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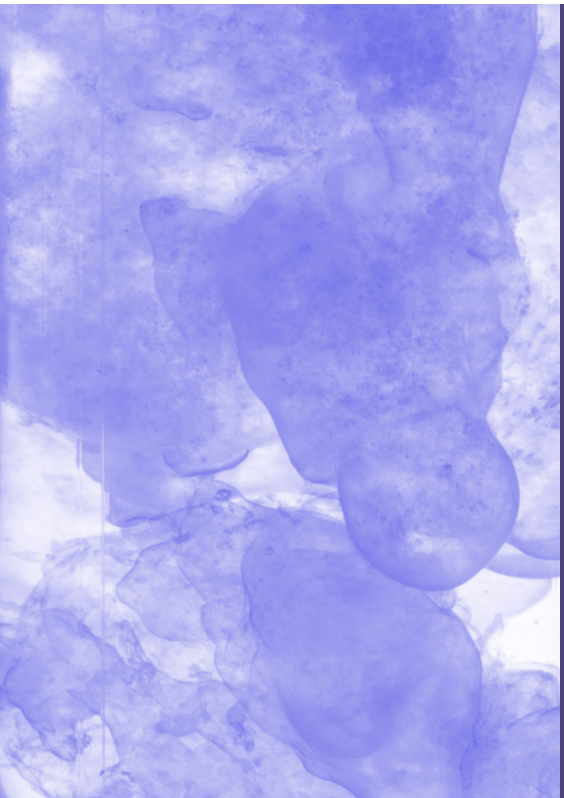
Section
Materials Science and Engineering



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Section Information

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.

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Content Highlights

Concrete Composites Based on Quaternary Blended Cements with a Reduced Width of Initial Microcracks

Author: Grzegorz Ludwik Golewski

Abstract: This article is devoted to the study of the combined effect of siliceous fly ash (FA), silica fume (SF), and nanosilica (nS) on the cement matrix morphology and size of microcracks occurring in the Interfacial Transition Zone (ITZ) between the coarse aggregate and the cement paste of concrete composites based on ordinary Portland cement (OPC). The manuscript contains analyses of width of microcracks (Wc) occurring in the ITZ area of concretes based on quaternary blended cements and changes in ITZ morphology in the concretes in question. Experiments were planned for four types of concrete. Three of them were composites based on quaternary blended cements (QBC), while the fourth was reference concrete (REF). Based on the observations of the matrices of individual composites, it was found that the REF concrete was characterized by the most heterogeneous structure. However, substitution of part of the cement binder with active pozzolanic additives resulted in a more compact and homogenous structure of the cement matrix in each of the QBC series concretes. Moreover, when analyzing the average Wc values, it should be stated that the modification of the basic structure of the cement matrix present in the REF concrete resulted in a significant reduction of the analyzed parameter in all concretes of the QBC series. For QBC-1, QBC-2, and QBC-3, the Wc values were 0.70 μm, 0.59 μm, and 0.79 μm, respectively, indicating a decrease of 38%, almost 48%, and 30%, respectively, compared with the working condition of concrete without additives...

https://doi.org/10.3390/app13127338

Recent Trends and Progress in Corrosion Inhibitors and Electrochemical Evaluation

Authors: Kiran Bijapur, Vandana Molahalli, Apoorva Shetty, Arafat Toghan, Paola De Padova and Gurumurthy Hegde

Abstract: Science and engineering research studies are currently concentrating on synthesizing, designing, producing, and consuming ecologically benign chemical species to replace harmful chemicals. This is due to the increasing demands of conservation knowledge and strict ecological regulations. Numerous environmentally friendly substitutes produced from natural resources, including biopolymers, plant extracts, chemical pharmaceuticals (drugs), and so on, are now frequently used as inhibitors to replace dangerous corrosion inhibitors. Many compounds have been extensively used. A range of methods, including physisorption, chemisorption, barrier protection, thin-film growth, and electrochemical procedures, will be used to provide corrosion resistance. The various kinds of corrosion inhibitors (CIs), the mechanisms underlying inhibition, and the evaluation procedures have all been covered in-depth...

https://doi.org/10.3390/app131810107

Evaluation and Current State of Primary and Secondary Zinc Production—A Review

Authors: Henryk Kania and Mariola Saternus

Abstract: This article presents the history of zinc, its production and demand. The quantity of zinc production, both primary zinc from ores and concentrates, and secondary zinc from scrap and zinc-rich waste, was discussed. A comprehensive economic analysis covers zinc prices in the years 1960–2021. The basic methods of obtaining zinc from ores, including pyrometallurgical (Imperial Smelting Process ISP, Kivcet, Ausmelt) and hydrometallurgical (roasting–leaching–electrowinning RLE, atmospheric direct leaching ADL, Engitec Zinc Extraction EZINEX, zinc pressure leach) and their short characteristics, are presented. The global zinc market and the main areas of its application were analyzed. Technologies used for the recovery of zinc from scrap are discussed along with their characteristics. Galvanized steel is the main source of secondary zinc, both in the galvanizing process and in the remelting of galvanized steel. It can be easily recycled with other scrap steel in the electric arc furnace (EAF) for steel production. Currently, with high volatility in the price of zinc, as well as its natural resources in the earth's crust, recycling is an important activity, despite the fact that zinc concentrates have a relatively constant chemical composition, while the resulting zinc waste contains zinc in varying amounts.

https://doi.org/10.3390/app13032003

Recent Trends in the Characterization and Application Progress of Nano-Modified Coatings in Corrosion Mitigation of Metals and Alloys

Authors: Abhinay Thakur, Savaş Kaya and Ashish Kumar

Abstract: Nanotechnology is a discipline of science and engineering that emphasizes developing, modifying, characterizing, and using nanoscale components in a variety of applications. Owing to their multiple advantages, including adhesion strength, surface hardness, long-term and extra-high-temperature corrosion resistance, improvement of interfacial behavior, etc., nanocoatings are efficiently utilized to minimize the influence of a corrosive environment. Additionally, nanocoatings are often applied in thinner and finer concentrations, allowing for greater versatility in instrumentation and reduced operating and maintenance costs. The exemplary physical coverage of the coated substrate is facilitated by the fine dimensions of nanomaterials and the significant density of their grounded boundaries. For instance, fabricated self-healing eco-sustainable corrosion inhibitors including PAC/CuONPs, PAC/Fe_3O_4NPs, and PAC/NiONPs, with uniform distributions and particulate sizes of 23, 10, and 43 nm, correspondingly, were effective in producing PAC/MONPs nanocomposites which exhibited IE% of 93.2, 88.1, 96.1, and 98.6% for carbon steel corrosion in 1M HCl at the optimum concentration of 250 ppm...

https://doi.org/10.3390/app13020730

Ceramic Matrix Composites for Aero Engine Applications—A Review

Authors: George Karadimas and Konstantinos Salonitis

Abstract: Ceramic matrix materials have attracted great attention from researchers and industry due to their material properties. When used in engineering systems, and especially in aero-engine applications, they can result in reduced weight, higher temperature capability, and/or reduced cooling needs, each of which increases efficiency. This is where high-temperature ceramics have made considerable progress, and ceramic matrix composites (CMCs) are in the foreground. CMCs are classified into non-oxide and oxide-based ones. Both families have material types that have a high potential for use in high-temperature propulsion applications. The oxide materials discussed will focus on alumina and aluminosilicate/mullite base material families, whereas for non-oxides, carbon, silicon carbide, titanium carbide, and tungsten carbide CMC material families will be discussed and analyzed. Typical oxide-based ones are composed of an oxide fiber and oxide matrix (Ox-Ox). Some of the most common oxide subcategories are alumina, beryllia, ceria, and zirconia ceramics. On the other hand, the largest number of non-oxides are technical ceramics that are classified as inorganic, non-metallic materials. The most well-known non-oxide subcategories are carbides, borides, nitrides, and silicides. These matrix composites are used, for example, in combustion liners of gas turbine engines and exhaust nozzles. Until now, a thorough study on the available oxide and non-oxide-based CMCs for such applications has not been presented...

https://doi.org/10.3390/app13053017

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