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Editorial

New Materials and Advanced Procedures of Obtaining and Processing—Applied Sciences Insights

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The emphasis of this Special Issue is on showcasing the most recent advancements in the field of materials and techniques used in a variety of applications, including medical and civil engineering.

The primary uses concern the materials used in environmental engineering, health care, dentistry, and civil engineering, as well as the methods used in the handling and processing of these materials.

Materials ranging from nano- to macro-sized, including alloys, ceramics, composites, biomaterials, polymers, and more, have been investigated in order to gain knowledge of both processes and materials.

In the first article [1], the properties of a novel material based on pillared graphene and the icosahedral clusters of boron B12 as a supercapacitor electrode material were examined using the first-principle density functional theory (DFT) approach. The efficiency of the new composite material is demonstrated by its specifically high quantum capacitance, specific charge density, and negative value for formation heat. It is demonstrated that as clusters are added, the density of electronic states rises, naturally increasing the electrode conductivity. We forecast that the effectiveness of current supercapacitors will be enhanced with the usage of a composite made of pillared graphene and boron.

The necessity to develop methods for drive shaft designs that are more reliable and can guarantee the development of frozen soils during a deposit investigation confirms the relevance of the research. The goal of study [2] was to justify the critical loads and stresses in hardened gear coatings acting under the intense wear of the contact surface (with a broken contact symmetry) in order to prolong the service life and improve the energy efficiency of the highly loaded drive gear teeth of core drilling pump transmission shafts. Additionally, the interaction between the eccentric shaft gear and transmission shaft gear teeth at different axial torques was studied. The drive transmission shaft gear and eccentric shaft gear, which define the energy consumption of the drill bit's depth stroke, were justified in terms of their effective power. This paper also suggests a way to use Legendre polynomials to support the technological and power parameters of the transmission shaft. The relationship between the variation in the load distribution factor and the contact spot deviation factor from the design axis and the contact stress base cycles was determined using a nomographic chart.

In another study [3], the linear polarization resistance method (LPR) was used to quantify the corrosion rate in pipelines utilizing a three-electrode corrosion setup. To investigate the sample's surface and the corrosion products, optical and SEM tests were carried out. With the dissolved oxygen content in the solution kept at 6 mg/L, how the concentration of NaCl affects the rate of corrosion at various pH levels, temperature ranges, and flow rates (6 ppm) is investigated. It was discovered that the corrosion rate varies between 1 and 10 mils per year, increases with flow velocity, and reaches its peak at

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Reynolds numbers above 10,000. An increased fluid velocity demonstrates that corrosion is flow-insensitive.

In other research [4], TA3 alloys were implanted with Nb ions, and the impact on TA3's tribocorrosion behavior in Ringer's solution as well as biological corrosion behavior was comprehensively examined. The implanted samples had a smoother surface as a result of the sputtering and radiation damage, and the Nb ions predominated in the alloy as the solid solution element according to the surface microstructure and XRD data. The implantation of Nb ions can raise the corrosion potential of the samples, demonstrating greater thermodynamic stability according to electrochemical polarization tests. In a corrosive environment with wear behavior, the implanted samples show greater thermodynamic stability according to the results of tribocorrosion tests. The worn surface also had fewer pitting pits, indicating improved corrosion resistance. However, the partial softening of the surface and brittle passivation film caused the sample's abrasive wear and oxidation wear degree to increase.

The actual experiments and experimental processing results collected in order to construct a model for forecasting the surface roughness based on the optimization of cutting parameters are additional major contributions made in other publications [5]. The method of obtaining the regression equation of the surface roughness from a standard end-milling process on aluminum alloy 7136 in temper T76511, using two statistical methods of data analysis, adds novelty to the paper. This process used standard milling tools, standard milling parameters recommended by the tool manufacturer, a three-axis CNC machine, and a standard vice. For the suggested research area, this material is little-known and used to make extruded parts. The purpose of this study is to establish the surface roughness equation derived by milling aluminum alloy 7136 using Taguchi's experimental design once and the central composite design once. An effective mathematical model is created using the Taguchi method and the central composite design to forecast the ideal value of specific processing parameters. ANOVA analysis is used to compare the calculated and experimental surface roughness values. The Minitab application is used to examine the beginning features (surface roughness) and the controlled factors (cutting speed, depth of cut, and feed). The advantages and disadvantages of the two methods used were then analyzed and presented.

The movement precision and accuracy of a 3D printer's extruder system in relation to the print bed are examined in this work by utilizing the characteristics of 2D circular trajectories produced by simultaneous displacements on the x and y axes. The sampling of displacement evolutions, obtained with two non-contact optical sensors, is made possible using a computer-aided experimental setup. To assess and explain circular trajectory errors, some processing methods for displacement signals were proposed (e.g., open and closed curves fitting, the detection of recurrent periodical patterns in x and y-motions, low-pass numerical filtering, etc.). The description of these faults can attest to the 3D printer's proper operation for maintenance purposes and, particularly, for computer-aided accuracy corrections [6].

In the next research paper [7], a theoretical and experimental investigation of the vibrating beating phenomena is proposed. This phenomenon is produced when two rotating, unbalanced shafts are placed inside the headstock of a lathe and are connected by a flat friction belt. The work was conducted using a straightforward computer-assisted experimental setup for the capture, processing, and simulation of absolute vibration velocity signals. A horizontal geophone that is used as a sensor and mounted on a headstock produces the input signal. A vibration velocity signal was transformed into a vibration displacement signal via numerical integration (using a novel antiderivative calculus and signal correction method). This method allowed for the conversion of an absolute velocity vibration sensor into an absolute displacement vibration sensor. Numerical modeling made an important discovery that was fully supported by experiments on the evolution of the resultant vibration frequency (or combination frequency) of the beating vibration displacement signal. It was found that the combination frequency is modestly variable

(tens of millihertz variance over the complete frequency range) and exhibits a periodic pattern, in contrast to certain previously reported research results. Depending on how the amplitudes and frequencies of the vibrations engaged in the beating relate to one another, this pattern has negative or positive peaks that are strategically placed in the nodes of the beating phenomenon. Other accomplishments on problems related to the description of the beating phenomena were also made. With an entire frequency range inaccuracy of less than 3 microhertz, research on a simulated signal demonstrated that the method employed for combination frequency measurements exhibited great theoretical accuracy. On the basis of a computer-aided analysis (curve fitting) on the free damped response, a study on the experimental measurement of the dynamic amplification factor of the combined vibration (5.824) due to the resonant behavior of the headstock and lathe on its foundation was also carried out. These accomplishments guarantee a better understanding of the conditions and demands for dynamic balancing as well as the phenomenon of vibration beating.

Regarding the biomaterials field, for a predictable result, the optimum biomaterial used in endodontics to seal radicular canals should have a number of characteristics, including biocompatibility, the start of ontogenesis and cementogenesis, ease of handling, enough time for manipulation, and an affordable price [8]. The root canal procedure can be followed with prosthetic repair for a flawless seal. The purpose of the study is to quantify the local response to the implantation of three biomaterials in the subcutaneous connective tissue of rabbits. The study concentrated on qualitative and quantitative analyses based on histopathological examinations, which were supported by the positive findings of the study's application of oral rehabilitation treatments and, in turn, resulted in an increase in patients' quality of life of 95% and produced the stomatognathic system's optimal functioning.

The utilization of diverse nanoparticles [9] as medication delivery systems to target and eliminate pathogenic bacteria may be a good solution for the prevention and treatment of severe illness, according to recent nanotechnology research findings. Antimicrobial medication encapsulation into nano-sized systems emerged in recent years as a viable substitute that improved treatment efficacy and reduced side effects. Both Ery-PLA and Ery-PLGA nanostructures exhibit a sustained drug release, according to the erythromycin release profile from PLA/PLGA. Ring-shaped, stiff, and spherical nanoparticles were visible in the morphology photos. Thermal analyses of the Ery-PLA and Ery-PLGA samples revealed that the pure medicine exhibits an endothermic peak with a melting temperature of around 150 °C. For thermographs of antibiotic-loaded PLA and PLGA nanoparticles, the antibiotic melting peak vanished, indicating the presence of erythromycin. This shows that the antibiotic is evenly distributed at the nanoscale across the host's polymer matrix. The chemical structure of drug-loaded polymer nanoparticles was not altered, as shown by the almost identical peaks in the FTIR spectra of the Ery-PLA and Ery-PLGA nano-architectures.

Another in vitro experiment [10] examined the impact of dentifrices containing nano-hydroxyapatite (n-HAp) on mineral deposition and dentinal tubule blockage. Ten human teeth dentin samples were placed in 40% citric acid for 30 s before being separated into four groups at random (three study groups and one control group). All samples from the control group displayed a full and wide opening of the dentinal tubules, but varying degrees of tubule closure by mineral depositions were observed in the study groups. Dentinal tubules were significantly occluded by toothpaste containing n-HAp, and mineral deposition on the dentin surface increased significantly.

Measurements of facial tissue thickness and estimated feature shapes are necessary for cranial reconstruction, which frequently serves as the last stage in medicolegal identification [11]. The purpose of this study is to develop a valid and repeatable method for estimating the maximum nose width (MNW) based on the maximum nasal aperture width (MAW) in an adult sample from Romania. An adult Romanian subject sample of 55 computer tomography (CT) images was chosen from a neurosurgery hospital's database. Using 3D systems Freeform Modelling Plus Software, two measurements of the MNW and the MAW comprised the craniometrics that were taken. A moderate relationship between

the MAW and the MNW was found using correlation analysis. MAW and sex were found to form a statistically significant regression pattern using regression analysis. Based on MAW measurements taken on the skull, the preliminary results offer accurate forecasts of MNW for facial reconstruction.

Finally, a very important aspect of the applied sciences is the field of cultural heritage.

An analysis of three bronze socketed axes found in Romania's Neamţ County is presented in the paper [12]. In order to clarify the nature of the materials utilized and the production procedures, the surface structures, as well as those from the interface of the corrosion layer with the metal core of the basic alloy, were examined. In conjunction with X-ray spectrometry (EDX), optical and electron microscopy analyses revealed the type of deterioration that occurred throughout the depositional period as a result of chemical alterations and physical damage. A number of metallurgical methods employed were also identified, along with some finishing and ornamentation procedures that contributed to the determination of the objects' functionality.

Another study [13] proposed an interdisciplinary inquiry model of pottery that enables the scientific study of this group of objects. Examinations were conducted on 11 ceramic pieces from the Middle Bronze Age settlement of Piatra Neamţ-Lutărie in Eastern Romania, taking into account details about the color, production method, kind, size, usefulness, and category of the vessel, as well as information regarding ceramic paste inclusions. Optical microscopy (OM), scanning electron microscopy (SEM) with energy-dispersive X-ray analysis (EDX), and micro-Fourier-transform infrared spectroscopy (FTIR) were used to examine the samples. The results showed how various vessel categories functioned in a prehistoric population and provided valuable information about pottery manufacturing technology, such as raw material sources and fire temperatures.

In conclusion, this Special Issue managed to collect high-quality papers on various applications in applied sciences, and we hope to provide a solid state-of-the-art reference in this research area.

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