality of various raw materials from which food is made on the basis of the HACCP standard. Based on the statistical analysis of the quality of different food raw materials, the impact of each raw material on the overall quality of the final product is shown.

Keywords: food quality, food safety, standard, hazard analysis and critical control points (HACCP).

REVIEW OF THE MICRO-DRILLING PROCESS OF MODERN COMPOSITE, SMART AND NANO-MATERIALS

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Abstract: Micro-drilling (MD or μD) is type of machining (processing) technology used for the drilling of miniaturized parts of small diameter in micro-scale, ie. diameter in a range of a few microns to several hundred microns. When micro-drilling metal workpieces, average micro-drilling speeds typically range between 2000 and 4000 rpm (revolutions per minute), while micro-drilling plastics use lower speeds to reduce the risk of breakage or melting.

In paper is given the review of the micro-drills for drilling small holes in modern composite, smart and nano-materials. An overview of the calculation and mathematical modeling of function of cutting forces, tool wear and torque depending on the cutting regime and geometric parameters of the micro-drill when drilling small holes in different composite and nano-materials is analyzed.

Keywords: machining, micro-drilling (MD or μD), composite materials, smart materials, nano-materials.

DEVELOPMENT AND APPLICATION OF BIOTECHNOLOGIES IN THE FUNCTION OF IMPROVING AGRICULTURAL PRODUCTION

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Abstract: Biotechnology (GM technology) has become a tool and a new "conventional" standard for plant seeds, replacing older varieties, that is, introducing improvements/innovations in agricultural production. It enables the development of crops with beneficial traits when conventional breeding techniques are unable to develop such traits. The use of GMOs in plant production is becoming a well-established practice, and the Leader approach (a form of process management) is based on a comprehensive overview of the resources and perspectives of a certain area, connecting various sectors and providing the opportunity for local communities to express their views on future production. If the future of a certain local environment is jointly predicted, the bearers of local development unite, because Leader influences the establishment of new partnerships and forms of management and enables co-authored ideas and concepts to be applied and realized in practice. The Special Accession Program for Agriculture and Rural Development (SAPARD) for pre-accession assistance to agriculture has been implemented since 2000 and aims to provide assistance to structural adjustments in agriculture, development of rural areas and implementation of parts of Community law. Financing on the basis of SAPARD is defined on the basis of the agricultural population, agricultural areas, gross national product and specific territorial issues. Genetic engineering (molecular cloning, genetic manipulation, recombinant DNA technology), and even as "new genetics", is a field of biotechnology in which genes and natural DNA sequences are used as resources, which are manipulated in various ways to achieve certain goals in agricultural production. In this paper, the steps in genetic engineering are proposed: isolation and modification of the gene of interest, construction of the gene cassette, and construction of the vector and insertion of the gene into the vector, transformation and selection - separation of GMOs from non-transformed organisms. The conclusions of our research can be considered useful for the makers/bearers of agricultural policy in rural areas, to implement their interests of sustainable development and poverty reduction more quickly and efficiently and to make more available the relevant information on the improvement of agriculture in rural communities and their potentials, because the benefits of this kind multiple and long-term production.

Keywords: agriculture, eco-production, genetic engineering, biotechnology, DNA, SAPARD, sustainable development.

DETERMINISM IN THE UNIVERSE OF LITHIUM EXPLOITATION, THROUGH REAL MONITORING OF THE PRODUCT LIFE CYCLE

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Abstract: Determinism refers to the teaching that everything that exists is connected by causal, cause-and-effect relationships, primarily of a material nature. Here there is no chance, arbitrariness, or free act in the universe, but everything is predetermined by the previous history of events. The opposite of determinism is a kind of coincidence, and the concept of "product life cycle" is used in the modern economy as a basis for the development and adaptation of products to the demands of discerning consumers. Energy efficiency and environmental protection should be taken into account in the design of construction and production of modern vehicles. During the constant penetration of competition from other countries into the domestic market, the management of companies/enterprises must (in order to survive and grow) find new organizational forms. It is believed that the optimal size of firms does not exist in real life. It is assumed that with their growth, the factors of (in)efficiency in the exploitation of natural resources, production, transport, storage and services also grow, i.e. enormous cost growth. In this co-authored work, and in the continuation of the 21st century, we highlight newer approaches to the study of the growth of companies, enterprises, firms and institutions, and I would like to remind you of the most famous: Theory of economic concentration, Theory of optimal company size, Investment theory, Organization theory, Artificial intelligence, Nano and biotechnology, IT Support in Science, Management Science and Eco-Safety. Our research/predictions reveal significantly elevated downstream concentrations of boron, arsenic and lithium in nearby rivers compared to upstream regions. In addition, we show here that soil samples show repeated violations of remediation threshold values with environmental consequences for both surface and groundwater. With the opening of mines in the Balkans, problems will be multiplied by tailings, mine waste water, noise, air pollution and light pollution, endangering the lives of the local population and destroying sources of fresh water, agricultural land, livestock and property. The practical implementation of the proposed eco-safety measures (given in the paper) would contribute to the improvement of work safety conditions and the preservation of the working and environmental environment.

Keywords: determinism in the universe, exploitation, pollution, eco-security.

BIOLOGICAL MATERIALS (DNA) - PROJECTS AND CHALLENGES IN THE WORLD

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Abstract: In 1953, Watson and Crick discovered the structure of DNA, and soon after, other scientists discovered that DNA is unique to every living thing. Thanks to this, DNA can be used, for example, to distinguish a sample from a crime scene. One of the interesting projects presented in the work (the Genography project) is a genetic-anthropological research that seeks to map the great human migrations that have occurred throughout history by collecting and analyzing DNA samples from over 100,000 people from five continents. It is also called the "trip to the moon" of anthropology. The paper shows where this specificity of DNA analysis is used (forensics, reference databases for metabarcoding, environmental pollution monitoring).

Keywords: DNA, genography, genetics, ecology.