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Message from the Section Editor-in-Chief

The Section on Materials Science and Engineering encourages multi-disciplinary research in the field of novel material development and innovative material applications. It spans the full range of material types, encompassing polymers, ceramics, metals and hybrid materials. The main focus is on novel developments and applications in society relevant themes. More specifically, articles dealing with the application of materials in novel electronic, optical or mechanical devices, the use of functional materials in applications related to energy and the environment and novel manufacturing techniques, such as additive manufacturing, are highly welcomed. Applied Sciences in general and this Section on Materials Science and Engineering in particular offers a high quality peer review followed by a rapid publication decision.

Featured Papers

DOI:10.3390/app12042245

The Behavior of Hybrid Fiber-Reinforced Concrete Elements: A New Stress-Strain Model Using an Evolutionary Approach

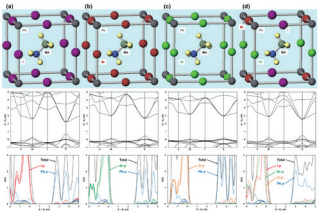
Authors: Ali A. Abdulhameed, Alaa Hussein Al-Zuhairi, Salah R. Al Zaidee, Ammar N. Hanoon, Ahmed W. Al Zand, Mahir M. Hason and Haider A. Abdulhameed

Abstract: Several stress-strain models were used to predict the strengths of steel fiber reinforced concrete, which are distinctive of the material. However, insufficient research has been done on the influence of hybrid fiber combinations (comprising two or more distinct fibers) on the characteristics of concrete. For this reason, the researchers conducted an experimental program to determine the stress-strain relationship of 30 concrete samples reinforced with two distinct fibers (a hybrid of polyvinyl alcohol and steel fibers), with compressive strengths ranging from 40 to 120 MPa. A total of 80% of the experimental results were used to develop a new empirical stress-strain model, which was accomplished through the application of the particle swarm optimization (PSO) technique. It was discovered in this investigation that the new stress-strain model predictions are consistent with the remaining 20% of the experimental stress-strain curves obtained. Case studies of hybrid–fiber–reinforced concrete constructions were investigated in order to better understand the behavior of such elements. The data revealed that the proposed model has the highest absolute relative error (ARE) frequencies (ARE 10%) and the lowest absolute relative error (ARE > 15%) frequencies (ARE > 15%).

DOI:10.3390/app12031710

Effects of Adding Alkali Metals and Organic Cations to Cu-Based Perovskite Solar Cells

Authors: Riku Okumura, Takeo Oku, Atsushi Suzuki, Masanobu Okita, Sakiko Fukunishi, Tomoharu Tachikawa andTomoya Hasegawa



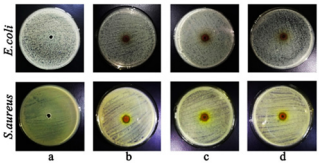
Abstract: First-principles electronic band calculations were used to investigate the effects of alkali metals and organic cations added to Cu-based perovskite solar cells. The copper d-orbital band was slightly above the valence-band maximum and functioned as an acceptor level for carrier generation. Excitation from iodine p-orbitals and copper d-orbitals to alkali metal s-orbitals could suppress carrier recombination and promote carrier transport. Experimental solar conversion efficiencies increased after adding both Cu and Na, in agreement with the calculations. Total-energy calculations indicated that the perovskite crystal stability increased with the addition of ethyl ammonium, although the total energy decreased with the addition of Cu and Na.

DOI:10.3390/app12063091

Hyaluronic Acid-Based Wound Dressing with Antimicrobial Properties for Wound Healing Application

Authors: Francesca Della Sala, Gennaro Longobardo, Antonio Fabozzi, Mario di Gennaro and Assunta Borzacchiello

Abstract: Wound healing is a naturally occurring process that can be aided by a wound dressing properly designed to assure an efficient healing process. An infection caused by several microorganisms could interfere with this process, delaying or even impairing wound healing. Hyaluronic acid (HA), a main constituent of the extracellular matrix (ECM) of a vertebrate's connective tissue, represents a promising biomaterial for wound dressing thanks to its intrinsic biocompatibility, hydrophilicity and bacteriostatic properties. In this review, different and recent types of HA-based wound dressings endowed with intrinsic antimicrobial properties or co-adjuvated by antimicrobial natural or synthetic agents are highlighted.

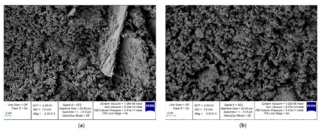


DOI:10.3390/app12020613

The Influence of Composition and Recipe Dosage on the Strength Characteristics of New Geopolymer Concrete with the Use of Stone Flour

Authors: Alexey N. Beskopylny, Evgenii M. Shcherban, Sergey A. Stel'makh, Levon R. Mailyan, Besarion Meskhi and Diana El'shaeva

Abstract: Currently, considering global trends and challenges, as well as the UN sustainable development goals and the ESG plan, the development of geopolymer binders for the production of geopolymer concrete has become an urgent area of construction science. This study aimed to reveal the influence of the component composition and recipe dosage on the characteristics of fine-grained geopolymer concrete with the use of stone flour. Eleven compositions of geopolymer fine-grained concrete were made from which samples of the mixture were obtained for testing at the beginning and end of setting and models in the form of beams and cubes for testing the compressive strength tensile strength in bending. It was found that the considered types of stone flour can be successfully used as an additive in the manufacture of geopolymer concrete. An analysis of the setting time measurements showed that stone flour could accelerate the hardening of the geopolymer composite. It was found that the addition of stone waste significantly improves the compressive strength of geopolymers in comparison with a geopolymer composite containing only quartz sand. The maximum compressive strength of 52.2 MPa and the tensile strength in bending of 6.7 MPa provide the introduction of potassium feldspar in an amount of 15% of the binder mass. Microstructural analysis of the geopolymer composite was carried out, confirming the effectiveness of the recipe techniques implemented in this study.

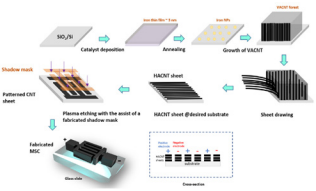


DOI:10.3390/app12020862

A Review of Fabrication Technologies for Carbon Electrode-Based Micro-Supercapacitors

Author: Veerle Vandeginste

Abstract: The very fast evolution in wearable electronics drives the need for energy storage micro-devices, which have to be flexible. Micro-supercapacitors are of high interest because of their high power density, long cycle lifetime and fast charge and discharge. Recent developments on micro-supercapacitors focus on improving the energy density, overall electrochemical performance, and mechanical properties. In this review, the different types of micro-supercapacitors and configurations are briefly introduced. Then, the advances in carbon electrode materials are presented, including activated carbon, carbon nanotubes, graphene, onion-like carbon, and carbide-derived carbon. The different types of electrolytes used in studies on micro-supercapacitors are also treated, including aqueous, organic, ionic liquid, solid-state, and quasi-solid-state electrolytes. Furthermore, the latest developments in fabrication techniques for micro-supercapacitors, such as different deposition, coating, etching, and printing technologies, are discussed in this review on carbon electrode-based micro-supercapacitors.



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