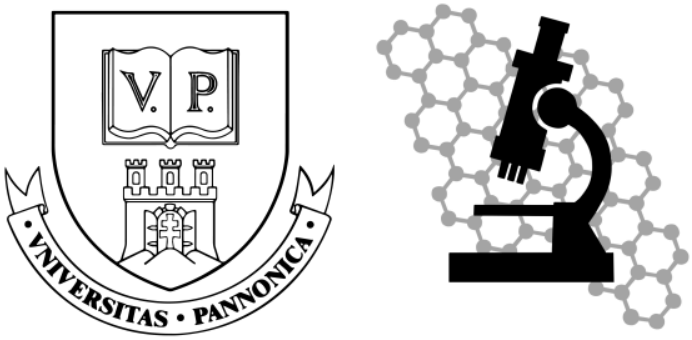
PhD hallgatók anyagtudományi napja XXIII

Materials science day XXIII of PhD students



Absztraktkötet

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Veszprém, Pannon Egyetem

Veszprém, University of Pannonia

PhD hallgatók anyagtudományi napja XXIII

Materials Science Day XXIII of PhD Students

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Az összefoglalók sorrendje az előadások időrendjét követi. / The order of the summaries follows the chronological order of the presentations.

A hallgatók által beküldött összefoglalókat a szervezők minden további korrektúra nélkül teszik közzé. / The organisers published the abstracts submitted by students without any further proofreading.

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Tartalomjegyzék

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Diatomaföld és trassz adagolásának hatása a kaolinit mechanokémiai aktiválására és puccolános reaktivitására

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Ebben a kutatásban a kaolin mechanokémiai aktiválását két különböző puccolános anyag (trassz vagy diatomaföld) adagolása mellett végeztük el, hogy a kaolinit szerkezetét és puccolános aktivitását módosítsuk. A mechanokémiai aktiválást nagy energiájú száraz őrléssel hajtottuk végre a kaolinit fázis teljes (100%-os) és részleges (~90%) amorfizálásáig, amelyet röntgendiffrakcióval, Fourier-transzformációs infravörös spektroszkópiával, termikus analízissel, pásztázó elektronmikroszkóppal, valamint fajlagos felület meghatározásával jellemeztünk. A puccolános reakcióképesség jellemzésére olyan habarcs próbatestek nyomószilárdságát vizsgáltuk, amelyekben a portlandcement 10%-át mechanokémiailag aktivált mintákkal helyettesítettük. A trassz vagy diatomaföld hozzáadása jelentősen csökkentette a kaolinit teljes és részleges amorfizálásához szükséges őrlési időt és energiát. A portlandcement mechanokémiailag aktivált anyagokkal történő részleges helyettesítése növelte a habarcs próbatestek nyomószilárdságát a megnövekedett reaktív szilícium-dioxid és alumínium-oxid tartalom okozta nagyobb puccolános reaktivitás miatt.

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Stroncium meghatározása biológiai mintákban ICP-AES spektrometriával

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Az előadásunkban egy olyan, alacsony stroncium tartalom kimutatására és mérésére alkalmas ICP-AES módszert mutatunk be, amely kis mennyiségű mintát igényel. A vizsgálandó mintákat egy $SrCl_2$-os állatkísérletet folytató partner biztosította számunkra, és ezek egerekből vett vér,- combcsont,- csontvelő,- izomszövet,- vizelet,- és székletminták voltak. A minták előkészítésére - a székletminta kivételével - nem kellett további műveletet és időt fordítani, mivel tömény savban oldott formában érkeztek, így csak az esetleges hígítás maradt hátra. A széklet mintákat mikrohullámú feltáró berendezéssel vittük oldatba. A módszerhez szükséges stroncium vonalakat a szakirodalmi adatok és az általunk használt ICP-AES spektrométer vezérlő szoftverébe beépített színképvonal könyvtár javaslata alapján választottuk. 4 ionvonal, - Sr 216,596 nm, Sr 338,071 nm, Sr 407,771 nm, Sr 421,552 nm, és 1 atomvonal, - Sr 460,733, - teljesítményjellemzőit vizsgáltuk. Az ehhez szükséges oldatok 0,3 µg/l, 0,7 µg/l, 2,75 µg/l, 10 µg/l, 25 µg/l és 125 µg/l koncentrációban tartalmaztak stronciumot.. A mérések során az 5 stroncium vonalra kapott eredményeket vizsgáltuk és meghatároztuk a háttér-ekvivalens koncentrációt. Továbbá a vakoldat adatait felhasználva megadtuk a vonalakra jellemző kimutatási határt és a legkisebb meghatározható mennyiséget. A minták mérésére a Sr 407,771 nm és a Sr 421,552 nm vonalakat választottuk, mivel ez a két vonal bizonyult a legérzékenyebbnek. A módszer ellenőrzéséhez spikeolt mintákat is alkalmaztunk, melyeknek visszanyerési értékei a 95 - 102 %-os tartományba estek. A kapott eredmények a visszanyerési értékekre vonatkozó elfogadási határértékek között vannak, így a módszer használhatóságát igazolják.

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A geológiai eredetű radonkockázat felmérése a Dunántúlon

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A radon felelős a természetes eredetű sugárterhelés 50-60 százalékáért, és a dohányzás után a tüdőrákos megbetegedések kialakulásában a második vezető tényező. A beltéri radonkoncentrációt alapvetően két fő paraméter befolyásolja: az adott terület geológiai adottságai és a felhasznált építőanyagok minősége.

Magyarországon jelenleg nem áll rendelkezésre egy átfogó geológiai eredetű radon kockázati térkép, ami megmutatná, hogy mely területek igényelnek fokozott figyelmet a radon szempontjából. A térkép elkészítéséhez a talajgáz radonkoncentráció és a talajpermeabilitás alapján számított geogén radonpotenciál értékek meghatározása szükséges.

A geogén radonpotenciál felméréshez az Európai Uniós szabályozással összhangban 10x10 km-es területi felosztás mellett minden cellában 3-5 mérési pontot jelöltünk ki a Dunántúlon. A mérési pontokon meghatároztuk a talajgáz radon aktivitáskoncetrációját, a permeabilitást, valamint a környezeti dózisteljesítményt. A terepi mérések mellett talajmintákat is gyűjtöttünk laboratóriumi elemzésekhez, mely során meghatároztuk a természetes gamma-sugárzó izotópok (Ra-226, Th-232, K-40) aktivitáskoncentrációját, összes béta-aktivitást, valamint a radon exhaláció mértékét. Vizsgáltuk, hogy az egyes radiológiai paraméterek mennyiben függenek össze a geogén radonpotenciállal.

Az 1263 mérési pontból 814 esetben alacsony, 424 esetben közepes és 25 esetben magas geogén radonpotenciál értéket határoztunk meg. A talajminták laboratóriumi vizsgálatai még folyamatban vannak, azonban a meglévő részeredmények alapján elmondható, hogy úgy tűnik, a gamma dózisteljesítmény vagy a rádium izotóp aktivitáskoncentrációja nem alkalmas a geogén radonpotenciál megbízható becslésére.

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CVD receptúrák és a bevonatolási környezet vizsgálata a bevonatolási hatékonyságot előre becslő rendszer kifejlesztése céljából

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A forgácsoló eszközök, valamint a képlékeny alakítástechnikában használt szerszámok esetén mechanikai tulajdonságnövelés céljából különböző bevonatokat alkalmaznak. Ezen tulajdonságnövelési lehetőségek mellett az utóbbi időben egyre jelentősebb célként fogalmazódik meg az eszközök élettartamának növelése is. Manapság az egyik leggyakrabban alkalmazott bevonatolási technológia a CVD eljárás. A kémiai gőzfázisú leválasztáson alapuló eljárás segítségével néhány század milliméter vastagságú bevonatok segítségével hatékonyan lehet növelni a különböző mechanikai tulajdonságokat. A CVD eljárással készített bevonatok hatékonysága megkérdőjelezhetetlen, azonban számos területen szükséges a további fejlesztés, az új bevonati receptúrák kidolgozása, illetve a már meglévő összetételek alkalmazási tartományainak kiterjesztése területén.

A kutatás fő célja a különböző alakadó és forgácsoló szerszámok mechanikai tulajdonságainak javítása érdekében készülő új CVD bevonati receptúrák megmunkálási környezettel összefüggő vizsgálatainak megvalósítása, melynek eredményeként olyan előre becslő modellt lehet felállítani, amely modell hatékonyan képes előre meghatározni a receptúra valamely összetevőjének mennyiségi változásából következő mechanikai tulajdonság módosulást. A kutatás másik fő célja megvizsgálni, hogy miként hatnak a kialakuló mechanikai tulajdonságokra a bevonatoló berendezés reaktorán belüli felvett alkatrész pozíciók. Előzetes vizsgálatok szerint relevánsan befolyásolja mechanikai tulajdonságot az alkatrészek reaktoron belüli elhelyezkedése. A kutatási feladat során a bevonatolási vizsgálatok során szerzett tapasztalatok alapján olyan modell felállítására van lehetőség, amely modell alapján szintén egy előre becslő mechanizmus képes dolgozni, mely rendszer virtuális környezetben lesz képes meghatározni a kívánt mechanikai tulajdonságok eléréséhez az alkatrész reaktoron belüli pozícionálási igényét.

Development and comparison of machine learning models to analyse the synthesis of methylenedianiline

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The most important intermediate of methylene diphenyl diisocyanate (MDI), the most widely and quantitatively produced isocyanate in the world, is methylenedianiline (MDA). MDA is produced from the reaction of aniline and formaldehyde catalysed by inorganic acids, most commonly HCl. The reaction parameters used during the synthesis of MDA have a fundamental impact on the quality parameters of the resulting MDA product mixture, and thus on the properties of the final MDI product mixture as well. Although an industrially important intermediate, there is currently very limited information in the literature about the synthesis of MDA molecules and about the effect of the synthesis parameters on the quality. In this work, the correlations between the independent reaction parameters and dependent quality parameters characterizing the MDA mixture were explored by developing different regression models with the use of experimental laboratory synthesis data. After eliminating measurements considered to be outliers, it was found that almost all of the independent parameters can be described with satisfactory accuracy using only a few dependent parameters, therefore it is possible to develop a model which can be used to optimise product quality according to market needs or to different objective functions by adjusting production parameters. By expanding the available data set with the addition of industrial operational data or additional laboratory data, or by extending the measured independent parameter set, the accuracy of the regression models can be further improved.

Keywords: MDA, methylene-dianiline, data analysis, neural network, linear regression, LASSO – method

Logistics resources reallocation for process optimization based on the DBSCAN algorithm

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Industry 4.0, signifies the extensive application of digitization, automation, and intelligent technologies in industrial processes. Sensors play a prominent role in this context, as they perceive physical environmental changes and transmit data to digital systems. An example of such a sensor could be an Indoor Positioning System (IPS), which enables the tracking of devices (such as forklifts) involved in logistics processes.

By knowing the positions of the resources we can assess their activities as value-added (e.g., the forklift carries raw materials) or non-value-added (e.g., forklift idling). Consequently, at any given moment, we can identify where available resources are located and where tasks need to be performed. Subsequently, there is a need for resource allocation in a way that minimizes the costs of aggregated idle times (which can be distance or time).

The presentation introduces a DBSCAN-based algorithm that helps qualify our processes and a transportation problem-based algorithm for resource reallocation as well. The proposed methodology was inspired by addressing a logistics problem, which will be showcased in a demonstrative manner as a case study.

THE DIFFERENCES IN OIL (PETROLEUM AND HYDRAULIC) WETTABILITY BEHAIVOR ON MATERIALS SURFACES

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A vital component of many businesses is the movement of liquids, such crude oil, through metal conduits, like steel pipes. But these liquids encounter frictional forces as they go through the metal bodies, slowing down the flow rate. This frictional process frequently causes the erosion of metal layers, which in turn causes corrosion and even the equipment to collapse. Due to the water content and intrinsic contaminants in crude oil, which worsen the interaction with the metal surface, this problem is more noticeable. Therefore, it is critical to comprehend and manage this issue if one hopes to maintain equipment, save maintenance costs, guarantee operational effectiveness, and increase the infrastructure's useful life across all industries. This review's primary goal is to examine earlier studies that investigated ways to improve liquid wettability—particularly for oil—on metal surfaces. Additionally, to determine whether it is feasible to increase corrosion resistance by precisely regulating the wettability of lubricants and by improving the metals' surface qualities while taking different operating situations into account. Furthermore, a variety of doable suggestions and recommendations for future planning can be quite helpful in reducing the detrimental impacts of corrosion on infrastructure and equipment. Additionally, it encourages sustainability, lowers maintenance expenses, and guarantees the dependability of machining systems that are essential to many sectors.

Hydraulic oil (Hydro HME10) and petroleum were the two types of oil types used in the experiment, and they were duplicated on ceramic surfaces (TiC and WC) and metal surfaces (Ni, Ag, Al, Cu, and Sn). According to the MARSURF M 400 Surface Roughness Measuring Instrument, the substrates' average surface roughness (Ra) was 0.02± 0.0002 µm. For every sample, a (KSV) software is used to measure and record the change in oil droplet contact angles during a 5-minute period. The findings are then analysed. The following were the primary findings. Petroleum exhibited superior wettability compared to other oils we tested on a variety of substrates (on a WC surface, for instance, $\Theta_{petroleum}$= 10° , but $\Theta_{Hydraulic}$ = 14°). Throughout the testing period, it was continuously maintained at lower contact angles on the TiC surface, indicating improvement. Additionally, we noticed that as the atomic radius of the pure metal substrate increases, the contact angle of oils also increases.

Keywords: Wettability, Anti-Corrosion, Metals, Ceramics, Surface tension

The Challenges of Producing Ceramic Foam Glass Made from Incinerator Slag, Waste Glass and Red Mud

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This work tends to produce ceramic foam glass (CFG) from the sintering of the mixture of slags from municipal solid waste (MSW) incinerators, waste glasses, and red mud as the foaming agent. These investigations shall be made on the pore structure, leaching, physical and mechanical properties like compression, and thermal stability of the sintered foams subjected to different sintering temperature schedules. These characterizations will assist in defining the suitability of the CFG in building and construction work. The result is expected to show that the preparation of foams utilizing high content of MSW slag can eliminate the problem of its disposal and displays huge commercial possibilities of CFG, ensuring an effective low-cost, green, and efficient construction industry while maintaining a circular environment.

Modification of glassy carbon nanoparticles using Titanium Nanoparticles as a platform for determining diclofenac Sodium

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This article presents an investigation on the behavior of a chemically modified glassy carbon electrode as a sensing platform for the detection of Diclofenac Sodium. The study also explores the potential application of this electrode in analyzing real samples, including blood, urine, and wastewater. In addition, the synthesis of Titanium Nanoparticles and filaments used in the electrode modification was carried out using a novel method developed by our research group. This unique combination of materials has significantly enhanced the novelty of the technology, as no previous studies have reported such a combination. The GC electrodes were modified using the drop-casting method. Initially, two solutions were prepared. In the initial experiment, a solution was prepared by combining chitosan (1 mg) with 5 mL of Acetic Acid (1%) and TiO_2 nanoparticles. In the second experiment, chitosan (1 mg) was utilized in a 5 mL solution of Acetic Acid (1%), along with TiO_2 nanoparticles and nanotubes of filaments. These components were prepared for the purpose of detecting diclofenac sodium (DS). Next, a volume of 3 µM of each solution was applied onto the GC electrode and subsequently dried to facilitate solvent evaporation at ambient temperature. The procedure was replicated on three separate occasions. Furthermore, the determination of the DS was conducted through the utilization of cyclovoltammetry (CV) technique, employing a computer-controlled AutoLab potentiostat (PGSTAT302N, and PGSTAT 12, EcoChemie, Utrecht, Netherlands) operated by GPES 4.7 software. The cyclovoltagrams show the behavior of the prepared modified sensors in the presence of DS. It can be observed at -0.6 V an oxidation peak appears because of the oxidation of the diclofenac. Also, there is no reverse peak appearing, which shows the irresistibility of the process in which the DS is oxidized, and the reduction reaction does not occur. Furthermore, the anodic intensity peak was greatest when the TiO_2-4HIS-Chit/GCE was evaluated. The I_p was equal to 9.14µA which was 10 times greater than the peak reported by the TiO_2-Chit/GC electrode. Which probes the efficiency of the prepared filaments in the recognition of the DS. The findings presented in this study demonstrate the efficacy of filament sensing and the enhancement of electrical properties in TiO_2 nanoparticles. In conclusion, it can be stated that the sensors developed in this study have demonstrated efficacy in detecting DS in wastewater samples. Furthermore, the robustness of this technology suggests its potential for application in online monitoring systems

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Investigating the Compatibility of PVC Based Ternary Blends

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Polymer blending is a technique used to create and develop new materials with a diverse range of properties surpassing those shown by individual components, using pre-existing polymers. The characteristics of these polymer blends depend on various factors, especially the composition of the blends. This study aims to investigate the compatibility and some mechanical properties of PVC/TPU/Plasticizer systems produced through a roll milling process at various mixing ratios. Thermally stimulated discharge (TSD) was used to assess the compatibility of the blends. The TSD current curves obtained from the TSD test showed the molecular-level compatibility of PVC/TPU/Plasticizer, PVC/TPU, PVC/Plasticizer, and TPU/Plasticizer blends. Hardness measurements and tensile tests were conducted to assess mechanical properties. The hardness showed a decrease with an increasing plasticizer content in the PVC/plasticizer and TPU/plasticizer blends. Similarly, the hardness of PVC/TPU blends decreased with an increased TPU content. The tensile strength of PVC/Plasticizer, PVC/TPU and TPU/Plasticizer blends decreased with the second component content. Notably, the reduction in tensile strength of PVC/plasticizer, attributed to the presence of plasticizer, was more pronounced than the decrease observed in PVC/TPU due to the inclusion of TPU. The blend composition also influenced Young's modulus and elongation at the break, with elongation at the break increasing alongside an increased plasticizer content. As anticipated, Young's modulus of PVC/TPU decreased with a higher TPU content, owing to TPU's elastomeric properties. Remarkably, the incorporation of 20 phr of TPU into the PVC/plasticizer 100/50 blend was observed to enhance elasticity and elongation at the break without significantly compromising tensile strength. Consequently, it was concluded that minor adjustments in the TPU composition can effectively enhance the required properties for specific applications. These polymer blends exhibit miscibility and technological compatibility, rendering them suitable for industrial applications.

Investigation of Enzymatic Degradation of Plastics

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Some adverse effects will emerge to the ecosystem; especially those sources which are affiliated with organic pollutants, including plastics or heavy metals to water bodies. This condition happens because they are environmentally persistent and have mutagenic, teratogenic, and carcinogenic effects on living organisms. Many technologies have been invented that are affordable to release water from contamination. Yet, they are still difficult to be applied on a larger scale due to high costs and side effects. Microplastics, which are defined as plastic particles less than 5 mm in size, are considered as a potential environmental pollutant and attract attention due to their adverse effects on cells. To create a microplastic-free environment, one must build more effective microplastic degradation technologies and plastic recycling systems. On the other hand, microalgae such as Chlorella vulgaris represent one of the most efficient converters of solar energy into chemical energy in the form of biomass. They could bond polymer and heavy metals surfaces such as exopolysaccharides and the competency to generate depolymerizing enzymes such as ligninolytic enzyme make them potential candidate to be excellent biodegradation agent. Unfortunately, only a few study concerns microalgae compared with bacteria and fungi.

Keywords: ecosystem, plastics, heavy metals, Chlorella vulgaris, growth curve pattern

Atomic Layer Deposition of Inverse Opals for Photocatalytic Degradation of Methylene Blue under Visible Light Illumination

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Recent advancements in photocatalysis have highlighted the promise of TiO_2 and ZnO inverse opal (IO) structures for efficient degradation of organic pollutants (eg. Methylene blue) under visible light irradiation. However, the photocatalytic activity of Al_2O_3 IOs remains limited due to their inherent chemical stability. To overcome this limitation, researchers have explored the fabrication of composite IO photonic crystals by integrating TiO_2 or ZnO with amorphous Al_2O_3. In this study, pristine IO structures of TiO_2 and ZnO, as well as their corresponding composites TiO_2/Al_2O_3 and ZnO/Al_2O_3, were successfully synthesized using thermal and plasma-assisted atomic layer deposition (ALD) techniques in the presence of polystyrene (PS) opal templates. The fabricated IO structures were characterized using a suite of analytical techniques, including thermogravimetric analysis (TG/DTG/DTA-MS), scanning electron microscopy (SEM), X-ray diffraction (XRD), photoluminescence (PL) spectroscopy, ellipsometry, Raman spectroscopy, and UV-visible spectroscopy. The characterization results confirmed the formation of monodispersed, microporous, and well-ordered nanostructures for all IO samples. The crystalline arrangement of TiO_2 IO and ZnO IO was determined to be tetragonal anatase and hexagonal wurtzite, respectively. Pure TiO_2 and ZnO IOs exhibited optical characterization with two distinct absorption edges around 400 nm. These absorption edges correspond to "slow" photon absorption enhancements and are located at 540 nm and 590 nm for TiO_2 IO and at 560 nm for ZnO IOs, which is known as their photonic band gap. The observed absorption peak structure arises from the interaction of light with the periodic structure of the IO material, causing the light waves to slow down. The photocatalytic activity of the synthesized IO structures was evaluated by monitoring the degradation of methylene blue under visible light illumination. The results demonstrated that the thermal ALD-prepared TiO_2/Al_2O_3 and ZnO/Al_2O_3 samples exhibited higher photocatalytic activity compared to their plasma-assisted ALD counterparts. This enhanced photocatalytic activity was attributed to the more ordered IO structure achieved with thermal ALD, as confirmed by the characterization results.

Keywords: Atomic layer deposition, Inverse opal, composites, TiO_2 IO, ZnO IO, photocatalysis

Green and sustainable organic pollutant degradation by the synthesis and use of a g-C_3N_4/Ag nanocomposite driven by visible light.

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Industrial water contamination has increased in recent decades. Environmentally friendly and sustainable methods to reduce industrial pollution emission from firms are crucial. The cost-effective semiconductor-based photocatalysis method has great potential. Traditional semiconductor like TiO_2 absorb just 4% of solar light's ultraviolet (UV) energy. Narrow-band-gap semiconductors with strong visible light absorption are being developed to harness green and infinite visible light. Polymeric graphitic carbon nitride (g-C_3N_4), a visible light-activated photocatalyst, is popular owing to its durability and chemical stability. Due to its small bandgap energy and chemical stability, g-C_3N_4 offers great promise for visible-light photocatalysis. Graphitic carbon nitride's photocatalytic breakdown of organic contaminants may be improved in many ways, notwithstanding previous efforts.

The g-C_3N_4 photocatalyst was synthesized using melamine as the precursor. The synthesis process included heating the melamine in a covered ceramic pot at a rate of 10 °C per minute, reaching a temperature of 550 °C, and maintaining this temperature for a duration of 4 hours. The modification was carried out using silver (Ag) in bioinspired methodologies. The methodologies used in this study included the utilization of plant extracts as electron donors for the reduction of silver(I) ions, with the experimental circumstances being subject to variation. During these reactions, the reduction of Ag(I) ions in situ or the immobilization of reduced colloidal Ag occurred on the surface of the catalyst. The model compounds used in the UV-Vis photocatalytic activity investigations were para-nitrophenol and coumarin. Coumarin is often used as a hydroxyl radical scavenger.

Spectrofluorometry measured the concentration of produced 7-hydroxycoumarin, whereas photometry measured para-nitrophenol and coumarin. Quantifying 7-OH coumarin synthesis can estimate hydroxyl radical formation. Total organic carbon (TOC) and high-performance liquid chromatography (HPLC) tests assessed mineralization and intermediate generation during photocatalysis.

Our experiments reveal that bioinspired catalysts are photocatalytic activity in UV and visible wavelengths.

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Utilizing Nanoparticle Technologies to Improve Wastewater Reclamation in Water-Scarce Regions of Iraq

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The increasing frequency and severity of drought events in Iraq, namely in the Tigris-Euphrates River Basin, highlight the urgent need for alternate water sources in response to growing agricultural, industrial, and household water needs. The climatic challenges, characterized by an increase in temperatures and a decrease in precipitation, worsen the existing semi-arid and arid conditions, hence intensifying the battle for water resources. This research paper explores the potential of nanoparticle technologies as a feasible approach to enhance wastewater treatment procedures, therefore making a valuable contribution to water reclamation efforts and mitigating the pressure on existing water resources. The study conducted a comprehensive literature review to assess the effectiveness of various nanoparticles in wastewater treatment processes. This review included an analysis of nanoparticles application such as ZnO, Ag, CNTs, magnetic nanoparticles, nanosilica, and metal oxide nanoparticles. The focus was on their roles in different stages of wastewater treatment, including sedimentation, filtration, aeration, coagulation and flocculation, adsorption, and advanced oxidation. The lierature review indicates that the use of nanotechnologies has a substantial impact on improving the effectiveness of pollutant removal, reducing the time required for treatment, and mitigating the occurrence of biofouling. Consequently, this advancement positions treated wastewater as a viable and promising alternative water source. The incorporation of nanoparticle technology is a significant opportunity to address the increasing water needs and promote sustainable water management practices in Iraq, given the complex climatic and environmental conditions.

Keywords: Nanoparticle Technologies, Wastewater Treatment, Water Reclamation, Sustainable Water Management, Climate Adversities

Polonium-210 activity concentrations in different brands of cigarettes smoked in Ghana and evaluation of the induced radiation dose

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Keywords: ^{210}Po, smoking, radiation, lung cancer

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Cigarette smoking has increased in recent years, predominantly among the young population in low-income African countries. As a result, smoking-related lung cancer diagnoses and deaths are on the rise. In this study, the Alpha spectrometry was used to measure the activity content of ^{210}Po in local and foreign cigarette brands smoked in Ghana. The concentrations of ^{210}Po activity in cigarettes ranged from 16.3 ± 2.6 mBq cig^{-1} to 32.4 ± 5.1 mBq cig^{-1}. The average activity measured in all cigarette samples was 26.3 ± 4.1 mBq cig^{-1}. The average annual effective dose of ^{210}Po radiation caused by smoking was determined to be 0.067 mSvy^{-1}. It was realized the radiation dose in cigarette is responsible for 0.234% of lung cancer cases. According to the excess lifetime cancer risk (ELCR) determined in this study, smoking causes between 14 and 29 deaths per 100,000 people. The study's findings suggest that ELCR, which is caused by radioactive chemicals found in cigarettes, accounts for 1.67% of all cancer cases. As a result, it is clear that there is a lack of public knowledge and that a better understanding of the function of radioactive chemicals in cigarettes in Ghana's overall public health picture is required.

Environmental Impact of Naturally Occurring Radionuclides in Ghana's Mining Areas

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Natural radioactivity sources are the main source of public exposure to ionising radiation. The existence and possible elevation of naturally occurring radionuclides concentration in soils and water presents an increasing potential health risk to the general public especially if the concentration elevation is assisted by processes mining and mineral processing activities. Mining, oil and gas extraction, and mineral processing can lead to elevated concentrations of these radionuclides. The distribution of these radionuclides is highly dependent on geological conditions and the type of rock present in the soil, resulting in varying concentrations across different locations. The public is exposed externally by gamma-ray exposure from natural radioactivity concentrations in soil and internally from the ingestion of drinking water containing natural radioactivity primarily due to ^{238}U, ^{232}Th, and ^{40}K and their daughters and subsequent decay products. This study assesses the activity concentration and the radiological impact of naturally occurring ^{238}U, ^{232}Th, and ^{40}K in soil and water in some mining areas in Ghana in order to establish regional and national data on Naturally Occurring Radioactive Materials (NORMs) in Ghana.

Five soil samples were collected for each study area. Each soil sample underwent initial air-drying at room temperature followed by controlled oven drying for 12 hours, at a constant temperature of 105°C, until attaining a stable weight. The samples were then grinded and sieved through a 2 mm pore-size mesh for uniformity. For the water samples, 1.5 liters of the water samples were collected into plastic containers with two drops of hydrochloric acid to mitigate the potential adhesion of radionuclides to the container walls and ensure that the radionuclide content remains in the water matrix. Following these preparatory steps, and prior to measurement via gamma-ray spectrometry analysis with a high-purity Germanium detector (HPGe), homogenised samples were sealed within Marinelli beakers for a duration of 28 days to allow equilibrium conditions to be established between parent and daughter radionuclides.

The average activity concentrations of ^{238}U, ^{232}Th, and ^{40}K in the soil samples were determined to be 58.9±15.6 Bqkg^{-1}, 47.8±14.5 Bqkg^{-1}, and 286.1±56.9 Bqkg^{-1} respectively. The average activity concentrations for the water samples were determined as 1.62±0.33 Bql^{-1}, 2.08±0.53 Bql^{-1}, and 22.36±3.44 Bql^{-1} respectively. Furthermore, the soil samples were radiologically suitable to be used as a building material as their respective radiological hazard indices were below the limits. The estimated average annual effective doses from external and internal exposure pathways in soil and water samples were 0.09 mSvy^{-1} and 0.50 mSvy^{-1}, respectively. Although the total annual effective dose due to both the external gamma dose rate from soil and ingestion of drinking water was determined to be 0.59 mSv which is below the 1 mSvy^{-1} dose limit recommended by the International Commission of Radiation Protection (ICRP) for Public Radiation Exposure Control, the level of risk or possible radiological hazard to members of the public is significant and should not be ignored considering the increasing activities of mining in these communities.

Experience of the radiological survey of Hungarian buildings

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Introduction: The radioactivity is a natural characteristic of our environment. Everything is radioactive at a certain level, like as our body. But some materials are more radioactive than others. Normally, people spend the largest fraction of their time within buildings. Therefore it has significance that the indoor radiation levels are typically higher comparing to the outdoor level. The indoor gamma radiation originates only from the building materials, but the radon ingress into the house through many pathways.

Objective: Reference level exists only for the radioactivity of building materials and average annual indoor radon concentration. Hence it was needed to derive a reference level for indoor gamma radiation and to describe an assessment method. There is no accepted guidance on short term radon measurement but the interest grows rapidly on it among the general public, therefore it is needed to develop an assessment method.

Method: We have data regarding the indoor gamma radiation level of 875 buildings. Detailed gamma radiation survey was done in 505 buildings among them. The total number of recorded gamma dose rate values is a little bit more than 16,200. The measurements were done mainly by active dose rate meters and in some cases by passive TL detectors. We also made a survey for outdoor gamma radiation on national scale. Short term radon measurements were also made using active instruments in 290 buildings, which results were compared to 2.678 long term radon measurements data. Detailed statistical analysis was made from our results.

Results: We obtained that the indoor gamma radiation level is about 1.5 times higher comparing to the outdoor level. The radiation levels in buildings vary on a large scale. It shows high dependence on the presence of slag. The indoor – outdoor ration was only 1.2 in buildings where slag was not built in and 1.8 where slag was built in. The highest values were measured when the floor space was filled with slag and only parquet was laid over it. We obtained that the short term and long term radon measurements results were comparable. Our analysis showed that the radon level changing tendency followed typical phenomena, which can be used to assess the radon risk potential. We also determined some minimal criteria for short term measurement. We developed a formula for the determination of the indoor radon potential using the results of short term measurements.

Conclusions: The source of elevated indoor gamma radiation is almost always the presence of slag with higher radioactivity built-in into the building structure. But the level of increment remains mostly within on acceptable level. According to our experience, the duration of the short term radon measurement should be at least 3 days long, even by closed conditions. The speed of accumulation of radon can be a good indicator for indoor radon risk but alone is not enough. We obtained better results when we used the average and maximal radon level too to characterize the indoor radon potential.

The New Conception of Radiological Sustainability Possibilities by Reutilization of Residues Products and Building Materials

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All minerals and raw materials of terrestrial origin contain some radioactive materials from human and natural sources, among which 238U, 232Th and 40K can be mentioned as the most important ones from the point of view of radiation protection. Generally speaking, for radiological sustainability, recycling or reutilization of residue or by-products which contain NORMs, rather than disposing of them as waste, is the first consideration to achieve the re-utilization of materials in building materials and the aim of radiological sustainability. The concept of radiological sustainability has been reviewed using the possibility of the reutilization of NORMs regarding the 2050 sustainable development concepts. This study is reviewing the capability of re-production of NORM residues based on their properties and the applicable treatment before reutilization. Linking the waste producers and construction materials industry as mineral end-users could contribute to the creation of industrial symbiosis and result in waste reduction and preserving natural resources on one hand, and CO2 reducing and energy saving on the other hand. According to EU-BSS (European Basic Safety Standards Directive), the characterization of NORMs as a secondary raw material for use as construction materials is necessary, however as an additive or secondary material their radiological behavior and material properties are quite important regardless of their origin. This is to say that the reutilization of NORM residues provides a better financial and environmental solution while reducing possible radiological effects on humans. The use of other wastes containing NORMs, e.g., coal slag and fly-ash, have become frequent after the development of cement production. However, the use of these by-products has to be restricted in several cases, as on the one hand, waste impairs the structural properties of the end-product, and on the other hand, different contaminants will have dissolved and entered the environment, causing harm to the environment or to human health. NORM residue or waste could become a high material resource for the cement industry. In this regard, the assessment of radium equivalents (Raeq) and external and internal indexes (I-indexes) are useful tools to classify NORM residues before their inclusion in building products. This assessment and/or indexes reflect the risk of external exposure much better than the specific activity concentration of Ra-226, Th-232 and K-40. Equally, building material properties such as density and thickness should be taken into consideration when designing building materials that contain NORM residue. The average values of the activity concentration and corresponding radiological hazard indices as applied to the mixture application of the residues in some building materials are relatively low. These NORM residues are generated in large quantities, and would be of high economic benefit while reducing possible radiological effects on humans and the environment if they are relatively incorporated in mixtures or as additive building material production and this offers flexible reuse options depending on the final product. By integrating radiological considerations into sustainable development initiatives, we can work towards a safer, healthier and more sustainable future.

Exploring construction materials and processes to reduce greenhouse gas emissions

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The construction industry is responsible for a significant amount of greenhouse gas emissions, accounting for approximately 11% of global emissions, which is mainly caused by the nature of the materials used. This presentation explores the use of various construction materials that can help reduce these emissions, in addition to studying the impact of certain processes such as Refurbishment, renovation and reuse of materials on the trend of the greenhouse gas emissions, which will lead to promoting sustainable building practices. The presentation delves into the environmental impacts of conventional construction materials, such as cement, steel, and aluminum, and highlights the potential of alternative materials, including recycled materials, bio-based materials, and low-carbon materials. The aim is to emphasize the importance of adopting a holistic approach to sustainable construction, encompassing material selection, construction practices, building design, and operational efficiency. By embracing these strategies, the construction industry can play a crucial role in mitigating climate change and transitioning towards a more sustainable future.

The Tribological Behavior of TiN/TiC CVD Coatings under Dry Sliding Conditions Against Zirconia and Steel Counterparts

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Abstract: Chemical vapor deposition (CVD) is deposition of solid onto a heated surface caused by a vapor-phase chemical process. It belongs to the atomistic class of vapor-transfer processes, which means that the deposition species are atoms, molecules, or a combination of both. Therefore, CVD is a technology that relied on the production of a gaseous species carrying the coating material within a coating reactor or chamber. Alternatively, the gaseous species could be created outside of the coating reactor and delivered through a delivery system. Currently, CVD coatings are being utilized to prevent the severe attrition of components used in various industrial situations where corrosion, oxidation, or wear occurs. TiN and TiC coatings have been used on cutting tools for over three decades and continue to be important components of current tools. Titanium nitride and titanium carbide (TiN, TiC) are well-known for their strong adhesion, high melting-point, chemical stability, lack of phases change, high hardness, and wear resistance. The use of TiN and TiC improves the thermal stability, oxidation behavior, and abrasive wear of the coating. Consequently, applying TiN and TiC coatings on cutting tool materials increases features such as hardness thermal shock, oxidation, chemical stability, toughness, and tribological characteristics.

During the research work, the wear and friction properties of TiN/TiC coatings produced with diffrent manufacturing parameters were investigated against steel and zirconium counterparts. The coatings, which were deposited on WC-Co substrate, were characterized based on their microstructure, phase composition, and microhardness. The tribological behavior of the coatings was examined in accordance with ASTM G99 and ASTM G133 standards using pin-on-disc tests with steel and zirconium counterfaces, while the adhesion of the coatings was investigated with a modified scratch test. According to the results obtained from the experiments, the use of zirconium counterpart is advantageous even for coatings produced with different microhardness and layer thickness using CVD method. The results show that the change in the friction coefficient can be well traced with properly chosen parameters, thereby determining the wear resistance of the coating.

Keywords: CVD, TiN, TiC, Tribological Behavior; Wear-Resistant Coatings; Zirconia

Challenges Associated with Anodizing Casting Al-Si Alloys

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Anodizing aluminum and its alloys is a complex process that requires meeting specific surface performance criteria contingent upon environmental factors and intended applications. Products such as castings, extrusions, rolled goods, forgings, deep drawn items, and sintered powder metal goods derived from aluminum and its alloys frequently aim for an anodized finish. However, this process becomes notably more challenging for aluminum alloys high in silicon content. This presentation aims to delve into the intricacies of anodizing high-silicon die-casting Al-Si base alloys. The study utilizes advanced surface imaging techniques and comprehensive analytical testing methods, including SEM-EDS with element mapping and GD-OES spectroscopy. These methods investigate the influential correlations affecting specific defects and overall quality in DC-anodized Al-Si alloy samples.

A Comparative Analysis of Diverse Austenitization Processes

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This research delves into the influence of temperature and atmospheric oxygen concentration on the depth of decarburization in tool steels, employing diverse processes. Two specimens per grade underwent varying austenitization durations. K110 steel was austenitized at 1030 °C, while M200 underwent processing at 850 °C using five distinct methods: Atmospheric Hardening, Cast Iron Chips, Protective Gas Atmosphere with continuous nitrogen flow, Steel Tube, and Vacuum Hardening. As a results, decarburization was not observed in all applied methods. The various techniques exhibited different levels of efficacy in minimizing decarburization, underscoring their efficiency in the process of steel hardening. The results obtained validate the effectiveness of these methods in achieving optimal outcomes for steel hardening.

Micro- Structure and Macro- Hardness of various zones of steel joints, varied in chemical composition and thickness

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Intensity experimental study has been performed to show the effect of arc welding parameters on the micro- structure and macro- hardness of steel joints, varied in chemical composition and thickness. Carbon steel and stainless steel plates were the welded dissimilar metals, which used in this study. Light microscope was used to examine the microstructure of welded joints. Ferrite- Perlite structure was seen in various zones of the carbon steel joints (WM, FL, HAZ & PM), but austenitic structure was seen in the weld metal zone of stainless steel and (carbon steel- stainless steel) joints. Low carbon steel electrodes (E6013) & (E7018-1) were used to join carbon steel plates, and stainless steel electrodes (E316L-16) were used to join stainless steel and (carbon steel- stainless steel) plates. The macro- hardness test has showed that hard phases were not formed in the various zones of welded joints.

Keywords: Arc welding process, Carbon steel, Stainless steel, Thickness, Chemical composition