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Airborne PM2.5 Particle Removal via Filtration Using Novel Nanofibrous Material with Incorporated Microporous Carbon

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Now, more than ever, air filtration is a key process in pollution prevention and mitigation. Particulate matter 2.5 µm (PM2.5) was found to be a major contributor in polluted air, making their filtration essential in protection of humans from the negative effects of polluted air. Novel polyacrylonitrile (PAN)-based nanofibrous material was developed, alongside a simple method for its production. Electrospun PAN is used in dual purpose, both as a base material of the filter media, and as a starting material for the preparation of the active component of the filtering material - microporous carbon nanofibers (MCNFs). The obtained filters were tested and key features of quality air filters were confirmed – PM2.5 particle removal efficiency was measured and could reach 99% for standard experimental conditions. Furthermore, it was shown that the introduction of the carbon nanofibers enhanced the thermal and mechanical propertied of the filtering material when compared with the base PAN material. With the intention for these materials to be used in industrial air filtering and facemask production for human use, additional testing was conducted, including thermal imaging of a facemask with the inserted PAN/MCNFs filtering media, showing decreased temperature variation of the facial region of the user, which can be correlated to enhanced comfort in wearing such facemask. The wide spectrum of positive properties of the studied material opens several possibilities for this filtering media to potentially be used for industrial and commercial purposes.

Keywords: air filtration, polyacrylonitrile (PAN)-based nanofibrous material, PM 2.5 particle

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Safety and ergonomics aspects in human-robot collaboration

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The Industrial Revolution 4.0 (IR4.0) showed an advanced collaboration between humans and machines in manufacturing enterprises through the implementation of innovative technologies such as collaborative robots (cobots). This groundbreaking interaction leads to positively impact the work environment in manufacturing process. Introduction of robots in the production process has improved the efficiency and productivity of enterprises at one side and at the other side improve safety and ergonomics aspects. Collaborative robotic arms present some inherent safety measures, which allow the prevention dangerous situations and the implementation of safe applications. Nevertheless, this state usually changes as soon as they are integrated into a working environment and equipped with different types of end-effectors.The main focus of this research paper is on the safety and ergonomics aspects in human-robot collaboration. Cobots are deployed alongside operators during the different phases of process. While humans tackle unexpected situations better, aware of a much larger part of the environment than formally declared, and show more dexterity in complex or sensitive tasks, on the other hand, robots exhibit high precision and repeatability, can handle heavy loads and operate without deterioration even in difficult or changing environments. Special attention in this research paper is paid to the systematizing the most significant benefits during human robot-interaction and pointing to challenges during this collaboration.

Keywords: Collaborative robots; Ergonomics; Human-robot collaboration; Industry 4.0; Workplace safety

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The influence of farming system on quality traits and bioactive compound contenton spelt and bread wheat

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Bread wheat is among the 'big three' cereal crops in the world and a staple food for the majority of the human population. Its unique rheological properties and bread making quality are responsible for its global distribution and utilization. It is mostly grown in conventional farming systems where higher yields are achieved with the application ofsynthetic pesticides and fertilizers. However, the growing interest in the production and re-expansion of spelt wheat has recently increased due to its implication in the production of healthy food, mostly originated from organic and low-input farming systems. The aim of this study was to compare the quality traits and bioactive compound content of five bread and five spelt wheat varieties, grown under conventional and organic farming in Hungary and under conventional farming in Serbia, during the three consecutive seasons (2018/2019, 2019/2020 and 2020/2021). Most of the analyzed traits showed significant differences between varieties, species and farming systems. Higher protein and gluten content but lower flour water absorption, dough stability and sedimentation test values were observed in spelt wheat and under conventional farming system. The amount ofarabinoxilanand β glucan content was higher in bread wheat, while the content of alkilresorcinol was higher in spelt wheat. Conventional farming systems in Hungary and in Serbia differ in some traits. The year effect influenced all examined quality and bioactive compounds parameters.

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Keywords: bread wheat, spelt, organic farming, fraits

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In season variability of multispectral and RGB vegetation indices extracted from UAV images collected in diverse soybean germplasm

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The objective of this study was to examine the variability of different multispectral and RGB vegetation indices during the soybean vegetation period using digital images collected with unmanned aerial vehicle (UAV). Vegetation indices as a novel tool can help breeders utilize hidden information to better understand the genetic variability of analyzed genotypes and improve breeding programs. To obtain more precise data about the variability of analyzed vegetation indices, divergent soybean germplasm was used.

The trial was conducted in 2021, on the experimental fields of the Institute of Field and Vegetable Cropsin Rimski Šančevi, Serbia. A total of 117 different soybean genotypes were included in the experiment. Sowing was conducted in April while image acquisition with UAV was done five times during the soybean vegetation period. Time points for image collection were determined by growing degree days (GDDs) calculated after plant emergence. Analyzed genotypes were photographed at 215, 372, 594, 727, and 919 GDDs respectively. All flights were performed around solar noon with cloud clear sky at 60 m altitude using a UAV (DJI P4M) and multispectral camera with five spectral bands (RED, GREEN, BLUE, RED EDGE, and NEAR INFRARED). Individual images were stitched in ortho mosaic which was used for extraction of each channel digital number from the multispectral image. The values of digital numbers were used for the calculation of three multispectral (DVI, GDVI, GARI), and three RGB (VARI, TGI, NGRDI) vegetation indices.

The values of analyzed vegetation indices, both multispectral and RGB changed throughout the growing season. Most indices (except TGI) had lower values at the beginning of the soybean vegetation period and then increased over time. The multispectral indices DVI, GDVI, and GARI reached the highest value at around 594 GDDs, only VARI from RGB indices reached its peak at the same time while TGI and NGRDI were highest at 919 GDDs. All indices have decreased at 727 GDDs in comparison to their values at 594 GDDs which may be related to the potentially unfavorable conditions that soybean plants were exposed to. Vegetation indices could be used to monitor the condition of the crops and better understand the processes that took place during the soybean growing season.

Keywords: soybean, UAV, vegetation indices

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Different approaches to microplastic extraction from soils

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Microplastic particles (MPs) emergence and expansion have occurred rapidly and almost imperceptibly on a worldwide basis. Its presence and persistence in terrestrial environments recently started attracting considerable attention from scientific researchers, policymakers, the media, and the general public. Several methods were developed in order to isolate MPs from complex soil samples. Density separation demonstrated to be the most efficient and cost-effective to date It consists of the following steps: soil sieving, grinding and measuring, MPs extraction using the saturated salt solution of the appropriate density higher than the MPs that need to be isolated, supernatant filtration, and visualization of MPs adhered to filter. Several approaches could be applied to soil MPs separations, considering the utilization of different extracting solutions, working conditions, and phases order, which we investigated herein. As soil samples contained around 5% of organic matter (OM), the first protocol implied organic matter digestion using 30% H2O2 before the extraction, while the second one was performed vice versa. In both protocols, the extraction solvent that was used was saturated NaCl solution, density 1.2 g cm-1. According to the obtained results, and bearing in mind the fact that MPs could be entrapped in soil aggregates, OM digestion before the extraction was considered suitable to continue the investigation. In the following protocol, digestion was conducted at different temperatures and durations of 7 days at 25˚C (room temperature) and 24h at 60˚C, respectively, which enabled more efficient OM removal. The temperature and time of exposure may need additional tuning according to the soil type. While using NaCl solution, only polymers with a density lower than 1.2 g cm-1 could be extracted, so in the next procedure, it was replaced by a saturated solution of ZnCl2, which density could go up to 1.9 g cm-1. Hence, the final protocol based on the previous optimization involved digestion with H2O2 at 60˚C for 24h, followed by covering the dry residue with saturated ZnCl2 solution. The mixture was left overnight for density separation. The upper layer of the solvent where the MPs tend to concentrate was taken by a glass dropper and filtered through a Whatman glass filter (pore size 1.6 µm, diameter 25 mm). Achieved efficiency regarding OM reduction rate and MPs extraction on examined soils was satisfactory for further investigations.

Keywords: microplastic, soils, extraction, organic matter, density**.**

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Synthesis of efficient disinfectants based on ZINC ORTHOTITANATE – ZINC OXIDE composites

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In recent years, the bacterial contamination has become a global problem leading to a constant need for new antibacterial agents, especially inorganic ones. The aim of this work was the synthesis of inorganic antibacterial composites based on environmentally friendly and low-cost TiO2 and ZnO. Starting from Ti(C4H9O)4and Zn(NO3)2, four samples, noted as P-ZnTi-500,P-ZnTi-800, H-ZnTi-500, H-ZnTi-800,were obtained using two methods, precipitation and hydrothermal synthesis, and two calcination temperatures, 500 and 800 °C. The antibacterial activitywas tested towards Gram-negative Escherichia coli and Gram-positive Staphylococcus aureus.

The XRD results showed that the biphasic mixtures of approximately 30 wt.% of Zn2TiO4 and 70 wt.% of ZnOwereobtained after calcination at 500 ˚C while Zn2TiO4 was the major phase in samples calcined at 800˚C beside ZnO, ZnTiO3 and Zn2Ti3O8, amounting 49 and 58 wt.% in H-ZnTi-800 and P-ZnTi-800, respectively.The calculated a-parameters of all obtained cubic Zn2TiO4 were independent of synthesis ranging from 8.45 to 8.47 Å. At 500 ˚Cnanocrystalline Zn2TiO4 were formedwith the crystallite sizes 35 and 17 nm forH-ZnTi-500 and P-ZnTi-500, respectively, and microcrystalline ones at 800 ˚Cwith the crystallites larger than 110 nm. More of softer agglomerates consistingof spherical particles were formed at 500 ˚C compared to 800 ˚C. As a consequence, samples obtained at 500 ˚C showed significantly better antibacterial activity with high reduction in the number of bacteria cells: 81.9 % E. coli and 57.5 % S. aureus for H-ZnTi-500 and 73.9 % E. coli and 52.8 % S. aureus for P-ZnTi-500.

Keywords: zincorthotitanate; hydrothermal synthesis; antibacterial activity; nanomaterials

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Carbon felt-polypyrrole-silver chloride composite as positive materials for rechargeable magnesium batteries

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Over the last decades we are witnesses of astonishing development of different electrode materials for alkali-ion and metal-air batteries, supercapacitors, and supercapattery. Even so, some rather old electrochemical systems have still space for further improvement. Seawater-activated primary battery, as another example of the old systems, discovered in 1878 and developed by Bell Telephone Laboratories in 1945 as the power source for electric torpedoes, are used for a wide range of applications. Among many different cathode materials, silver chloride (AgCl) and lead chloride (PbCl2) are most widely applied. An improvement of AgCl synthesis is reported in our previous work in which the fast and low-cost modified process of successive ion layer adsorption and reaction (SILAR) is effectively applied to form carbon felt-silver chloride cathode materials for primary cell.

In this work we investigated electrochemical synthesis of polypyrrole on a carbon felt (CF/PPy) electrode. Further, the CF/PPy electrode is modified by AgCl by applying modified SILAR method. Using the cyclic voltammetry and charge-discharge techniques, it is shown superior behavior of composite CF/PPy-AgCl electrode. For the possible rechargeable aqueous based magnesium alloy AZ63 |3.5% NaCl | CF/PPy-AgCl cell in the current range of 135 to 1350 A g-1 the specific capacity in the range of 35-25 Ah kg-1, energy of 45-25 Wh kg-1 and power of 100 to 1600 W kg-1 are obtained. Also the cyclic stability is determined, and concluded that such a simple cell using small photovoltaic cell could be charged at least 100 times, depending of Mg-alloy mass. The possibilities of further improvement of the system is considered.

Keywords: elevrvode materiams, polypyrrole, carbon felt (CF/PPy) electrode

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X-Ray analysis by Williamson-Hall and stereological analysis of mechanically alloyed Cu-Zr-B alloys

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Ternary Cu-2.71Zr-2.27B (wt.%) alloys were fabricated using powder metallurgy, i.e., mechanical alloying followed by cold pressing and sintering. Influence of the mechanical alloying parameters on microstructural and morphological changes of Cu-Zr-B powder mixture was investigated using scanning electron microscopy and X-ray diffraction. Stereological analysis was employed to determine changes in size and shape of copper particles during 40 hours of mechanical alloying. It was shown that with an increase in mechanical alloying time, the size of copper powder decreases. Williamson-Hall analysis was used to calculate crystallite sizes (D, nm), lattice parameter (nm), lattice strain (ε, %), and dislocation density (ρ, m-2). It was shown that with increasing mechanical alloying time, lattice parameter as well as lattice strain both increases. Particles undergo high forces through ball-particle-ball and wall-particle-ball collisions during mechanical alloying. These collisions induce accumulation of dislocations in copper matrix and a decreasing in its crystallite size due to dominant plastic deformation mechanisms. Dislocation densities reach its maximum value at around 30 hours of mechanical alloying, after which they decrease owing to the recrystallization of copper matrix.

Keywords: mechanical alloying, Cu-Zr-B, X-ray

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Antibacterial activity of amine-functionalized silver-enriched beta zeolite

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Zeolites are inorganic, crystalline aluminosilicates that nowadays has been used as adsorbents, catalysts and carriers of catalytically activated substances, due to the small size of their pores, large internal surface, and well-defined chemical composition. In this paper, the modification of beta zeolite using (3-aminopropyl)-triethoxysilane (APTES) was investigated. The results of the Fourier transform infrared spectroscopy and thermogravimetric analysis confirmed the presence of amino groups derived from APTES onto the modified zeolite surface. APTES-enriched zeolite was further used as an adsorbent of silver ions from aqueous solutions. The obtained results reveal that a zeolite after modification exhibited significantly better adsorption efficiency (97%) in comparison to the unmodified (37%). The kinetic data follows the pseudo-second-order model which indicates a chemical interaction between silver ions and functional amino groups on the surface of the silanizedbeta zeolite. Ag-APTES enriched beta zeolite also was studied as anantibacterial agent toward the pathogenic bacteria Gram-negative Escherichia coliDSM 498 and Gram-positive Staphylococcus aureus ATCC 25923.

Keywords: betazeolite, aminosilane, modification, silver ions, antibacterial activity

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Geological implications of central banat gravity survey after incorporation of modern corrections

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Gravity anomalies are the scope of interest when doing gravity surveys. They are used for determining the subsurface density distribution. The values of the anomalies are relatively low in comparison to the absolute gravitational acceleration values. These anomalies are calculated as the difference in measured and normal values. Applying various corrections is necessary during the calculation, because this process will remove the noise in the signal. Classical corrections, used for decades, are: Fay correction (for height), Bouguer correction (for the layer density) and topographic correction. Recently, correction for the atmosphere has also been developed.

The data quality required nowadays implies the use of modern corrections. Modern corrections include the updated Fay correction, Boulard B correction, as well as the atmosphere correction. In the tested Central Banat area, which belongs to the Pannonian Basin System, the atmosphere correction is the dominant one. It is calculated by using the following formula: 〖Δg〗_atm=0.874-9.9·10^(-5) h+3.56·10^(-9) h^2. Boulard B correction is visible in the areas with higher latitudes, although the studied area is relatively flat. Fay correction has little effect. It can be concluded that a series of anomaly high and low areas exists in the NW part of the map and can point to the existence of areas of uplifted basement and sedimentary depressions. The reduced-error interpretation is dependent on the use of modern corrections.

Keywords: gravimetry, subsurface exploration, Banat, modern corrections

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