



UNIVERSITY OF BELGRADE
TECHNICAL FACULTY IN BOR

BOOK OF ABSTRACTS

9th INTERNATIONAL STUDENT
CONFERENCE ON TECHNICAL
SCIENCES

Editor
Jasmina Petrović

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9th INTERNATIONAL
STUDENT CONFERENCE
on Technical Sciences

24-25 October,
Bor Lake, Serbia



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PREFACE

The Technical Faculty in Bor, University of Belgrade, in cooperation with numerous partners from Serbia and abroad, proudly organizes the 9th International Student Conference on Technical Sciences (ISC 2025). The conference is held at Bor Lake, on October 24–25, 2025, as a part of the traditional 56th International October Conference on Mining and Metallurgy (IOC 2025).

The aim of this conference is to provide young researchers with an opportunity to present the results of their work, exchange ideas, establish new collaborations, and take important steps in their academic development. By bringing together students, mentors, and experts from various fields of technical sciences, ISC encourages an interdisciplinary approach and fosters a culture of collaboration, innovation, and shared learning.

The conference is held in memory of Professor Dragana Živković, the founder and initiator of the idea of a student gathering dedicated to science and research. Her enthusiasm, support, and belief in young researchers left a lasting impact, and in her honor, awards bearing her name are once again presented this year — for the best oral and the best poster presentation.

The Book of Abstracts ISC 2025 includes 51 papers authored by participants from seven countries, underscoring the international relevance of the conference and its contribution to fostering collaboration among young scientists worldwide.

I would like to express my sincere gratitude to all participants, mentors, co-organizers, members of the scientific and organizing committees, as well as to all institutions that supported the realization of this event. It is our hope that this year's conference will once again inspire new ideas, collaborations, and friendships – for that is the true essence of science.

On behalf of the 9th ISC Organizing Committee,
Assistant Professor Jasmina Petrović, PhD

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INVITED LECTURE

**ICALPHAD: AN INTELLIGENT SOFTWARE PLATFORM FOR
CALCULATING PHASE DIAGRAMS AND OPTIMIZING MATERIAL
THERMODYNAMICS**

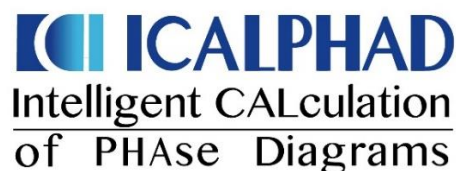
Yuchao Shi, Taibai Fu, Xinyi Zhang, Liang Zhang, Shiyi Wen, Yuling Liu, Yingbiao Peng, Jiangxing Wang, Ziqing Xie.

Mentor: Yong Du

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Abstract

This presentation introduces ICALPHAD, a powerful and user-friendly software platform designed for calculating phase diagrams and optimizing thermodynamic properties in material systems. By integrating an intuitive graphical interface with a modular architecture, the software significantly simplifies complex computational tasks. Its key functionalities include the generation of binary and ternary phase diagrams, the calculation of essential thermodynamic properties – such as Gibbs energy and heat capacity – and the ability to simulate external conditions like magnetic fields. A standout feature is its intelligent optimization module, which employs multi-objective algorithms to effectively handle incomplete experimental data, making it particularly valuable for academic research and student projects. This lecture will demonstrate how ICALPHAD serves as an essential educational and research tool, enabling users to easily explore and deepen their understanding of phase equilibria and material behavior.



Keywords: *ICALPHAD, phase diagrams, thermodynamics, multi-objective optimization*

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OPTIMISATION OF HEAT TREATMENT TO ACHIEVE HIGH MECHANICAL PROPERTIES OF AN AlSi10MgMn ALLOY PRODUCT FOR E-MOBILITY

Students: Tim Drevenšek, Nežka Valenčič, David Vuga, Matija Makarovič, Blaž Perko, Nejc Balantič

Mentors: Maja Vončina, Tilen Balaško

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Abstract

In addition to the automotive and aerospace industries, aluminium alloys have a very high potential in a variety of other areas such as medicine, pharmaceuticals, military, etc. This requires the development of new high-strength and corrosion-resistant aluminium alloys that combine 100% recyclability, low weight, high load-bearing capacity and maximum energy absorption. Silafont-36 or the aluminium alloy AlSi10MgMn seems to be a promising alloy in this field.

The aim of the project was to achieve optimum mechanical properties on a casting made from the AlSi10MgMn alloy, which is used in electric cars. The casting was produced using die casting technology. First, the Thermo-Calc software was used to predict the equilibrium phases present in the AlSi10MgMn alloy. The simulation indicated a primary α -Al, eutectic solidification of α -Al + β -Si, and other eutectic solidified phases, such as Mg_2Si , $\text{Al}_{15}\text{Si}_2\text{Mn}_4$, and $\text{Al}_9\text{Fe}_2\text{Si}_2$ intermetallic compounds. At lower temperatures also Q- $\text{Al}_5\text{Cu}_2\text{Mg}_8\text{Si}_6$ phase and β - Mg_2Si phase precipitate. To confirm these predictions, differential scanning calorimetry (DSC) was used to identify the thermal events related to phase transformations. Finally, the microstructure using a scanning electron microscope (SEM) was examined to verify the presence and distribution of these phases. In addition, the temperatures for solution annealing and artificial ageing were defined and the times required to achieve the most suitable mechanical properties for such a casting were optimised. Vickers hardness measurements and tensile strength tests were carried out on the heat-treated samples to determine the optimum heat treatment temperature and time.

Solution annealing was performed at temperatures of 465 °C, 480 °C, and 500 °C for 2 hours, followed by water quenching. Artificial ageing was carried out at 210 °C and 230 °C for various durations, and subsequently, the samples were quenched in water. According to the hardness measurements, the highest value of 71 HV was achieved in the sample solution annealed at 500 °C and artificially aged at 210 °C for 1 hour. The tensile test showed that the best mechanical properties were achieved with solution annealing at 465 °C for 2 hours and ageing at 230 °C for 2 hours, resulting in a yield strength of 147 MPa, a tensile strength of 201 MPa, and an elongation of 4.5%. Increasing the solution annealing temperature and reducing the ageing time led to a decrease in both strength and ductility.

Keywords: aluminium alloy AlSi10MgMn, phase equilibria, heat treatment, mechanical properties

ACKNOWLEDGEMENT

This work was made in a frame of project Optimization of heat treatment to achieve high mechanical properties of a product made of AlSi10MgMn alloy for e-mobility, which is being implemented based on the public call for proposals "Problem-based learning of students in the working environment: economy, non-economy and non-profit sector in the local/regional environment (PUS in the working environment 2024-2027)".

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INFLUENCE OF HEAT TREATMENT ON THE MICROSTRUCTURE DEVELOPMENT AND HARDNESS OF THE ALLOY EN AW-7175 WITH LANTHANUM

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Abstract

Aluminium alloys of the 7xxx series, especially alloy EN AW-7175, are of crucial importance in industries where high strength and low density are important properties. A wide range of heat treatments, such as solution annealing and ageing, are used to achieve optimum mechanical properties. During processing, precipitation particles are formed which hinder dislocation movement and thus increase strength.

The aim of this study was to investigate the influence of different lanthanum concentrations on the microstructure and properties of the aluminium alloy EN AW-7175. Using the Thermo-Calc software, various equilibrium diagrams were calculated (isopleth phase diagram, diagram of the content of thermodynamically stable phases as a function of temperature, etc.) in order to understand the phase transitions at different lanthanum concentrations in the alloy. Differential scanning calorimetry (DSC) was used to investigate the melting, solidification and thermal properties of these alloys, while scanning electron microscopy (FEG SEM) and energy dispersive X-ray spectroscopy (EDS) were used for microstructural analysis. The samples were subjected to heat treatment processes that included solution annealing, quenching and ageing at three different temperatures: 90 °C, 130 °C and 220 °C. Subsequently, hardness tests were performed on all samples to evaluate the mechanical performance.

The results showed that the addition of lanthanum does not change the phase precipitation sequence but significantly influences the phase morphology. Lanthanum promotes the formation of the LaAlSi phase at the expense of Mg₂Si, which decreases with increasing lanthanum content. In addition, lanthanum alters the Al₄₅Cr₇ phase, leading to the formation of larger, sharp-edged Al₂₀Cr₂La particles. The highest hardness values were measured after ageing at 130 °C, although the total hardness decreased with increasing lanthanum content.

Keywords: *aluminium alloy EN AW-7175, lanthanum, solution annealing, aging, microstructure, hardness*

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GREEN ROOFS' ENVIRONMENTAL IMPACT ACROSS DIFFERENT GEOGRAPHICAL REGIONS

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Abstract

Green roofs have been implemented across various geographical regions, resulting in extensive research that covers a range of aspects, including their performance, design, and integration with sustainable urban development.

The implementation of green roofs across different geographical regions has demonstrated a range of benefits, with varying performance and adoption rates influenced by local climate, policy, and socio-economic factors. In colder climates, green roofs effectively enhance sustainability and provide substantial cooling benefits during summer. In temperate zones, studies emphasise the importance of native plant communities and ecoregional adaptations. In contrast, Mediterranean and tropical regions require materials and design approaches that are modified to suit their specific needs. Green roofs have shown considerably reduced internal temperatures when compared to traditional roofs in humid subtropical areas that experience high heat and heavy rainfall events.

Germany is one of the leading regions in the implementation of green roofs. The country has established standard quality guidelines for green roof installations on buildings. In line with their strategy, other countries have introduced incentives or mandates to encourage the use of green roofs. Quantitative analyses reveal a recent surge in adoption and technological innovation, especially in the US and China.

This research review demonstrates the successful implementation of green roofs across diverse geographical regions, yielding a variety of environmental, economic, and social benefits. Further research and innovative approaches are crucial to further promote the widespread implementation of green roofs as a sustainable solution for urban environments and climate change mitigation.

Keywords: *green roofs, climate, environmental, sustainable*

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SHOT PEENING SURFACE TREATMENT OF Zn-BASED ALLOYS

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Abstract:

The aim of this study was to investigate the effects of shot peening on Zn-Cu and Zn-Cu-Ti alloys. This study was conducted in collaboration with the Technical University of Oviedo and consisted of stages performed in Romania at the "Gheorghe Asachi" Technical University of Iași, as well as in Spain at the University of Oviedo. The first stage, which was conducted in Romania, focused on obtaining the metallic samples through induction furnace casting using heated metal moulds. The raw materials used were zinc and copper for the Zn-Cu alloy (2 wt% Cu), and zinc, copper, and titanium for the Zn-Cu-Ti alloy (2 wt% Cu and 2 wt% Ti). The samples were subjected to mechanical processing involving disc cutting and water jet cooling to achieve a thickness of 10 mm. The samples were subsequently subjected to a grinding process using successive grits ranging from 60 to 2,400, followed by a final polishing step using felt and an alumina suspension. The second stage, carried out in Spain, involved applying a shot peening (SP) treatment. SP is a mechanical surface treatment process in which small spherical particles (shots) are projected at high velocity toward the surface of a material, modifying its surface properties. In this case, the specimens were subjected to conventional (100% coverage) and severe shot peening treatments (500% and 1000% coverage), using zirconia shots (B100 ceramic beads, 125–180 μm) and an Almen intensity of 8A. After the SP treatments, microhardness trends and microstructural changes were analysed in cross-sections of the specimens following metallographic surface preparation (grinding, polishing, and etching). Surface roughness was also evaluated using a roughness tester.

Through this study, a better understanding of the influence of shot peening treatment on the microstructure and durability of Cu-Zn and Cu-Zn-Ti alloys is desired, as these alloys have the potential to improve the mechanical properties and wear resistance of materials.

Keywords: shot peening, almen intensity, ZnCu alloy, ZnCuTi alloy

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USE OF LIGHT-CURED BIO RESINS FOR THE PROTECTION OF BIODEGRADABLE ALLOYS

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Abstract

The increasing demand for biodegradable metallic alloys (Mg, Fe and Zn based alloys) in biomedical and environmental applications has drawn attention to the critical issue of their rapid degradation in physiological and natural environments. While the biodegradability of such alloys is essential for temporary implants and sustainable engineering solutions, uncontrolled corrosion often compromises their mechanical stability and functional performance [1]. In this context, the use of bio-based photopolymerized resins as protective coatings represents a promising strategy to modulate the degradation rate and ensure controlled performance. This study explores the potential of bio-derived, photocurable resins to form thin, uniform, and biocompatible layers on the surface of biodegradable alloys [2].

Photopolymerization, activated under light exposure, enables precise curing and adherence, minimizing the need for toxic solvents and energy-intensive processes. The coatings act as temporary barriers, reducing the immediate exposure of the metallic substrate to aggressive environments while allowing gradual and predictable resorption. Particular emphasis is placed on the resin composition, curing parameters, and their influence on coating morphology, adhesion, and degradation kinetics [3]. Experimental evidence suggests that such coatings can effectively extend the functional lifetime of biodegradable alloys without hindering their eventual resorption or biocompatibility. Thus, bio-photopolymerized resins provide a sustainable, versatile, and clinically relevant solution for protecting biodegradable metallic materials, with potential applications in orthopedics, cardiovascular devices, and eco-friendly structural components.

Keywords: *biodegradable alloys, bio-based photopolymerized resins, protective coatings, controlled degradation, biocompatibility*

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MECHANISMS OF NITROGEN OXIDES FORMATION

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Abstract

Although previously overlooked by professionals in thermal engineering, nitrogen oxides (NO_x) represent a significant contributor to both global and local environmental pollution. This topic is of particular relevance today, at a time when environmental pollution and interest in ecological issues are more prominent than ever. In Serbia, the majority of electrical and thermal energy is still produced through combustion processes in boiler furnaces, which further amplifies the importance of this issue. Engineering studies generally focus on emission reduction measures without researching deeply into the chemical and kinetic background of the problem. Therefore, this paper presents the types of nitrogen oxides and the mechanisms of their formation - topics that are often unfamiliar to professionals involved in the design and maintenance of such facilities. The first part of the paper briefly outlines the chemical-kinetic fundamentals necessary for understanding the subject matter. Subsequently, the formation mechanisms of nitrogen oxides are explained, with emphasis on those predominantly occurring during the combustion of gaseous fuels - namely, the Zeldovich (thermal) mechanism and the prompt mechanisms, both of which remain insufficiently investigated. Following this, an analysis of the main influencing parameters on NO_x formation - such as temperature, pressure, and excess air ratio - is provided. The paper also addresses the environmental and health impacts of these pollutants, including acid rain, photochemical smog, and respiratory illnesses.

Keywords: *chemical reactions, nitrogen oxides, combustion, Zeldovich mechanism, prompt mechanisms*

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OPTIMIZATION AND RENEWABLE ENERGY INTEGRATION IN A PRIMARY SCHOOL IN NIŠ UNDER FUTURE CLIMATE SCENARIOS

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Abstract

In the context of accelerated climate change, school buildings must be redesigned to simultaneously reduce energy dependency and enhance sustainability. This study analyzes a primary school in Niš with a specific energy consumption of 165 kWh/m² per year, using the EC-Earth3 climate model under the SSP1-2.6, SSP2-4.5, SSP3-7.0, and SSP5-8.5 scenarios. Input data included reference meteorological files for 2020 and projected climate conditions for 2050 and 2080.

The research integrates energy simulation, multi-criteria optimization, and renewable energy integration. Various intervention packages were evaluated, including building envelope retrofits, system upgrades, and the application of photovoltaic modules and solar thermal systems to achieve increased energy autonomy.

Results indicate that the combined application of optimization and renewable energy technologies can significantly reduce primary energy consumption and CO₂ emissions, even under more extreme climate scenarios. These strategies enhance building robustness, mitigate risks associated with rising cooling demand, and support the long-term sustainability of educational facilities.

Keywords: *energy simulation, CO₂ emissions, system upgrades, photovoltaic, sustainability*

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This research was financially supported by the Ministry of Science, Technological Development and Innovation of the Republic of Serbia (Contract No. 451-03-137/2025-03/200109).

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MATERIALS USED FOR THE PRODUCTION OF BIODEGRADABLE COMPOSITES

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Abstract

This study highlights the use of biodegradable materials in the medical field for the prevention and repair of fractures, ruptures, and vascular or bone blockages. Various studies have been analyzed, demonstrating that these degradable biomaterials, when alloyed with different materials such as magnesium, zinc, and iron, have the ability to degrade in a controlled manner within the biological environment, facilitating tissue regeneration without leaving behind residues that could be harmful to the body after the resolution of medical issues. However, research results indicate that these materials have limited applicability due to their restricted degradation rate and the rapid loss of mechanical properties. To enhance their applicability, reinforcement elements such as biodegradable ceramic materials, nanodiamonds, metallic fibers, and advanced composites are integrated into the biodegradable matrix.

Keywords: *biodegradable, biomaterials, mettalic*

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POST-FIRE CHANGES IN THE MICROSTRUCTURE OF A WELDED JOINT RESULTING FROM DIFFERENT THERMAL IMPACT SCENARIOS

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ABSTRAT

The impact of fire episodes on permanent structural changes both in a welded joint made of S235 structural steel and in its immediate surroundings is assessed in detail in this paper. A distinction is made between the weld material (WM), the heat-affected zone (HAZ), and the base material (BM). Changes resulting from fires with different development scenarios, including: short-term and long-term heating time, as well as, differentiated heating temperature values, are analyzed. Particular attention is paid to permanent phase transformations, occurring as a result of prolonged subcritical heating, leading to spheroidization of cementite and significant modification of the ferritic-pearlitic microstructure. The consequences of these processes, resulting in reduced hardness and tensile strength while simultaneously increasing ductility, are highlighted. Attention is also paid to fire scenario parameters, such as the maximum heating temperature of the joint, the duration of this temperature exposure, and the cooling method implemented in practice. The results of the conducted analyses indicate the need for individual assessment of each case possible to occur, especially in terms of its post-fire metallographic analysis of the joint under study.

Keywords: *welded joint, long-term subcritical annealing, phase transformation, post fire microstructure*

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MINING WASTE MANAGEMENT IN SERBIA: SYSTEMIC CHALLENGES AND REPORTING DEFICIENCIES

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Abstract

In the total volume of non-hazardous waste generated in Serbia in 2023, non-hazardous mining waste accounted for as much as 92.16%, while hazardous mining waste (HMW) represented 99.58% of the total amount of hazardous waste generated nationwide [1]. Among 38 European countries, Serbia recorded the highest quantities of both total mining waste (TMW) and HMW in 2022, amounting to 164.9 million and 29.7 million tonnes, respectively [2]. When it comes to mining waste management, the 2022 report of the State Audit Institution of the Republic of Serbia (SAI) highlights that operators often dispose of and manage mining waste without the permits required by law. Furthermore, the SAI emphasizes the absence of an effective system for reporting and verifying the accuracy of data regarding both the quantities and characteristics of the mining waste being generated [3]. At the time of writing this paper, only two legal entities in Serbia possess valid permits for the management of HMW. Specifically, one company is authorized to collect and transport all classified types of HMW, while the second operator holds a permit for the storage and treatment of two specific types of HMW (waste codes: 01 05 05 and 01 05 06) [4]. In light of the marked increase in the quantity of both TMW and HMW in Serbia since 2022 (Figure 1) [5], it becomes evident that addressing this issue requires a systemic, multidisciplinary approach. Such an approach must involve competent ministries, professional and scientific institutions across the country, and the wider public.

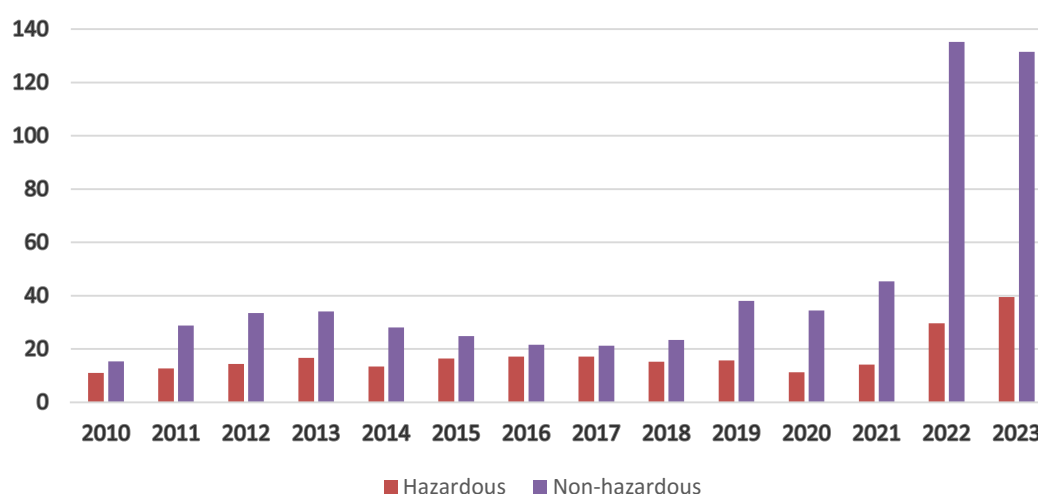


Figure 1. Annual quantities of generated mining waste in Serbia, 2010–2023 (in millions of tonnes)

Keywords: *mining waste management, Serbia, Regulatory compliance, EU environmental standards*

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THE IMPACT OF CLIMATE CHANGE ON THE SUCCESS OF RECLAMATION

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Abstract

After the completion of mining activities, it is the obligation of mining companies to carry out the reclamation of degraded areas. For successful implementation of reclamation, it is necessary to choose a plant species that will thrive in barren soil. When selecting a plant species, we must pay attention to climate change, which brings increasingly drier and hotter summers. For this reason, increased aridity during the summer months has been observed in the southeastern region of Serbia. We are witnessing numerous attempts to implement reclamation, but climate change requires us to pay greater attention to this issue.

Keywords: *degraded areas, reclamation, climate change*

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ALTERNATIVE APPROACH TO BOND WORK INDEX DETERMINATION FOR RAW MATERIALS OF NON-STANDARD PARTICLE SIZE

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Abstract

The determination of the Bond work index (BWI) is a key parameter in estimating energy requirements for mineral comminution processes. However, the standard Bond procedure is limited by the requirement of specific feed particle sizes, which restricts its applicability in practice. This paper presents an alternative methodological framework for evaluating the (BWI) when raw material samples deviate from the prescribed size distribution. Experimental investigations were carried out on zeolite, dacite, and basalt samples, with systematic variation of top feed sizes. The results indicate that the (BWI) is not constant but increases as the feed top size decreases, leading to measurable changes in Bond equation parameters. Based on these findings, new calculation procedures are proposed, enabling reliable estimation of BWI both for non-standard and standard particle sizes, depending on the available reference values. The proposed approach provides deviations of less than 2%, which is significantly lower compared to other alternative procedures reported in the literature. This contributes to improving the accuracy of energy consumption predictions in mineral grinding processes, especially in cases where only limited or non-standard samples are available.

Keywords: *bond work index, comminution, non-standard feed size, grindability, energy estimation*

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MAJOR AND TRACE ELEMENTS OF TRIASSIC AND PERMIAN LIMESTONES OF SLOVAC AND ČELIJE, VALJEVO

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Abstract

Serbia has a large number of carbonate deposits that are excavated in significant quantities. In the vicinity of the city of Valjevo, there are more than 70 limestone quarries [1]. In order to determine the applicability of limestone, the important factor is its chemical purity [2]. For the purposes of this study, a total of 9 limestone samples were collected from the immediate surroundings of the Slovak quarry and near Čelije village. The sample set comprised 5 samples of Triassic age and 4 samples of Permian age.

The concentrations of Ca and Mg in all dissolved samples were determined by the standard volumetric method, while other major and trace elements were determined directly by a handheld X-ray fluorescence spectrometer (HH-XRF).

The classification of all carbonate samples is determined by the Ca/Mg ratio [3]. Additionally, chemical purity is determined by the content of Ca, Mg, and Fe oxides [2]. Three samples of Triassic age can be classified as limestone, whereas two samples can be classified as magnesian limestone and dolomitic limestone, respectively. On the other hand, all Permian carbonates are classified as magnesian limestone. Additionally, the Ca/Mg ratio was used to establish changes in depositional environment. The relative content of clay minerals was determined using the K/Rb ratio. Based on the correlation of K and Rb concentrations, a significant difference between the Triassic and Permian limestones was established.

This study revealed data that can be used to determine potential new limestone deposits in wider Valjevo area.

Keywords: *limestone, X-ray fluorescence, major elements, trace elements*

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INTRODUCING MINERAL CHEMISTRY TO HIGH SCHOOL STUDENTS: SEM-EDS ANALYSIS OF GADOLINITE-(Ce)

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Abstract

The application of Scanning Electron Microscopy – Energy Dispersive X-ray Spectroscopy (SEM-EDS) offers valuable methodological opportunities for introducing high school students to the concept of mineral chemical composition. Integrating multiple-choice questions (MCQs) into this process provides educators with an effective tool for promoting active participation and maintaining classroom engagement [1]. The presented example involves the analysis of SEM-EDS results obtained from a rock sample containing gadolinite-(Ce) [2]. After the EDS spectrum is shown (Figure 1), students are asked to solve a test composed of MCQs. Question 1: Which mineral phase is most likely dominant in this sample? A) Quartz (SiO₂), B) Hematite (Fe₂O₃), C) Gadolinite-(Ce) – (Ce,La,Nd,Y)₂FeBe₂Si₂O₁₀, D) Monazite-(Ce) (CePO₄). Question 2: Which elements in the spectrum most directly support the identification of the dominant mineral phase? A) Ce, Nd, La, Y, Si, Fe, O; B) Si, Al, K, O; C) Fe, S, Mg, C; D) Ca, P, Si, Al. Question 3: Which element(s) would not dissolve during acid digestion (using concentrated HNO₃ and HCl) of the identified mineral phase? A) Fe, Be, O, P; B) Si; C) Y; D) Al, Be. Since Question 3 requires additional knowledge of silicate mineral chemistry and the analytical challenges of silicon quantification (e.g., requiring hydrofluoric acid digestion), it may be omitted or supplemented with further explanation depending on the lesson objective [3]. This educational approach is flexible and can be adapted to various curricula and subjects. With proper instructional support, it provides a meaningful introduction to mineralogical analysis and its relevance to geoscience and material sciences.

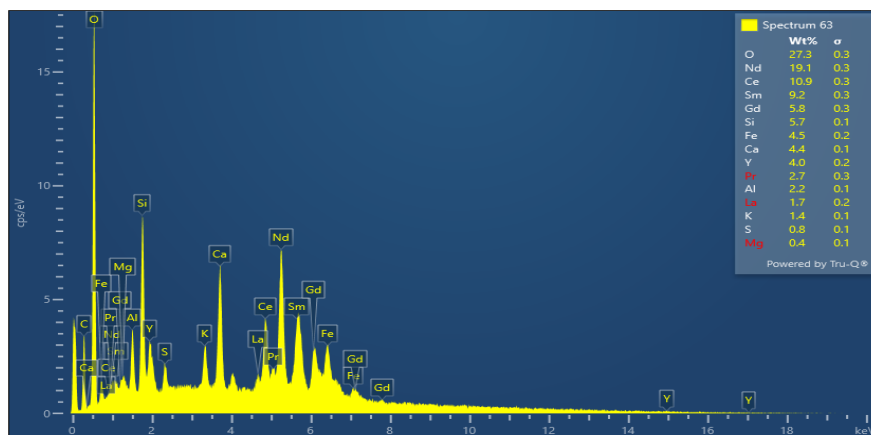


Figure 1. EDS spectrum of a sample containing gadolinite-(Ce)

Keywords: *mineral chemical composition, SEM-EDS analysis, gadolinite-(Ce), geoscience education, multiple-choice questions (MCQs)*

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MECHANICAL PROPERTIES OF SOME STEEL COINS IN CIRCULATION FROM DIFFERENT COUNTRIES

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Abstract

The production of coinage has a long-standing tradition and holds considerable historical importance for every nation. As a fundamental element of the monetary system, coinage reflects the historical, cultural, and political identity of a state through its design, composition, and symbolism. In contemporary economic systems, coins are an indispensable part of everyday financial transactions. Their widespread use underscores the importance of understanding their properties. Specifically, knowledge of the mechanical and microstructural properties of coins is essential for ensuring their durability, resistance to wear, and reliability as a means of exchange. The chemical composition of a coin provides insight into its structural integrity, directly correlating with the quality of the materials used in its production. This, in turn, serves as a reflection of the economic state of the country. In the context of rising inflation and increasing global metal prices, many states face the challenge of producing coins whose intrinsic value remains below their face value for as long as possible. This economic and metallurgical balance is critical for maintaining the efficiency and sustainability of national monetary systems [1-11].

The objective of this study is to characterize steel coinage from Serbia, Hungary, and Bosnia and Herzegovina, with a focus on mechanical properties (hardness, microhardness, and tensile strength), microstructural analysis, and chemical composition. The analyzed coins are made of steel and coated with corrosion-resistant materials: 1 Dinar (2021, Serbia) – steel coated with copper and brass; 100 Forint (Hungary) – central part made of steel coated with brass; outer ring of steel coated with nickel; 1 Convertible Mark (Bosnia and Herzegovina) – steel coated with nickel; 50 Fening (Bosnia and Herzegovina) – steel coated with copper. All examined coins, made of low-alloy steel, exhibit a typical ferritic microstructure, with grain sizes ranging from 20 μm (1 Convertible Mark) to over 200 μm (1 Dinar, 2021). The coating thickness varies from 20 μm (1 Dinar, 2021 – consisting of a 15 μm copper layer and a 5 μm brass layer on top) to 70 μm (100 Forint – the central part coated with brass, and the ring with nickel). Among the analyzed coins, the 1 Convertible Mark coin demonstrated the best mechanical properties with the finest grain structure.

Keywords: *coins, chemical composition, mechanical properties, microstructure*

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INFLUENCE OF CASTING METHOD ON MICROSTRUCTURE AND MECHANICAL BEHAVIOR OF CuZn26Al4Fe3Mn3 BRASS ALLOY

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Abstract

The quality and properties of castings largely depend on their microstructure and associated mechanical characteristics, which are directly influenced by the applied casting method. This study investigated the effect of centrifugal and gravity casting on the formation of microstructure and the development of properties in the multicomponent brass alloy CuZn26Al4Fe3Mn3. The experiments were conducted so that parameters such as melt temperature, mold filling rate, and metallostatic pressure did not affect the results, allowing the observed differences to be attributed solely to the effects of different forces and solidification conditions. Mechanical properties were evaluated through hardness and tensile strength measurements, while microstructural analysis was performed using optical microscopy.

The results show that centrifugal casting leads to the formation of a fine-grained and more homogeneous structure, resulting in higher hardness and strength values. In contrast, gravity-cast samples exhibit a typical dendritic structure with a pronounced growth orientation along the direction of heat dissipation.

These findings confirm that the choice of casting technology is a key factor in achieving castings with controlled microstructure and enhanced mechanical properties.

Keywords: *centrifugal casting, gravity casting, microstructure, mechanical properties*

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INFLUENCE OF OBTAINING PROCEDURE ON GRAIN SIZE OF CuFeP ALLOY

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Abstract

Research in the field of severe plastic deformation (SPD) has grown significantly in recent years due to the numerous properties that can be achieved in various materials [1]. As an SPD method, the extrusion process plays a significant role in achieving a unique combination of high strength and ductility [2], as well as in obtaining an ultrafine grain structure with improved properties [3, 4, 5, 6]. The aim of this work is to analyze the influence of the obtaining procedure and thermomechanical processing on the grain size of copper microalloyed with iron and phosphorus (0,003 wt% Fe i 0,014 wt% P). Microalloyed copper was obtained in two ways: by melting cathode copper and prealloys in an induction furnace CuFe0,1 i CuP6,42 followed by the casting; and melting the same starting materials and casting using the “up-cast” process, followed by extrusion. The samples thus obtained were subjected to thermomechanical processing, which involved cold plastic deformation by rolling with 50% reduction, followed by annealing at 470 °C for 50 min. Based on micrographs, the average grain size and grain size distribution for each tested sample were determined using ImageJ software. The average grain size of the extruded sample was 18.58 µm, while for the sample obtained by melting in an induction furnace was 27.84 µm. Based on the obtained results, it can be concluded that the extrusion process proved justified in terms of grain comminution. During extrusion, thermal deformations of the bar were achieved, which led to dynamic recrystallization, and therefore the grain was significantly refined during the extrusion process. The combination of extrusion and cold rolling not only reduced the grain size, but also reduced the heterogeneity of grain distribution in the workpiece.

Keywords: CuFeP, extrusion, microalloying, “up-cast”, plastic deformation

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ALKALI-ACTIVATED FLY ASH AND METAKAOLIN MATERIALS WITH WOOD ASH ADDITION

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Abstract

Alkali-activated materials (AAMs) are inorganic aluminosilicate binders recognized for their high mechanical strength, thermal resistance, and environmental benefits [1, 2]. Their synthesis involves the use of industrial and agricultural waste by-products, such as fly ash and biomass ash, which contributes to waste valorization and reduces environmental pollution [3]. AAMs also represent a promising low-carbon alternative to Ordinary Portland Cement (OPC), with significantly lower CO₂ emissions [4]. Furthermore, they exhibit potential for use as adsorbents in wastewater treatment for the removal of toxic metals [5].

This study investigates the influence of wood ash incorporation (10 wt.% and 20 wt.%) on the microstructural and mechanical properties of AAMs synthesized from fly ash and metakaolin. Additionally, the effect of sodium hydroxide concentration (6M and 12M) in the alkaline activator on the structural characteristics of the resulting binders was evaluated. The materials were characterized using Diffuse Reflectance Infrared Fourier Transform Spectroscopy (DRIFT), X-ray Diffraction (XRD), Field Emission Scanning Electron Microscopy (FESEM), and compressive strength testing.

Results indicate that the addition of wood ash and variation in NaOH concentration significantly affect the morphology and structural integrity of AAMs. The DRIFT spectrum confirmed the formation of new aluminosilicate phases that form the amorphous gel structure within the AAM matrix, while XRD analysis identified quartz, as the predominant crystalline phases. FESEM revealed morphological changes associated with wood ash content and alkali concentration. A decline in compressive strength was observed with increasing wood ash content, indicating a reduction in matrix densification and compactness. These findings contribute to a better understanding of the role of biomass-derived additives (wood ash) in the development of sustainable alkali-activated materials.

Keywords: *alkali-activated materials, fly ash, metakaolin, wood ash*

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ENHANCEMENT OF WETTABILITY AND GRAIN REFINEMENT IN Sn-0.7Cu-xIn SOLDER ALLOYS BY INDIUM ADDITION

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Abstract

Concerns about the environmental and human health impacts of lead-containing solders, along with the adoption of relevant regulations and directives, have prompted researchers to develop high-performance, lead-free solder alternatives. In this study, the effect of indium addition on the wettability and microstructure of Sn-0.7Cu-xIn ($x = 0, 1, 3$, and 5 wt.%) solder alloys was investigated. The solders were fabricated using the powder metallurgy technique, which involves powder mixing, compacting, and sintering. Scanning electron microscopy (SEM) with energy-dispersive spectroscopy (EDS) revealed that increasing indium content reduces the grain size, resulting in a refined β -Sn microstructure. Wettability was determined by measuring the spreading area and contact angle between the solder and copper substrate. It was observed that the spreading area increased while the contact angle was reduced with higher indium content, indicating improved wettability and enhanced solder joint quality.

Keywords: powder metallurgy, spreading area, contact angle

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CHARACTERIZATION OF NICKEL COMPOSITE COATINGS WITH TiO₂ ADDITION

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Abstract

The aim of the research presented in this paper is the electrochemical production of nickel composite coatings with the addition of TiO₂, the determination of microhardness and the characterization of the surface by optical microscopy. The electrochemical deposition of nickel coatings was carried out using a commercial Ni-Ex solution with the addition of 20 g/L TiO₂ at different current densities 4 A/dm², 6 A/dm², 8 A/dm² and 10 A/dm². The coating was deposited on a brass sheet, while two lead plates were used as anodes. The time of the experiment was calculated in order to maintain a constant amount of electricity. The temperature of the electrolyte was maintained in the range of 55-60 °C. The morphology and structure of the surface coatings was investigated using optical microscopy.

Keywords: *nickel, brass, composite coatings, TiO₂, microhardness*

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INFLUENCE OF LAYER THICKNESS AND NOZZLE DIAMETER ON SURFACE QUALITY OF FDM-PRINTED FOUNDRY PATTERNS

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Abstract

The integration of additive manufacturing into foundry practice has introduced significant improvements in the design and production of casting patterns. In particular, 3D Printing based on Fused Deposition Modeling (FDM) has proven to be a cost-effective and flexible method for producing complex geometries that are otherwise difficult to achieve with conventional pattern-making techniques. However, the dimensional accuracy and surface quality of FDM – printed patterns directly affect the final casting, especially when patterns are used in sand-clay molds where surface roughness is transferred to the cavity.

This study investigates the influence of two critical printing parameters: layer thickness and nozzle diameter on the surface roughness (R_a) and overall suitability of 3D – printed patterns for aluminum casting applications. It was observed that using a nozzle diameter of 0.4 mm with a layer thickness of 0.1 mm provides a surface roughness in the range of R_a 12–16 μm , which is generally acceptable for sand casting patterns without additional post-processing. In contrast, increasing the layer thickness to 0.3 mm results in significantly higher roughness values (R_a 20–30 μm), which may negatively impact the mold surface finish and, consequently, the final casting quality.

The results highlight the trade-off between build time and surface quality: finer layer heights and smaller nozzles improve surface finish but considerably extend print duration. For practical casting applications, a compromise between surface quality and production efficiency is often necessary. Furthermore, post-processing techniques such as sanding, coating, or chemical smoothing can further reduce surface roughness to $R_a < 10 \mu\text{m}$, making the printed models even more suitable for high-precision castings.

This work emphasizes that optimization of FDM process parameters is essential to ensure that 3D-printed patterns not only accelerate the design-to-casting workflow but also meet the surface quality requirements of industrial foundry practice.

Keywords: *additive manufacturing, 3D printing, sand casting, surface quality*

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N, S ENRICHMENT OF COCONUT SHELL ACTIVATED CARBON AND CHARACTERIZATION BY SEM/EDX ANALYSIS

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Abstract

Activated carbon is a porous carbonaceous material with continually expanding applications in water treatment and desalination, wastewater treatment and air purification due to its unique characteristics^[1]. It can be produced from a variety of carbonaceous rich materials such as wood, coal, lignite and coconut shell.^[2] In this work, coconut shell activated carbon was doped with nitrogen and sulfur to improve its surface functionality. Of particular significance is the incorporation of these heteroatoms, as functional groups with nitrogen and sulfur improve the affinity of carbon surfaces for polar molecules and metal ions. The synthesized material was characterized using scanning electron microscopy (SEM) combined with energy-dispersive X-ray spectroscopy (EDX). SEM micrographs revealed a well-developed porous morphology with irregular cavities and interconnected pores, typical for chemically activated carbon. EDX elemental analysis of the activated carbon confirmed the composition with a high carbon content of pure active carbon sample. We also obtained confirmation that the carbon skeleton is to a good extent enriched with nitrogen depending on whether we used urea or thiourea. In contrast, there was almost no sulfur when we used urea and a negligible amount when we used thiourea. Elemental mapping further demonstrated a relatively uniform distribution of these heteroatoms, indicating effective functionalization during the modification process. The findings indicate that activated carbon derived from coconut shells can be successfully modified through heteroatom enrichment, leading to improved physicochemical characteristics suitable for future adsorption or catalytic uses.

Keywords: active carbon, urea, thiourea, SEM/EDX

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POLYMER-MODIFIED GRAPHENE SCREEN-PRINTED ELECTRODES FOR SENSITIVE AQUEOUS ANALYTE MONITORING

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Abstract

The development of robust, low-cost electrochemical sensors is critical for real-time process control and environmental monitoring in mining and metallurgical operations. This research focuses on the systematic electrochemical evaluation of polymer-modified screen-printed electrodes (SPEs) as a platform for sensitive aqueous analysis. Commercial screen-printed graphene electrodes served as the conductive substrate. To enhance electrochemical reactivity, their surfaces were modified with polyvinylidene fluoride (PVDF) and chitosan (Ch) polymers.

The core of this research involved a detailed electrochemical characterization using cyclic voltammetry (CV). The electrochemical activity of the bare and modified electrodes was systematically tested in a 0.1 M phosphate-buffered saline (PBS) electrolyte containing a model redox-active analyte. The CV measurements were used to quantify fundamental performance metrics, including changes in peak currents, peak-to-peak potential separation (ΔE_p), and overall voltammetric response. These parameters provided direct insight into how the polymer modifications influenced the electrode's electrical conductivity and electron transfer kinetics. The electrochemical results clearly demonstrated that the modified electrodes yielded a significantly amplified and more favorable electrochemical response compared to the commercial graphene SPE. The chitosan-modified electrode exhibited superior performance, characterized by the highest peak currents and well-defined redox waves. Rigorous quantitative analysis of this optimized sensor established a low limit of detection (LOD) of 9.82 μM and a limit of quantification (LOQ) of 32.74 μM , achieved over a linear range of 1.5 to 7.4 μM . Furthermore, the electrode demonstrated excellent operational stability, repeatability, and reproducibility under continuous cycling. These findings underscore the potential of these modified electrodes as a reliable and sensitive analytical tool for monitoring key ionic species in hydrometallurgical and environmental applications.

Keywords: *electrochemical sensors, chitosan, polyvinylidene fluoride*

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CHARACTERIZATION OF GRAPHENE-MODIFIED PVC COMPOSITE FILMS FOR EMI SHIELDING IN SMART BUILDINGS

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Abstract

Graphene-polymer composites are emerging as next-generation materials for effective electromagnetic interference (EMI) shielding in smart buildings and demanding industrial applications. The ultimate performance of these composites is dictated by the dispersion and surface chemistry of the graphene (G) filler as well as the weight percentage of G within the polymer matrix. To optimize these properties, this study presents a comparative analysis of polyvinyl chloride (PVC) composite films containing two distinct graphene variants: a non-oxidized, acid-activated graphene and a fully oxidized graphene oxide. By systematically characterizing these materials, we aim to determine how filler functionalization influences the structural and thermal properties essential for durable shielding performance. These two graphene variants were subsequently dispersed into a PVC matrix to form thin composite films. A systematic characterization was performed to evaluate the influence of the graphene functionalization on the final composite properties. Scanning electron microscopy (SEM) was used to analyze the morphology and the quality of filler dispersion within the polymer. The structure of the graphene versus graphene oxide within the PVC matrix was confirmed using Raman spectroscopy. Furthermore, the thermal stability and degradation profiles of the composites were obtained by thermogravimetric analysis (TG/DTG) and differential scanning calorimetry (DSC). This comparative study provides crucial insights into how different graphene activation methods impact the structural and thermal properties of PVC composites, guiding the design of effective and durable materials for EMI shielding in industrial applications.

Keywords: *graphene, PVC composite, effective electromagnetic interference (EMI)*

ACKNOWLEDGEMENT

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GRAPHENE-BASED ELECTROCHEMICAL SENSOR FOR TETRAHYDROCANNABINOL DETECTION

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Abstract

This paper focuses on the development of graphene-based nanosensors for the effective detection of THC (tetrahydrocannabinol) in media that simulate human blood and urine samples. The goal is to design nanosensors that can accurately and reliably monitor THC concentrations, thus offering a promising method for tracking drug levels during treatment. In this study, a series of experiments was conducted using printed electrodes featuring a graphene-based working electrode, along with a cyclic voltammetry device and a scanning electron microscope (SEM) to characterize and evaluate the performance of the nanosensors.

The findings of this study demonstrate that graphene nanosensors provide high sensitivity and selectivity, along with rapid response times for real-time measurements. Their innovative and portable nature makes them suitable for applications in medical, legal, and forensic fields. This research marks a significant step forward in the practical use of graphene-based electrochemical sensors for the detection of psychoactive substances, with a particular emphasis on THC. Additionally, it paves the way for further refinement and adaptation of these sensors for real biological matrices, such as blood and urine.

Keywords: *electrochemical sensors, THC (tetrahydrocannabinol), Graphene electrode*

ACKNOWLEDGEMENT

The research was part of a scientific mobility at the Institute of Technical Sciences at the Serbian Academy of Sciences and Arts in Belgrade, Serbia, financed by the Western Balkan Fund. The author ID acknowledges the generous financial support from the Western Balkan Fund, and the generosity of the Institute of Technical Sciences of SASA for making this mobility possible.

XRD TEST OF Bi-Ni-Zn ALLOYS ANNEALED AT 700 °C

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Abstract

Ternary systems based on Bi-Ni [1-3] were studied in past but still some of the ternaries were not tested. Chosen system in our study is Bi-Ni-Zn. In this study seven ternary alloys were selected for XRD test. Device for XRD test was D2 PHASER, Bruker, Germany powder diffractometer equipped with a dynamic scintillation detector and ceramic x-ray Cu tube (KFL-Cu-2K). XRD patterns were recorded in a 2θ range from 10 to 75 with a step size of 0.02 and patterns were analysed using the Topas 4.2 software, ICDD data bases PDF2 (2013).

XRD results were compared with calculated isothermal section at 700° C. Good agreement with calculation and XRD test results are obtained. It is detected followed phase region in samples: sample 1 and 2 same phase (Ni), sample 3 (Ni) and β_1 phase, sample 4 β_1 phase, sample 5 NiZn_3 and β , sample 6 NiZn_3 , and in sample 7 phase γ . Figure 1 presents XRD pattern of sample 1 as one illustration.

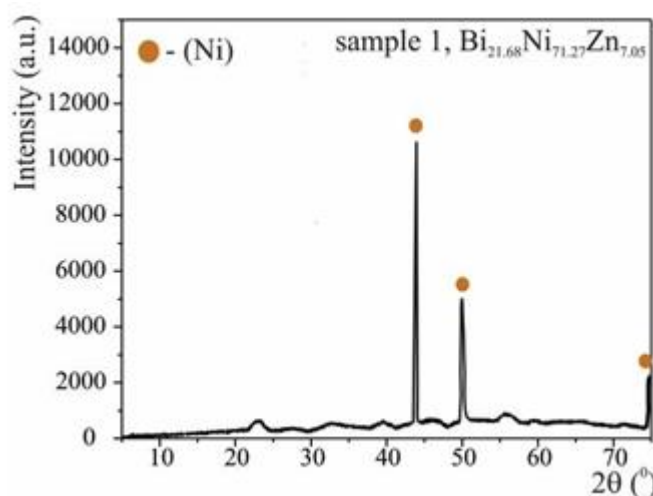


Figure 1. XRD pattern of sample1, $\text{Bi}_{21.68}\text{Ni}_{71.27}\text{Zn}_{7.05}$.

Keywords: Bi-Ni-Zn alloys, XRD test, annealed alloys at 700 °C

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XRD TEST OF Bi-Ni-Zn ALLOYS ANNEALED AT 400 °C

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Abstract

Nickel and nickel-based alloys are widely used in different industries [1,2], such as electronic, chemical, automotive, marine etc. Alloys are used for making vessels, pipes, heat exchangers, pumps, impellers, valves [3], alkaline batteries, gas engines and turbines [4], optical mirrors [5], equipment for food industry, chemical industry, petrochemical industry, as well as for galvanic coating of steel objects and other type of equipment. Due to the significant applications of alloys it is highly necessary to study Ni based alloys.

In this study six ternary alloys were selected for XRD test. Device for XRD test was D2 PHASER, Bruker, Germany powder diffractometer equipped with a dynamic scintillation detector and ceramic x-ray Cu tube (KFL-Cu-2K). XRD patterns were recorded in a 2θ range from 10 to 75 with a step size of 0.02 and patterns were analysed using the Topas 4.2 software, ICDD data bases PDF2 (2013).

Results shown that in sample 1 two-phase (Ni) and BiNi are detected. Figure 1 presents XRD patterns of sample 1. In structure of sample 2 three-phase are detected (Ni), BiNi and $\beta 1$. In sample 3 another three phases Bi_3Ni , BiNi and $\beta 1$. In sample 4 and 5 two phase NiZn_3 and $\beta 1$ while in sample 6 detected phases are (Zn) and δ .

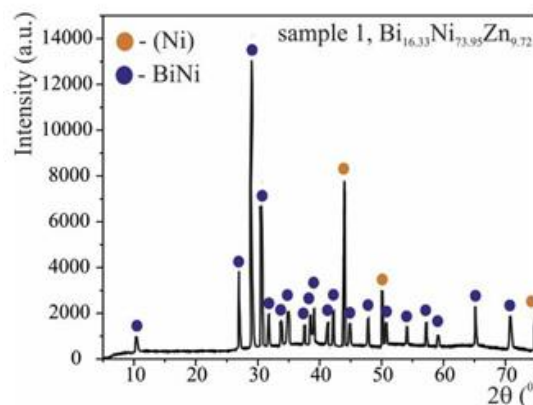


Figure 1. XRD pattern of sample1, $\text{Bi}_{16.33}\text{Ni}_{73.95}\text{Zn}_{9.72}$.

Keywords: Bi-Ni-Zn alloys, XRD test, annealed alloys at 400 °C

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DTA TEST OF THE Al-Bi-Ge TERNARY ALLOYS

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Abstract

Twelve ternary samples from three vertical sections Al-BiGe, Bi-AlGe and Ge-AlBi were selected for DTA test. The DTA measurements were performed with an SDT Q600 (TA Instruments). The overall uncertainty of the determined phase transformation temperatures was estimated to be ± 1 °C. Experimental results of the DTA test were recorded on three heating cycles. The determined temperatures of phase transitions are divided into two groups. The first group are the temperatures of the invariant reaction and the peak of the mono variant phase transition.

For all samples analyzed, the first and second peaks detected on the heating curve have a similar appearance and temperature values close to each other. These temperatures are therefore associated with the same phase transition. The temperature range of the first peak is between 266.31 °C (sample Al60Bi20Ge20) and 280.89 °C (sample Al80Bi10Ge10). The temperature range of the second peak is from 419.24 °C (sample Al10Bi80Ge10) to 431.34 °C (sample Al40Bi30Ge30). The last peak detected is described as a liquid temperature. All experimentally determined temperatures are compared with the calculated vertical sections. According to the calculation and compared to the experimental results it is clear that first temperatures are related to the invariant reaction $L \rightarrow (Al)+(Bi)+(Ge)$. Calculated temperature of reaction is 270.32 °C while experimental ones are in the range of 266.31 - 280.89 °C. Second temperatures are related to the $L \rightarrow L+(Al)+(Ge)$ invariant transformation. Calculated temperature of second reaction is 421.83 °C, while experimental are in the range of 419.24 °C to the 431.34 °C. Temperatures of mono-variant phase transition and liquidus temperature are in good agreement with calculated ones.

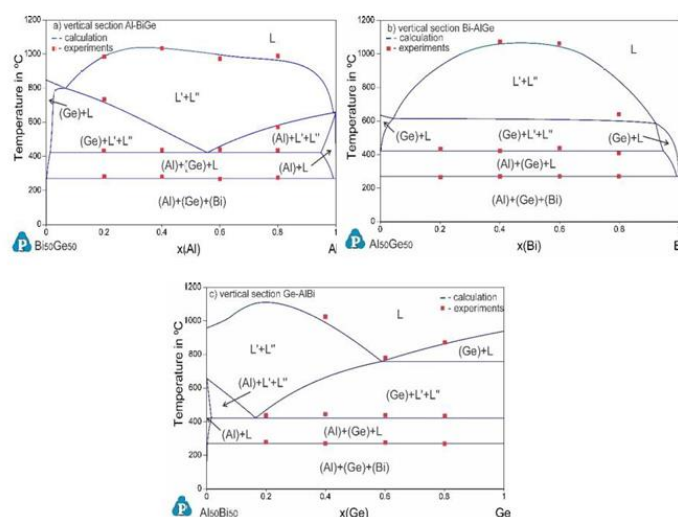


Figure 1. Calculated vertical sections of the ternary Al-Bi-Ge system compared with DTA experimental results: a) Al-BiGe, b) Bi-AlGe and c) Ge-AlBi.

Keywords: DTA test, alloys, phase diagrams

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INFLUENCE OF REPEATED QUENCHING ON THE MICROSTRUCTURE AND MECHANICAL PROPERTIES OF C60 STEEL

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Abstract

In this study, the influence of repeated quenching on the microstructure and mechanical properties, specifically hardness, of C60 steel was examined. Experimental analyses were performed on samples quenched in both water and oil, with particular emphasis placed on monitoring microstructural evolution and hardness variation after each quenching cycle. The initial quenching revealed that the anticipated martensitic microstructure did not form, primarily due to an insufficient holding time at the austenitizing temperature, which prevented complete transformation of the initial microstructure into austenite. Subsequent quenching cycles facilitated the formation of martensite, while the second quenching in water additionally promoted the development of a Widmanstätten microstructure. The maximum hardness was attained after the third quenching cycle, whereas a reduction in hardness was observed after the fourth cycle as a result of decarburization and microstructural heterogeneity. Furthermore, the results demonstrated that the hardness values achieved by quenching in water and oil were comparable. This indicates that quenching may be repeated in a controlled protective atmosphere without a significant impact on hardness. It was also confirmed that the careful selection of process parameters—specifically the austenitizing temperature and holding time—is essential for obtaining the desired microstructure and mechanical properties.

Keywords: *quenching, microstructure, hardness*

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MECHANICAL AND PHYSICAL PROPERTIES OF GYPSUM COMPOSITES WITH RECYCLED EPS

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Abstract

The reuse of recycled expanded polystyrene (EPS) in gypsum-based composites presents a promising pathway for developing sustainable and cost-effective construction materials. This study investigates the incorporation of recycled EPS into gypsum composites at 0%, 20%, 30%, and 40% volumetric replacement levels. The prepared mixtures were tested for density, flexural strength, compressive strength, and dynamic modulus of elasticity. The results revealed a clear trend of decreasing density and mechanical performance with increasing EPS content. Density decreased from 1270 kg/m³ (0% EPS) to 805 kg/m³ (40% EPS), representing a weight reduction of over 35%. Average flexural strength decreased from 3.07 MPa to 1.52 MPa, while compressive strength dropped from 7.13 MPa to 2.93 MPa. Ultrasonic pulse velocity values also declined from 71.17 μ s to 83.20 μ s, indicating reduced stiffness at higher EPS volumes. Despite these reductions, the EPS-modified composites demonstrated significantly lower weight, making them particularly suitable for non-structural applications such as partition walls and insulation panels. These findings highlight that recycling of EPS can contribute to reducing plastic waste, lowering material weight, and improving energy efficiency. Further research on additives, surface treatments, or fiber addition could enhance bonding and durability. Overall, recycled EPS represents a promising route toward sustainable gypsum-based composites and circular construction practices.

Keywords: *gypsum composites, expanded polystyrene, recycling, lightweight materials, sustainable construction, circular economy*

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EFFECT OF YTTRIUM ADDITION ON THE MICROSTRUCTURE OF PRECIPITATION-HARDENED MARTENSITIC STAINLESS STEEL

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Abstract

This study investigates the influence of yttrium microalloying on the mechanical and microstructural properties of 17-4 PH martensitic stainless steel, within a composition range of 1–5% Y. The samples were prepared by precise weighing on an analytical balance and remelted in a RAV MRJ 900 vacuum arc remelting furnace under argon protection, with five successive remelts performed to ensure chemical homogeneity [1]. The chemical composition was determined by X-ray fluorescence (XRF) spectrometry using a BRUKER spectrometer, while the mechanical characterization was carried out through Vickers microhardness tests ($HV_{0.2}$) according to ASTM E384-22 [2]. For each composition, five independent measurements were performed, and the obtained values were statistically analyzed. The microstructures were examined by optical microscopy after chemical etching with Kalling's reagent, to highlight the phases present and the degree of structural homogeneity [3]. The results indicated a progressive increase in average microhardness, from approximately 301 HV at 1% Yttrium to about 320 HV at 5% Yttrium. However, this trend was accompanied by significant data dispersion, particularly at 4–5% Yttrium, where standard deviations and coefficients of variation reached high levels.

The microstructural analysis confirmed these trends: samples with 1–2% Yttrium exhibited a uniform structure with fine grains and homogeneously distributed phases, while those with 4–5% Yttrium revealed inclusions, segregations, and pronounced heterogeneities [3].

The study demonstrates that lower Yttrium additions (1–2%) promote the formation of uniform and stable structures, whereas higher additions (4–5%) lead to increased hardness values, but are associated with reduced microstructural homogeneity.

Keywords: *yttrium microalloying, microstructures, microhardness, influence of rare alloying elements*

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RADIATION RESISTANCE SIMULATION OF Al-Mg-Li ALLOY IN THE SPACE ENVIRONMENT

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Abstract

The exposure to energetic or bombarding particles in the space environment causes irradiation damage in structural materials. Irradiation damage includes interstitial, substitutional and vacancy defect formation and clustering [1, 2]. Accumulation of these defects can negatively impact the functional properties of the material over mission lifetime, making the radiation tolerance a critical design criterion for space-grade alloys [3].

This study aimed to evaluate the radiation resistance of an aluminum–magnesium–lithium (Al-Mg-Li) alloy in a simulated space environment. The alloy was synthesized in laboratory conditions, followed by characterization of chemical composition, density, thermodynamic modeling of solidification sequence and metallographic analysis. Radiation behavior was assessed using ion stopping, range and transportation (SRIM and TRIM) simulation tools. Both SRIM and TRIM simulations were performed to evaluate the interaction of Al-Mg-Li alloy with helium ions (He^+). While stopping and range of ions were calculated for broad energy range (1 keV to 10 MeV), the transportation of ions in solid target was restricted to incident energy of 0.05 keV.

The characterization results show that synthesized Al-Mg-Li alloy has approximately 30 % lower density compared to other space-grade alloys with complex solidification sequence and high number of intermetallic phases [4]. The SRIM results indicate that low energy He^+ ions induce irradiation defects near the surface of the solid target. At higher energies, the particles mainly cause electronic excitations without significant damage. Detailed TRIM simulations of spatial distributions of displacements, vacancies, and substitutional atoms confirmed the previous observations.

The results of irradiation damage simulations in combination with low density enable the synthesized Al-Mg-Li alloy to be considered as potential space-grade material for structural applications.

Keywords: *Al-Mg-Li alloys, radiation resistance, space applications, SRIM and TRIM simulations, defects*

ACKNOWLEDGEMENT

The investigation was performed within the research topic “Design and Characterization of Innovative Engineering Alloys”, Code: FPI-124- ZZB funded by University of Zagreb within the Framework of Financial Support of Research and Infrastructural scientific projects: Center for Foundry Technology, Code: KK.01.1.1.02.0020 and VIRTULAB - Integrated Laboratory for Primary and Secondary Raw Materials, Code: KK.01.1.1.02.0022 funded by European Regional Development Fund, Operational Programme Competitiveness and Cohesion 2014 - 2020

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SEVERE PLASTIC DEFORMATION METHODS WITH APPLICATIONS IN THE MEDICAL FIELD

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Abstract

Severe Plastic Deformation (SPD) is a modern method that enable the development of ultrafine and nanocrystalline structures with enhanced mechanical and functional properties. This technique is applied to improve the hardness, wear resistance, and biocompatibility of materials intended for medical applications [1].

In the biomedical field, materials processed through the severe plastic deformation method are used in orthopedic implants, dental devices, and cardiovascular stents due to their unique combination of mechanical and biological properties. As example we can consider that the nanostructured titanium obtained through High-Pressure Torsion (HPT) exhibits high mechanical strength and superior biocompatibility, facilitating faster osseointegration of implants. Additionally, magnesium alloy treated by Equal Channel Angular Pressing (ECAP) is used for biodegradable stents, thanks to its controlled degradation rate in physiological environments.

The severe plastic deformation method also can influence the behavior of materials in terms of corrosion resistance and interaction with living tissues. Nanostructuring materials through ECAP and HPT enhances oxidative stability and reduces susceptibility to corrosion, which is essential for permanent implants. Moreover, this technique can be combined with surface treatments to achieve antimicrobial properties and minimize the risk of postoperative infections [2].

In conclusion, modern severe plastic deformation techniques provide innovative solutions for improving materials used in medicine, contributing to the increased lifespan of implants and reducing associated complications. The development and optimization of these technologies allow for the creation of advanced materials tailored to medical requirements, opening new opportunities for more effective and safer treatments.

Keywords: *severe deformation, microstructure, HPT, ECAP*

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EXPLORING ERP SYSTEM ADOPTION: EVIDENCE FROM AN ANOVA ANALYSIS

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Abstract

Enterprise Resource Planning (ERP) systems are essential for managing contemporary business operations of companies. This study investigates the determinants of ERP system Actual Usage as an endogenous variable through an extended Technology Acceptance Model. The research model integrates exogenous variables Work Compatibility, Perceived Usefulness, and Perceived Ease of Use, along with external factors such as Business Process Fit, System Complexity, Social Influence, System Performance, and User Manuals. To explore the influence of demographic characteristics on the constructs of the model, Analysis of Variance (ANOVA) was applied.

The empirical research was conducted in 2024 using an online questionnaire distributed via LinkedIn. A total of 139 valid responses were collected, with participants drawn from diverse sectors including information technology, finance, logistics, marketing, and human resources. The sample comprised 59.7% male and 40.3% female respondents, with the largest share (49.6%) aged 30-39. Most participants held either a BSc (41%) or MSc (43.2%) degree, and two-thirds were employed in large enterprises with over 250 employees.

The ANOVA results indicate no significant differences by company size or education level, except in the case of Perceived Usefulness. The duration of ERP usage influenced Work Compatibility, Perceived Usefulness, and Actual Usage. Frequency of system use showed significant effects for most constructs, except System Complexity and Perceived Ease of Use.

Keywords: ANOVA, ERP, empirical research

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RARE EARTH ELEMENTS UNINTENTIONALLY RELEASED FROM GLOBAL INDUSTRIAL ACTIVITIES

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Abstract

Rare earths, a group of 17 chemical elements, play a key role in modern industries such as electronics, metallurgy, renewable energy, medicine and military technology. Their unique magnetic, catalytic and optical properties make them indispensable for the manufacture of high-tech devices, from smartphones and electric vehicles to lasers, medical scanners and wind turbines. Although they occur naturally in the Earth's crust, the complexity of the ores and the low concentrations make their extraction a challenge that requires advanced and expensive technological processes. This paper examines the extraction methods, focusing on hydrometallurgical, pyrometallurgical and environmentally friendly approaches. The impact of human activities on environmental and health aspects due to pollution, especially from fly ash and industrial waste, is also considered. The increasing demand for these elements requires sustainable mining and recycling in order to reduce dependence on primary extraction and mitigate the negative impact on the environment. In addition, the development of new technologies for more efficient separation and processing is crucial for improving the environmental sustainability and economic viability of their production.

Technologies such as bioleaching, phytomining and the use of supercritical fluids are viable alternatives to traditional methods. In addition to the environmental aspect, research is also looking at toxicity, which varies according to concentration and raises concerns about the impact on ecosystems, particularly marine organisms and plants. In addition, global market dynamics and geopolitical issues play an important role in availability and price, further complicating supply. Considering all these factors, future research and innovation should focus on improving the efficiency of mining and recycling technologies, as well as developing substitutes that would reduce the need for these elements in key industries. This paper provides a comprehensive overview of the challenges and innovations aimed at improving efficiency, increasing environmental sustainability and reducing negative environmental impacts.

Keywords: *rare earth elements, extraction methods, environmental impact, toxicity, recycling*

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ELECTROCHEMICAL OXIDATION OF NAPHTHALENE

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Abstract

Polycyclic aromatic hydrocarbons (PAHs) are an important group of persistent organic pollutants released into the environment by anthropogenic and natural activities [1, 2]. Naphthalene is one of the two most abundant PAHs in nature [3]. Naphthalene concentrations in wastewater range from 40 to 47000 ng/L, while naphthalene is present in drinking water in concentrations ranging from 13.1 to 139000 ng/L [1]. Due to its toxicity, stability, and persistence in the environment, naphthalene is on the list of priority pollutants [3,4]. Therefore, the removal of naphthalene is important for the protection of the environment and the preservation of human health. Among the various treatment methods investigated, electrochemical oxidation has attracted great attention due to its high efficiency, environmental friendliness, simplicity of operation and relatively low cost [5,6]. During electrochemical oxidation, naphthalene usually decomposes into less toxic intermediates (1,4-naphthalenedione and 1,4-naphthoquinone), which can be degraded to CO₂ and H₂O by successive oxidation reactions [7]. The efficiency of the electrochemical oxidation of naphthalene strongly depends on several parameters, including the type of anode material, the pH of the electrolyte, the current density and the electrolysis time. The aim of this paper is to present the mechanism of electrochemical oxidation of naphthalene and the main process parameters that influence the efficiency of electrochemical oxidation.

Keywords: PAHs, naphthalene, electrochemical oxidation

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TESTING OF CHLORIDE CONTENT IN FUELS

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Abstract

The chloride content is one of the key parameters of fuel quality. This study investigates the issue of chloride content in fuel used for cement production and the impact it may have on the production process, their permissible values in fuel, as well as possible methods to reduce their negative impact on the overall process. For cement production, besides coal as the primary fuel, RDF (Refuse Derived Fuel) is also used as an alternative type of fuel. A device for determining the chloride content was used for the needs of this type of testing. Analyses were performed on 5 prepared coal samples and the same number of RDF samples, and they were done in 8 series. Based on the obtained results, it can be concluded that the chloride content in RDF is on average significantly higher compared to coal as a fuel. In all 8 tested series of samples, chlorides are least represented in coal, while their concentration in RDF varies significantly. Based on a total of all 40 analyzed samples from all 8 series of analyses, the lowest measured percentage of chlorides is 0.009%, while the highest measured percentage is 3.515%. On the other hand, as expected, the average chloride content in the coal showed a low percentage of 0.0465% in all 8 series of analyses. In the cement factory where analyses were performed, the permitted level of chlorides in alternative fuel should not exceed 0.70% as chlorides are specific to the combustion process. At high temperatures, these thermally unstable compounds evaporate, and if present in a concentration greater than allowed, they decrease the efficiency of kilns in the cement industry. Based on the collected data, it has been concluded that the series of samples number 3 contains the maximum concentration of chlorides in RDF and is therefore discarded from use, while series of samples number 6 contains the minimum concentration and is also the most advantageous series for the needs of the cement plant.

Keywords: *chloride content, coal, refuse derived fuel, cement production*

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OVERVIEW OF METHODS FOR REMOVING HEAVY METAL IONS FROM WASTEWATER

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Abstract

Water pollution by heavy metals is a serious environmental and health problem that requires effective methods for their removal. This paper analyzes various wastewater treatment processes, including chemical precipitation, adsorption, ion exchange processes, membrane processes and solvent extraction. Chemical precipitation and adsorption are found to be the most economical methods in the initial stage of purification, while membranes such as reverse osmosis are more effective in removing metals at very low concentrations. The adsorption efficiency of cadmium(II) removal in wastewater was 87.15% at pH of 8.6, an initial concentration of 12.5 mg/l and a temperature of 20°C.

Special attention is given to solvent extraction, a method that allows selective removal of metal ions by transferring them from the aqueous to the organic phase. The use of ionic liquids improves the environmental compatibility of this process, as less volatile organic solvents are used. Experiments showed high efficiency in the removal of ions such as cadmium, cobalt, lead, erbium, where the complexes of ions and extractant were stabilized in the condensed interfacial phase, and where only 5% of Sr^{2+} was extracted at a pH of 3.2, while the extraction efficiency increased to 55% at a pH of 6.2. So, with pH and the choice of extractant being the key success factors. In addition, researches have shown that adsorption with nanomaterials significantly increases the removal of lead and copper ions from wastewater.

The results suggest that solvent extraction is suitable for metal recycling and reuse of treated water, while other methods, such as adsorption, are simpler and more economical. This work contributes to a better understanding of the possibilities of applying different methods in wastewater treatment, with a focus on sustainable alternatives and improved efficiency of heavy metal removal.

Keywords: *removal of heavy metals, wastewater, toxicity, solvent extraction*

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SUSPENDED PARTICLES IN THE AIR AS A RESULT OF MINING ACTIVITIES

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Abstract

The aim of this paper is to analyze the main sources of pollution in mining, their impact on the environment and human health, and possible measures to reduce the negative effects. Mining is one of the most important industries that has a significant impact on the environment, mainly through the emission of particulate matter (PM). Mining processes such as prospecting, drilling, blasting, crushing and transportation of ore etc. release large amounts of PM particles of different sizes. The smallest particles (PM 2.5 and PM 10) are particularly dangerous as they can penetrate deep into the human respiratory tract and cause serious health problems, including respiratory and cardiovascular diseases. In addition to air pollution, mining has other negative impacts on the environment. It contributes to land degradation, erosion and the loss of natural habitats, which threatens biodiversity. Liu et al. (2013) found higher concentrations of heavy metals in agricultural soils near mines and metal smelters. The results showed that Cd and Cu were the two main pollutants in the soil with concentrations of 0.52 - 2.55 mg/kg and 27.87 - 426.15 mg/kg, respectively. The mean concentrations of As, Mn, Pb and Zn in soil were 33.99 mg/kg, 468.70 mg/kg, 125.32 mg/kg and 171.48 mg/kg, respectively. Water pollution from heavy metals and chemicals used in ore processing can also have long-term consequences for ecosystems and the quality of drinking water. The physical and chemical properties of particulate matter determine its reactivity, its transport in the atmosphere and its impact on health and the environment. Particulate matter contains a wide range of substances, including nitrates, sulfates, elemental and organic carbon, heavy metals and various organic compounds. Their size and composition depend on the emission source and meteorological conditions. The concentration of suspended matter is subject to seasonal fluctuations. It is lower in the rainy season due to the deposition of rain, while it is higher in the dry months due to the raising of dust (Corona Sanchez et al., 2021). The average 24-hour PM 10 concentration measured in a Rio Tinto mine in Spain was 26.1 $\mu\text{g}/\text{m}^3$, while PM 10 concentrations of 100–300 $\mu\text{g}/\text{m}^3$ were measured at a tailings pond in Namibia, which decrease when the tailings pond is covered with water (Sanchez de la Campa et al., 2011). The characterization of particulate matter in mining areas requires a combination of different methods to obtain a complete picture of its composition and effects. These methods include gravimetric analysis, spectrometric methods, optical microscopy and biological indicators. In view of these challenges, effective protective measures must be taken, such as the use of modern filtration systems, the humidification of surfaces to reduce dust and the recycling of waste materials. A sustainable approach to mining, that includes environmentally friendly technologies and remediation measures, is an important solution to reduce the negative impact on the environment.

Keywords: *mining, pollution, particulate matter (PM 2.5 and PM 10), human health, heavy metals*

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PROCESSING OF ZEOLITES FROM INDUSTRIAL WASTE

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Abstract

Zeolites can be processed from solid industrial waste in order to reduce the cost of their processing, but also to use them in the most favorable way for the manufacture of products, even for specific applications. This process reduces, reuses and recycles solid waste, which is economically viable and has environmental benefits. However, it also poses safety risks, as the removal of certain materials creates contaminants.

This article discusses the current state of research on zeolite processing methods and their advantages and disadvantages. The methods mentioned are interpreted using various experiments, highlighting the importance of hydrothermal crystallization as an integral part of many of these methods. In the experiments, attention is paid to the stability and purity of the zeolites obtained, their crystallinity and crystallization time are observed, as well as their degree of adsorption, since one of the most important applications of zeolites is precisely the adsorption of pollutants.

L.V. et al. have used hydrothermal dealumination, acid treatment and silanization to improve the hydrophobicity of NaY molecular sieves. The adsorption of toluene increased from 8 mg/g to 46 mg/g in a humid environment (relative humidity (RH) = 50 %). This brings us to the current applications of zeolites based on solid waste, which include gas purification, wastewater treatment and soil remediation, and explains the mechanisms of action of these zeolites. Li et al. prepared zeolite membranes from silica fume and kaolin, which achieved a cadmium removal efficiency of 99.22%. Ziejewska et al. produced ecological zeolites using coal ash, which showed high adsorption efficiency of methyl blue - it reached 85–97%. A cost analysis was also performed, which showed that zeolites based on solid waste are less expensive compared to commercial zeolites, emphasizing their high application value. To enable the industrial application of these zeolites, a more thorough investigation of hydrophobic and sulfur-resistant zeolites and research into the development of modified zeolites is required. Electrochemical and physico-chemical processes generally require low energy consumption and are environmentally friendly. This paper presents some guidelines for the optimization of solid waste-based zeolite production processes and their industrial application.

Keywords: *solid industrial waste, zeolite processing methods, hydrothermal crystallization, adsorption*

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COMPARISON OF BREAKTHROUGH TIME OF ZEOLITES AND ACS IN A STANDARD GAS MIXTURE OF CO₂, C₂H₄, C₂H₆, CH₄ and CO

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Abstract

• Introduction and objective

Emission from the fossil fuel combustion is one of the most dangerous pollutant causing agent into the atmosphere [1]. It is necessary to develop technologies that will allow us to utilize the fossil fuels while reducing the emissions of greenhouse gases (GHG) [2]. For this reason, several methods of adsorption have been developed over time [3]. In response to this, the properties of some of the adsorbents were examined in this probe.

• Methodology

The adsorption properties of three different adsorbents, two types of zeolites (5A and 13X) and one type of activated carbon spheres (ACS) were tested at room temperature and at an atmospheric pressure. Standard gas mixture used for testing consists of methane (28.40%), ethane (10.24%), ethene (15.35%), carbon monoxide (25.54%) and carbon dioxide (20.47%). Two other standard mixtures were used for calibration of the instrument. Gas Chromatography (GC) technique with Thermal Conductivity Detector (TCD) and Flame Ionization Detector (FID) were employed for measuring concentrations of permanent gases. A standard mixture of gases was passed through each of these adsorbents separately at an interval of 20 s with volumetric flow rate 100 ml/min. The moment when the adsorbent no longer effectively retains the pollutant is defined as breakthrough time.

• Results

Breakthrough times for the components of standard mixture is presented in Table 1.

Table 1. Breakthrough time for the components of standard mixture.

Adsorbent	Breakthrough time, [s]				
	CO ₂	C ₂ H ₄	C ₂ H ₆	CH ₄	CO
5A (zeolite)	40	20	40	20	20
13X (zeolite)	40	40	20	20	20
ACS (activated carbon spheres)	720	1620	1140	420	300

• Conclusion

The breakthrough time with zeolites was shorter as compared to ACS, indicating that the adsorption capacity of zeolites is lower than that of ACS.

Keywords: adsorption, activated carbon, carbon dioxide

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REMOVAL OF COPPER IONS FROM AQUEOUS SOLUTIONS USING GRAPE STALKS AS AN ADSORBENT

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Abstract

Heavy metals such as arsenic, copper, cadmium, lead and mercury are major pollutants of freshwater, especially due to the discharge of industrial wastewater. Due to their toxicity and persistence, they accumulate in aquatic organisms and enter the food chain. One promising method for removing heavy metals is biosorption, along with other techniques such as membrane filtration, ion exchange, and advanced oxidation. Biosorption is a physico-chemical process that involves mechanisms such as ion exchange, surface complexation and precipitation and relies on low-cost biological materials as biosorbents. Various types of biomass, including microorganisms, algae and plant materials, have been extensively investigated for their potential for biosorption of metal ions. In this paper, a kinetic analysis of the biosorption of copper ions on grape stalks is presented. The analysis of the experimental results was carried out using four kinetic models: the pseudo first-order kinetic model, the pseudo second-order kinetic model, the interparticle diffusion kinetic model, and the Elovich kinetic model. The obtained experimental results show that the biosorption of copper ions onto grape stalks follows the pseudo second-order kinetic model, with a correlation coefficient of $R^2=0.985$, suggesting that chemical interactions with surface functional groups determine the rate-limiting step of the process.

Keywords: *Biosorption, grape stalks, copper ions, adsorption kinetics*

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LIFE CYCLE ASSESSMENT ON THE EXAMPLE OF LED DRIVERS AND MODULES

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Abstract

This paper explores the concept of improving service or production processes to minimize their negative environmental impact in the future. It focuses on the Life Cycle Assessment (LCA) methodology, which consists of five key phases:

1. Goal and Scope definition
2. Inventory Analysis
3. Impact Assessment
4. Interpretation
5. Improvement

Each phase is thoroughly explained in the paper, followed by a practical example related to the production of LED drivers and modules. Additionally, the environmental impact of this production process is analyzed, along with proposals for optimizing and making it more sustainable.

Keywords: *Life Cycle Assessment, LED driver, LED module*

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ASSESSMENT OF HEAVY METALS IN CANNED FISH

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Abstract

Canned fish products are an important component of the global diet because they combine high nutritional value, protein quality, and long shelf life with broad market availability. At the same time, these products can represent a significant pathway for human exposure to toxic elements. A large body of evidence from international monitoring programs and academic studies has shown that canned fish frequently contains measurable concentrations of heavy metals such as mercury, cadmium, lead and arsenic. These elements accumulate in marine organisms through natural processes of bioaccumulation and biomagnification, and their levels may be influenced by geographic origin, species, fishing practices, and post-harvest handling. Additional contamination can occur during industrial processing and packaging. Although most reported concentrations comply with national and international safety standards, sporadic exceedances of regulatory limits and significant variability among products highlight the need for continuous, harmonized surveillance.

This paper reviews and synthesizes recent findings on the occurrence, concentration ranges, and sources of heavy metals in canned fish. It discusses current approaches to health risk assessment—including tolerable weekly intake, target hazard quotient, and cumulative exposure evaluation—and compares these data with existing regulatory frameworks. Emphasis is placed on the importance of sustainable fisheries, improved traceability, and strict quality control to protect consumer health. By integrating evidence from multiple regions, the review aims to provide a comprehensive, policy-relevant overview that balances the recognized nutritional benefits of canned fish with the imperative to minimize toxicological risks.

Keywords: *heavy metals, canned fish, bioaccumulation*

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pH AND CONDUCTIVITY CHANGES DURING RINSING AND COPPER ION BIOSORPTION ONTO SUNFLOWER HULLS

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Abstract

Copper (Cu) is a widespread transition metal that occurs naturally in the earth's crust and plays an important biological role. However, its excess - especially in the Cu(II) form - poses a serious environmental and health risk. Cu(II) is highly toxic, non-biodegradable and bioaccumulative. It enters the aquatic environment through both natural processes and human activities such as mining, industrial effluents and agriculture. While various treatment methods such as ion exchange, chemical precipitation, membrane separation and electrochemical processes have been used to remove copper from water, these methods can be costly or complex. Biosorption, an environmentally friendly and cost-effective alternative, utilizes biological materials to efficiently remove heavy metals such as copper and offers advantages such as high removal capacity, operational simplicity and effectiveness over a wide pH range. In this study, the changes in pH and conductivity during sunflower hulls rinsing and Cu²⁺ biosorption were investigated. The data obtained showed that the pH value of the solution increased during the rinsing of the sunflower hulls due to the transfer of H⁺ ions from aqueous phase into the structure of the biosorbent. The conductivity initially increased due to the leaching of alkali and alkaline earth metal ions and then decreased as a result of dilution. During the biosorption of Cu²⁺ ions, the pH of the solution decreased due to the release of H⁺ ions from deprotonated functional groups, which were exchanged with copper ions. Simultaneously, the conductivity increased due to the transfer of alkali and alkaline earth metal ions into the solution, where they were exchanged with copper ions.

Keywords: *biosorption, copper, sunflower hulls, pH, conductivity*

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SUSTAINABLE ELECTROSPINNING OF ZnO NANOFIBERS FROM ZINC GALVANIZING FLUE DUST

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Abstract

This work investigates the valorization of zinc galvanizing flue dust, a hazardous by-product of hot-dip galvanizing, for the production of ceramic ZnO nanofibers. Flue dust, composed of fine particles (<2 µm) and enriched with zinc and chlorides, was analyzed using AAS, XRF, and XRD, which confirmed significant zinc content alongside minor amounts of Fe, Al, Cu, and Pb. Thermodynamic modeling indicated that zinc predominantly exists as ZnCl^+ within the stability region of water up to pH 5 in HCl and 4.3 in H_2SO_4 at 60 °C. To assess its applicability, both synthetic ZnO and real flue dust were subjected to leaching in HCl and H_2SO_4 solutions of varying concentrations. The results demonstrated that 0.5 M solutions of both acids were optimal, yielding zinc-rich leachates suitable for electrospinning. The prepared solutions were combined with PVP, ethanol, citric acid, and acetic acid to form stable spinning solutions. Electrospinning was carried out using a Nanospider™ system, followed by calcination at 550–600 °C to remove organics and obtain ZnO ceramic nanofibers. Morphological analyses confirmed that nanofibers derived from real flue dust closely resembled those from synthetic ZnO, with HCl producing rough, oval fibers and H_2SO_4 generating hollow ribbon-like structures with high surface area. These findings confirm the feasibility of converting zinc flue dust into functional ZnO nanomaterials, offering both environmental and economic benefits.

Keywords: *ceramic nanofibers, ZnO nanofibers, electrospinning, zinc galvanizing flue dust, waste recycling*

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PROCEDURES FOR THE MANAGEMENT OF NON-HAZARDOUS CONSTRUCTION WASTE IN THE TERRITORY OF THE MUNICIPALITIES OF PODGORICA, ZETA AND TUZI

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Abstract

The construction sector significantly contributes to environmental degradation due to the large volumes of waste generated during building, renovation, and demolition activities. Although many materials produced in these processes have high potential for recycling and reuse, sustainable waste management practices are often neglected in practice. This paper analyzes the types of non-hazardous construction waste, the causes of its generation, and the factors influencing the quantity of waste produced. Special emphasis is placed on the situation in Montenegro, focusing on the urban municipalities of Podgorica, Zeta, and Tuzi, where the challenges of inadequate waste treatment are becoming increasingly evident.

In this context, the paper offers concrete proposals for improving the construction waste management system through the application of modern technologies. Additionally, models based on the principles of circular economy and life cycle assessment (LCA) methods are proposed, which could be implemented under local conditions. Through this analysis, key intervention points have been identified, enabling the construction industry to shift from being one of the main polluters to becoming a driver of sustainable development.

Within this work, special emphasis is placed on the identification of the types of construction waste that are most often generated in practice, as well as on the analysis of the causes that lead to its creation. Through a structured analysis, technical, organizational and social factors that influence the amount and type of waste are covered, with the aim of identifying key points in the construction process where intervention can be taken to minimize waste. Special attention is paid to non-hazardous construction waste, because this category offers the greatest potential for optimizing the process of recycling and reuse of materials without endangering health and without the need for complex processing treatments.

Keywords: *non-hazardous construction waste, recycling, waste treatment technologies, circular economy, environment*

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LiFePO₄ BATTERIES: PROPERTIES AND RECYCLING APPROACHES

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Abstract

The rapid growth in demand for lithium-ion batteries (LIBs) has positioned them as the cornerstone of modern energy storage, with lithium iron phosphate (LiFePO₄, LFP) chemistry playing an increasingly important role in electromobility and stationary applications due to its high safety, thermal stability, and long cycle life. Unlike other LIB chemistries containing cobalt or nickel, LFP batteries lack high-value critical metals, making their recycling less economically attractive and raising the need for efficient strategies focused on lithium recovery and FePO₄ regeneration.

This paper aims to characterize the main types of LIBs, with emphasis on LFP chemistry and evaluate current recycling methods, highlighting hydrometallurgical approaches. The methodology involved a review of scientific literature and experimental chemical analysis of black mass obtained after mechanical pretreatment of spent LFP cells. Analytical results showed that iron and lithium are the dominant components, while copper and aluminum are present due to electrode separation, and the residue consists mainly of graphite and phosphates.

Hydrometallurgical recycling using sulfuric acid with hydrogen peroxide as a leaching agent proved to achieve nearly 99% lithium recovery under mild conditions, with FePO₄ suitable for direct relithiation and cathode regeneration. Compared to pyrometallurgy, hydrometallurgy demonstrated higher selectivity, lower energy consumption, and higher-quality recovered products.

In conclusion, efficient LFP recycling is both an environmental necessity and an industrial opportunity. It supports the goals of the EU Battery Regulation and Critical Raw Materials Act, reinforcing the circular economy, reducing raw material dependence, and contributing to climate neutrality and sustainable growth.

Keywords: recycling, Li-ion batteries, LiFePO₄ batteries, hydrometallurgy

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HOW CAN YOU PARTICIPATE IN THE HOUSEHOLD HAZARDOUS WASTE MANAGEMENT IN SERBIA?

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Abstract

Household hazardous waste (HHW) arises from household products that have not been consumed or used in the household, and are potentially harmful to the people who live in a residence, and to their neighbors if they are not disposed of properly [1]. HHW typically contains corrosive, toxic, ignitable, or reactive ingredient, including: batteries, fluo tubes and light bulbs, packaging from household chemicals, paints, thinners, solvents, deodorants, sprays, waste textiles, small electronic (EE) waste (telephones, chargers, small kitchen appliances), large electronic (EE) waste (air conditioners, monitors, televisions), motor and hydraulic oil packaging, batteries, bicycle tires [2]. Some of these waste groups become special waste streams after use [3]. Such waste is difficult and costly for a household to disposed of safely. Households in Serbia are required to dispose of their waste in containers or in other ways provided by the local government unit, and hazardous household waste should be handed over to household waste collection centers or to an authorized legal entity for the collection of hazardous waste. Waste collection center is a place designated by a decision of a municipality, city, or local government unit, to which citizens bring waste and bulky waste, including hazardous household waste [4]. A map with waste collection centers in Serbia can be found on the engaged platform <https://srda.rs/> website. Also, citizens should to take advantage of the opportunity to bring this type of waste from their households to the facilities of Public Utility Company "City cleanliness", Belgrade, in the municipalities where they live.

Keywords: *household hazardous waste, Serbia, waste collection centers*

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RISK ASSESSMENT OF SENIOR LABORATORY TECHNICIAN ACTIVITIES IN THE METALLOGRAPHY AND HEAT TREATMENT LABORATORY WITH RESPECT TO PHYSICAL HAZARDS

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Abstract

This study presents a risk assessment of senior laboratory technician activities in the Metallography and Heat Treatment Laboratory, with a primary emphasis on physical hazards. The assessment encompassed an examination of the relevant legislative and regulatory framework governing occupational safety in Bosnia and Herzegovina, alongside the application of a semi-quantitative risk assessment methodology. Measurements of noise, electromagnetic radiation, illumination, and microclimatic factors were conducted across multiple measuring locations. The findings revealed that the recorded values were generally consistent and remained within the prescribed limits. Beyond physical hazards, potential biological, chemical, ergonomic, and psychosocial risks were also identified, thereby ensuring a comprehensive and multidimensional approach to risk assessment. Based on the outcomes of the assessment, a set of technical, organizational, and educational measures was proposed to mitigate risks to an acceptable level. The results underscore the necessity of continuous risk assessment, as well as the systematic implementation of preventive measures, with the ultimate goal of enhancing occupational safety and health within the laboratory environment.

Keywords *risk assessment, physical hazards, laboratory, occupational safety*

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