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New Frontiers in Multifunctional Material Science and Processing

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Efficient Adsorption of Methylene Blue and Rhodamine B by SBA-15 Materials: Implications for Wastewater Treatment

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Dyes pose a significant environmental problem due to their widespread use in industry. Their discharge into water bodies can affect aquatic ecosystems and cause human health issues. Efficient removal of dyes from wastewater is crucial to mitigate these adverse effects. Mesoporous silica materials SBA-15 were investigated as adsorbents to remove methylene blue and rhodamine b dyes. It was found that modifications of the synthesis conditions (the temperature and the duration of the synthesis reaction) affected the significant morphological differences of the synthesized SBA-15 materials and their ability to remove the mentioned dyes. Employing a dosage of 5 mg dm^{-3} at 22 °C, with a 60-minute contact time, it was found that rhodamine b showed 2 to 3 times higher adsorption capacity on both materials compared to methylene blue. Furthermore, SBA-15/100 demonstrated 2 to 4 times greater adsorption efficiency for both dyes than SBA-15/80. These results underscore the potential of SBA-15 materials as efficient adsorbents for dye removal, contributing to the advancement of sustainable solutions for environmental remediation.

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Improving the phase detection using machine learning approach: $Y_2MoO_6:Eu^{3+}$ at high pressures

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The Eu^{3+} activated Y_2MoO_6 ($Y_2MoO_6:Eu^{3+}$) powder was prepared by the self-initiated and self-sustained reaction method. After synthesis, in order to achieve the full crystallinity, the material was calcined at different temperatures. Phase identification in the post-calcined powder samples were performed by X-ray diffraction (XRD), and morphology was investigated by high resolution scanning electron microscope (SEM) and transmission electron microscope (TEM). Photoluminescence characterization of emission spectrum was obtained using Ocean optics spectrometer and laser diode excitation at 405 nm. High pressure dependence of $Y_2MoO_6:Eu^{3+}$ emission spectrum was acquired and used to determine the pressure dependent curve based on intensities of two prominent peaks. The phase transition is clearly observable by visual inspection of such obtained curve. Here, we show that further improvements in phase transition detection

are possible by using the machine learning approach. To facilitate the visual data assessment, we have incorporated The Principal Component Analysis (PCA), t-Distributed Stochastic Neighbor Embedding (t-SNE) and Uniform Manifold Approximation and Projection (UMAP) clustering of Y_2MoO_6:Eu^{3+} spectra at various pressures.

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Non destructive testing (NDT) of building materials mechanical properties

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Non-destructive testing methods in the construction industry enable the assessment of material properties without causing any damage. One of the commonly used methods for mechanical testing of building materials is the 3-point measurement and compression test, which both are destructive to the material. To avoid the use of destructive methods and simplify materials testing, some non-destructive methods are used to determine mechanical properties by connecting materials' internal structure, defects, pores or cracks, with the mechanical characteristics of materials.
One of the most used techniques for such testing is Ultrasonic Pulse Velocity (UPV) which uses ultrasonic waves to analyze the internal structure of materials. This study aimed to measure the ultrasonic pulse velocity to assess the mechanical properties of building materials. Used samples were cement mortar, stone material and elements of earthen architecture - clay blocks with carbolime. To support and test the accuracy of UPV analysis, the mechanical properties of these materials were examined, and by correlation and regression analysis, equations were obtained for evaluating the mechanical properties. As a result, it was shown that there is a correlation between pulse velocity and mechanical properties. However, to obtain more efficient regression equations, further research with a larger number of samples is necessary.
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P26 **Poster Session II**

Rod-Shaped α-Bi_2O_3: A Novel Electrode Material for Electrochemical Sensing of Acetaminophen in Pharmaceutical Formulations

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Effect Of The Erbium Content On The Structural, Morphological And Optical Properties Of Barium Titanate Ceramics

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In this work, the erbium (Er^{3+}) doped barium titanate ($BaTiO_3$) ceramics were investigated. Doped $BaTiO_3$ were prepared by using conventional method of solid-state sintering at 1320-1380 ºC for 4h. The obtained samples have been studied using a variety of characterization techniques: X-ray diffraction (XRD), Raman and infrared (IR) spectroscopy, photoluminescence (PL), scanning electron (SEM) and atomic force (AFM) microscopy. The investigated doped $BaTiO_3$ samples showed a typical tetragonal XRD patterns. EDS study confirmed the presence of Er^{3+} ions in the $BaTiO_3$. SEM analysis of Er/$BaTiO_3$ doped ceramics showed that in samples doped with a rare-earth ions low level, the grain size ranged from 20-40 μm, while with the higher dopant concentration the abnormal grain growth is inhibited and the grain size ranged between 2-10 μm. All of these ceramic samples exhibited a tetragonal perovskite structure, which implies that Er^{3+} ions were completely incorporated into the perovskite lattice. Based on the group theory analysis, the symmetry coordinates of the tetragonal $BaTiO_3$ were obtained and all the vibrational modes were presented by the linear combinations of symmetry coordinates. The A_1 and E modes are both Raman and IR active, while the B_1 mode is Raman active only. The results indicate that both of the microstructure and luminescence are found to be dependent on Er^{3+} substituting sites. Hence, these Er/$BaTiO_3$ can be used in display and optoelectronic devices.

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Advanced Chemical Analysis of Fly Ash Leachate and Mortars Using ICP-OES

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This study introduces a new approach using inductively coupled plasma optical emission spectrometry (ICP-OES) for the analysis of the chemical composition (34 elements: Al, Be, Cd, Co, Cr, Cu, Fe, Mn, Mo, Ni, V, Zn, Pb, Bi, Si, Zr, As, Hg, Se, Sb, Sn, Ti, Ba, B, Ag, Mg, Ca, K, Na, S, P, Li) of fly ash leachate, as well as mortars containing fly ash, zeolite, and bentonite. The method underwent rigorous validation and addressed measurement uncertainties. It offers an efficient way to detect traces of undesirable elements in fly ash leachate and in construction materials containing fly ash, zeolite, and bentonite, such as cement binders and mortars.