10th Biennial Congress of The Iranian Ceramic Society
& The 1st International Conference on Advanced Ceramics

4-6 May 2015 | Materials and Energy Research Center, Karaj, Iran

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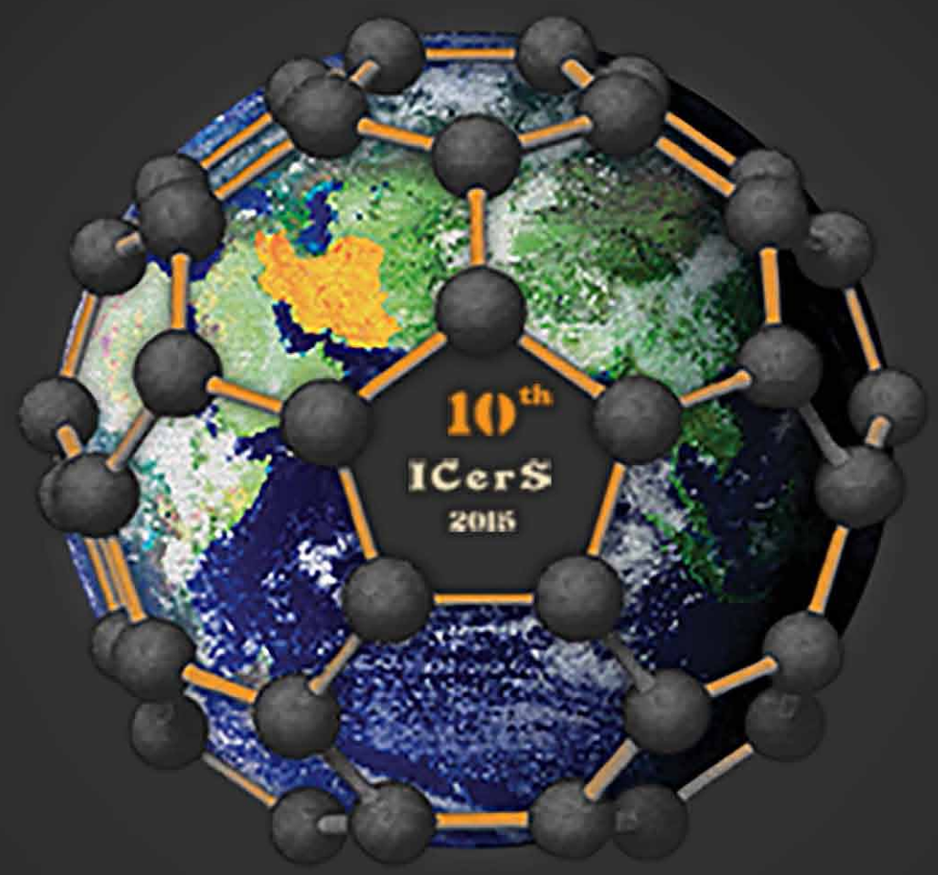

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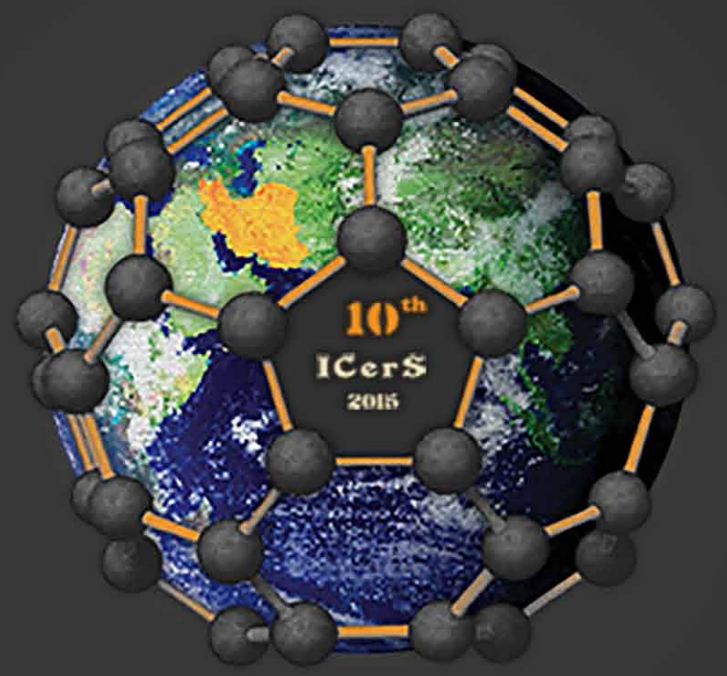

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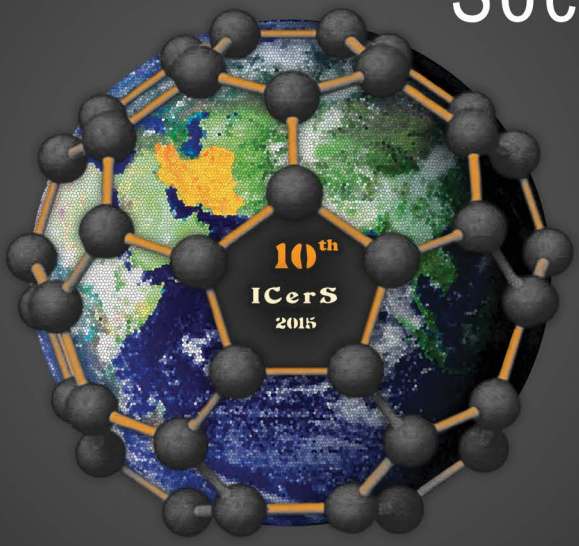
10th Biennial Congress of the Iranian Ceramic Society



Book of Abstracts

Edited By
Prof. Farhad Golestanifard
Dr. Mohammad Ali Bahrevar

Preface

It is a great pleasure to announce that the combined meeting of the 10th Congress of Iranian Ceramic Society and the 1st International Conference on Advanced Ceramics is hosted by Iranian Ceramic Society (ICerS) and Materials and Energy Research Center (MERC) from May 4 to 6, 2015. The board of directors of the Iranian Ceramic Society has been planning on invigorating the independent divisions of the society in collaboration with industry and is proud to confirm that, those divisions with industrial bases in Iran, have been successful in holding the first joint International Conference on Tile, Porcelain, and Sanitary ware last year. The second International Conference on Refractories will also be held in June, 2015.

We are glad to report that about 300 abstracts were initially received for this Congress. Upon reviewing the full manuscripts by the Scientific Committee, 50 and 120 articles were selected for oral and poster presentation, respectively. Moreover, 30 articles are presented by 10 internationally renowned scholars and 20 distinguished Iranian scientists from various research institutes and universities. We are proud at such a scientific turnout for the first conference on advanced ceramics in Iran heralding a brighter and more promising future in high-tech ceramics. This calls for a more detailed evaluation of advanced ceramics by private investors and the government in Iran in the light of the human resources and raw materials availability.

We appreciate the opportunity to express profound gratitude to our foreign and Iranian guests whose contribution has made this conference a success. We also deem it necessary to thank the conference sponsors, particularly, Ministries of Science, Research & Technology and Industry & Mines. Our special thanks go to our colleagues at MERC and the directorate of the ICerS. We personally feel indebted to the postgraduate students of the Iranian University of Science and Technology (IUST) and MERC as well as our scientific colleagues at MERC who had valuable contributions at every stage and made this event possible.

Prof. F. Golestani-Fard
Conference Chairman

Associate Prof. M.A.Bahrevar
Scientific Chairman

International Invited Speakers

Structural Ceramics for High Temperature Applications

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Abstract:

The biggest barrier in the extensive use of ceramics is their inherent brittleness and the lack of damage tolerance of ceramic structures. Ceramic matrix composites (CMCs) show a considerably higher fracture toughness and have already proven their feasibility in various applications like thermal protection systems (TPS) and brake disks. These safety-critical components have to withstand harsh conditions in terms of temperature and corrosion only for short times, accumulated to some hours. Increasing interest in CMCs arise in long-term applications like structural components for the combustion environment. Oxide as well as non-oxide CMCs are under development to be used for example in future thermal power plants and gas turbines. Liquid phase routes like polymer impregnation and pyrolysis (PIP), melt infiltration (MI) and slurry impregnation or combinations thereof are promising manufacture routes to overcome the still high processing costs of this class of materials. Different approaches are on the way to develop new CMC processes on the basis of prepregs and preforms with chopped or continuous oxide and non-oxide fibers. The paper reports about the current status of oxide and non-oxide composites, their applications and perspectives.

Colloidal Processing and Assembly of Ceramics, Nanoparticles and Inorganic-Organic Hybrids

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Abstract:

This talk will present recent research on the colloidal processing and assembly of ceramic, nanoparticles and inorganic-organic hybrid materials for functional, thermal and gas separation applications. The presentation will give examples on how the ability to control structure and functionality at all length scale has developed and is utilized for optimal design of nanostructured materials.

The colloidal processing and assembly routes to production of advanced materials will be introduced together present recent work on the structural evolution and the formation kinetics of large and highly ordered particle arrays of nanocubes and nanospheres with a combination of gracing incidence small angle X-ray scattering, electron microscopy and modeling. The presentation will also introduce a novel and facile powder processing approach for the rapid production of mechanically stable hierarchically porous materials from porous particles, e.g. zeolites. Examples on how the pore size distribution can be engineered will be shown and efforts on shape control will be demonstrated for optimum gas separation and odor removal performance.

Finally, it will be shown how nanocellulose can be processed, often in combination with inorganic materials, to produce composite films and foams with useful properties. Controlling the foaming and assembly can tailor the microstructure and functional properties of inorganic-nanocellulose hybrids. Recently, we showed that freeze-casting suspensions of cellulose nanofibres, graphene oxide and sepiolite nanorods can produce super-insulating, fire-retardant and strong anisotropic foams.

Plasma Spray Coating Process and Its Applications in Depositing Ceramic Coatings

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Abstract:

Thermal spray coating is a process used to produce protective coatings that shield mechanical components from corrosion, wear and heat. The technology is extensively used in aerospace industry and has found a great number of applications in auto industry, chemical processing and oil industry, pulp and paper industry, medical implants, energy, sensors, and many more industries. Traditionally, thermal spray coatings are produced by injecting fine powder into a high velocity, high temperature gas jet where they are accelerated and melted before being deposited on the component and forming the coating (Figure 1). More recently, advanced nanostructured coatings have been deposited by two recently developed spraying techniques, i.e., solution pre-cursor plasma spray (SPPS) and suspension plasma spray (SPS) processes. In these processes, DC (direct current) plasma or radio frequency inductively coupled plasma torches are employed as the heat and momentum source for the coating processes. In this presentation a review of the application of DC plasma spraying in depositing ceramic coatings will be presented and some of our recent work on hydrophobic coatings will be presented.

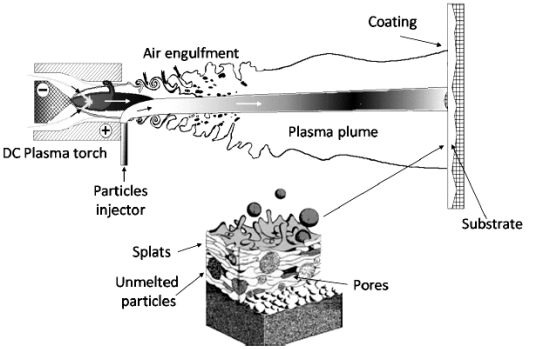

Figure 1. Schematic diagram of plasma spray coating

Design of Thermal Barrier Coatings for Gas Turbine Applications

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Abstract:

Thermal barrier coating (TBC) systems have been used in the gas turbine industry since the 1980s. The future needs both the air and land based turbine industry involve higher operating temperatures with longer lifetime on the component so as to increase power and efficiency of gas turbines. The first objective of this research was to investigate relationships between coating microstructure and thermo-mechanical properties of air plasma sprayed (APS) TBCs, and to utilize these relationships to design an optimized microstructure. Experimental as well as simulation techniques were used to achieve this goal. Important microstructural parameters influencing the performance of TBCs were identified and coatings with the identified microstructural parameters were designed, modelled and experimentally verified. The second objective was to investigate relationships between coating microstructure and thermo-mechanical properties of suspension plasma sprayed (SPS) TBCs. Of particular interest in SPS spraying is the ability to design microstructures that are difficult or impossible to generate via conventional powder spraying. In particular, the formation of segmented or fully columnar coatings is of great interest for TBC applications due to their inherent strain tolerance. Columnar and segmented SPS coatings were produced and evaluated along with their conventional APS counterparts in both thermal shock and thermo-cyclic fatigue (TCF) testing. The SPS coatings were shown to have dramatically improved thermal shock performance and long TCF life. Thermal conductivity were shown to be in-line with or lower than conventional porous APS coatings and significantly below the dense vertically cracked APS competitor coatings.

Ultra High Temperature Ceramics for Aerospace Applications

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Abstract:

The impelling demand for materials able to operate at high temperature and for long time pushes the scientific research towards continuous search of materials possessing more challenging properties. Propulsion systems or hypersonic vehicles components are exposed to significant heating flux where mechanical solicitations are also present. Therefore the main requirement that a material for such applications should satisfy is a combination of refractoriness at high temperature in oxidizing environment and sufficient mechanical resistance. Ultra-high temperature ceramics (UHTCs) have been identified as potential candidates for operating in harsh conditions owing to their melting point exceeding 3000°C and their resistance to ablation.

This lecture traces the main steps of our research activity on UHTCs, starting from densification issues. The high melting point and low self-diffusion coefficient make the full densification of these materials difficult: temperatures above 2000°C and the application of pressure are necessary conditions. However these processing parameters lead to coarse microstructures with trapped porosity. Worldwide, the most diffused methods to densify UHTCs are pressure-assisted techniques such as hot pressing or spark plasma sintering. ISTEC approach is mainly focused on the appropriate choice of sintering aids that allows densification to occur at reduced temperature or even without applied pressure. The most promising sintering aids are transition metal disilicides as they enable improvement of densification without affecting the material refractoriness. Remarkably, the addition of $MoSi_2$ is able to promote densification while suppressing grain coarsening and results in ceramics that retain their room temperature strength up to at least 1500°C.

Once proper densification techniques have been set up for monolithic UHTCs, the next problem to solve is the poor fracture toughness/thermal shock resistance. To overcome these limits, ISTEC activities have been recently focused on fabrication of ZrB2-based ceramics containing different reinforcing elements such as SiC particles, platelets, or whiskers but most of the activity has been devoted to the addition of short randomized SiC or C fibers. Processing techniques and characterization of these composites will be shown, including test of prototypes in relevant environments (arc

jet tests). Finally, processing of C-continuous or SiC-continuous fibers CMCs with ZrB_2 matrices are the focus of present activity. Preliminary results concerning the aspects of matrix densification, fiber/matrix interface and fracture behavior will be illustrated.

Strategies for Suppressing Abnormal Grain Growth During Liquid Phase Sintering

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Abstract:

Abnormal grain growth (AGG) often occurs during liquid phase sintering of ceramics, exhibiting several common characteristics: (i) AGG is observed only in systems with faceted grains; (ii) AGG tends to occur more intensively with a reduction of particle size; (iii) Sometimes, AGG occurs after an incubation period (incubated AGG); and (iv) After impingement of abnormal grains, grain growth behavior is usually stagnant.
This presentation first explains these characteristics under the consideration that the growth of a grain is a result of serial processes of diffusion of atoms through the liquid matrix and the reaction (atom attachment) at the solid/liquid interface. The growth of a faceted grain is governed by the interface reaction and the diffusion respectively for the driving force for growth smaller or larger than a critical value, showing nonlinear growth behavior with respect to the driving force. Based on this understanding, a mixed control model of grain growth is established and the principle of microstructural evolution is deduced as a result of a coupling effect between the critical driving force for appreciable growth of grains and the maximum driving force for the growth of the largest grain. It is found that the principle is valid for explaining and controlling the microstructural evolution not only during liquid phase sintering but solid state sintering. Several strategies for suppressing AGG are also deduced from the principle of microstructural evolution and are tested experimentally in cemented carbides. Abnormal grain growth in cemented carbides are suppressed by applying the deduced strategies in the processing. The experimental results further demonstrate the generality of the mixed control model and the principle of microstructural evolution in polycrystals.

Nanotechnologies to Control the Wetting Behaviour of Different Kind of Materials

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Abstract:

Wettability is a fundamental property of a solid surface, whose control plays a key role in many different industrial sectors, from the ceramic one to the aerospace, naval or maritime, to that of electronic and mechanical devices, pipes lines and so on.
In the last ten years, a lot of studies have focused on the possibility of mimicking the outstanding ability of living organisms to repel water and/or oily substances, trying to replicate it on synthetic materials. The basic concepts to design functional materials draw inspiration from the perfectly organized, hierarchical structures allowing the natural organisms to actively interact with the surrounding environment.
The great potential of synthetic super-repellent surfaces relies on the proper combination of surface topography and chemistry, which can be obtained by multi-disciplinary approaches involving targeted technologies and competences. Nanotechnologies offer powerful tools to design materials whose new functions originate from size-dependent mechanisms and are regulated by the presence of nano-scaled features and the suitable chemistry. Current knowledge highlights that high static contact angle (CA>150°), CA hysteresis lower than 5° (hysteresis is the difference between the advancing and receding CAs in dynamic sliding/rolling of a fluid drop) and an extremely reduced surface energy are required to produce i.e. de-icing, anti-fouling, self-cleaning materials, as well as water/oil filters, low friction components, and so on.
This lecture will focus on the experimental activities relating to amphiphobic metals, alloys, glasses and ceramics with a largely reduced wettability against water, alkane or lubricants, thus coupling super-hydrophobicity with oleophobicity on their surface. Suspensions of nano-oxides, with an average particle size of less than 30 nm, eventually coupled with perfluorinated, lubricant compounds, have been used to modify the material surfaces giving rise to solid-liquid-air working interfaces or, alternatively, to solid-liquid-liquid ones. Dip coating and automated spraying were selected as deposition techniques thanks to their high transfer degree and industrial feasibility. Optically transparent, homogeneous, nanostructured organic/inorganic hybrid coatings, with a thickness commonly in the 200-300 nm range that can be

implemented up to 1 µm if necessary, have been generated by sol-gel method, followed by thermal processing and introduction of low energy elements, such fluorine. Static contact angles with water as high as 178°±1° were obtained, the same materials presenting excellent dewetting phenomena, as certified by the contact angle hysteresis lower than 5°±1°.

Looking in perspective at the potential applications of functional surfaces in so many industrial sectors - each of them requiring durability in quite different working conditions (i.e. chemically aggressive environments, presence of mechanical stresses, friction effects, etc) - materials' scientists are even more asked to design lasting products able to keep unchanged their performances over the time. Thus, many efforts have been devoted to identify and then to manage the key factors to preserve the multiple co-existing functionalities. Mechanical resistance and durability to wearing phenomena, anti-frost performances and resistance to chemical attacks of functional materials will be presented, according to different scenarios. The obtained results encourage to think that a new class of materials can be planned, bringing great convenience in many strategic industrial sectors.

Bioceramics for Hard Tissue Replacement

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Abstract:

Materials for implantation in hard tissue must fulfill a range of requirements. They should have sufficient mechanical strength to support the bone but preferably with a Young's modulus that matches that of bone to prevent the weakening of the natural bone close to the implant due to stress shielding. They should be biocompatible and non-toxic but bioactive, to stimulate the growth of new bone and biodegradable to disappear as new bone is formed.

The earliest ceramics were alumina and zirconia, which are fully inert in the body. Later hydroxy apatite (HA) was developed. Though this is very similar to the mineral phase in bone, the bioactivity is limited and it is not biodegradable. HA has been modified by carbonating it which makes it more similar to natural bone mineral.

Some of the most promising materials are based on calcium silicate, which shows a very good bioactivity. However, its drawbacks are high hardness and brittleness and a biodegradability that is too fast.

In our work, we are trying to modify the mechanical properties by making composites of calcium silicate with various other materials, including graphene and biopolymer (POC). Furthermore, we are trying to control the release of ions, which influences both the stimulation of bone growth as well as the biodegradation of the calcium silicate.

Liquid Phase green Processing of Non-Plastic Powder

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Abstract:

Green fabrication of ceramics through liquid phase is a well-established ancient technology. However, till date, classical research on in-depth knowledge and improvement in the technology is going on. Non-plastic ceramic powder has another criticality in processing through liquid phase as it is difficult to keep suspended in the system.

A case study in fabrication of non-plastic silicon metal powder shape through liquid phase green shaping followed by slip casting process is discussed. The objective of research is to fabricate large odd shapes of silicon for making silicon nitride products. Castability of a slip depends on (i) the vehicle, (ii) particle loading, (iii) particle size and distribution, (iv) moulding process, etc., on one side, while (a) yield stress, (b) pseudo-plasticity, (c) thixotropy, etc. on the other. potential of silicon in the system also plays an important role in retaining the powder in the liquid in suspended condition (preferably to be >30 mv for a silicon-water system depending on the particle size). Herschel-Buckley and other models for the system has been studied with different deflocculating agent to stabilize the suspension having a flow index 0.5-0.6 and yield stress <10 Pa. Thorough study on the system on viscosity - shear stress - shear rate has also been done varying the particle size, particle loading, deflocculating agent, etc.

Recent Developments on ZrB_2 Based UHTC Composite

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Abstract:

Structural ceramics based on transition metal-based non-oxides like nitrides, borides and carbides have very high melting point (>2500 °C), good mechanical properties like hardness, fracture toughness and thermal properties and hence, are recommended for applications as ultra high temperature ceramics (UHTC). In UHTC family, zirconium diboride has exclusive combination of high mechanical properties, thermal and electrical conductivity and lowest theoretical density (6.09 g/cc). Moreover, low cost among others makes it a promising material for aerospace and thermal power applications. Because of strong kinetic constraints like high covalent bonding, oxygen impurities on particle surface and low diffusion rate, both high temperature and external pressure are required for sintering of monolithic ZrB_2. Overcoming poor sinterability of ZrB_2, as also of other UHTCs, is a challenging area of research. The addition of sintering aids and secondary phases like SiC, $MoSi_2$, Y_2O_3, ZrC, $ZrSi_2$, B_4C, $TiSi_2$, AlN, TiB_2, Si_3N_4, etc., enhances densification and other related properties, like mechanical, oxidation resistance, thermal properties, etc.

ZrB_2-based ceramics with addition of different carbide and boride B_4C, SiC and TiB_2 were hot pressed at 2100-2200°C and plasma sintered in Ar atmosphere. The effect of the sintering process and second phase carbide and boride addition on microstructure and mechanical properties, like, hardness, fracture toughness, scratch resistance, wear resistance and thermal properties, like oxidation resistance, conductivity, CTE, etc. of the composites is thoroughly compared to find their potential applications.

Table: Physical and Thermal Properties of ZrB_2 composites.

Comp.	Cond.	Density g/cc	Hv (1kgf) GPa	K_{IC} (1kgf) $(MPa(m)^{1/2})$	COF (10N)	Wear rate (mm^3/Nm)	WRC	T. Cond. (RT-1000C) (W/m.K)
ZrB_2	HP2200	5.98	14.72 ±1.3	2.30±0.22	0.69	$1.97x10^{-3}$	0.03	40-90
ZrB_2-B_4C10	HP2100	5.37	20.81±1.6	3.93±0.22	0.40	$0.49\ x10^{-3}$	0.01	50-60
ZrB_2-SiC10	HP2200	5.46	19.08 ± 1.53	2.49 ± 0.25	0.69	$11.92x10^{-3}$	0.30	70-90
ZrB_2-$TiB_2$30	HP2200	5.56	22.34 ± 1.65	3.01 ± 0.19	0.39	2.43×10^{-3}	0.08	47-67

Hv= Vickers's Hardness, KIC =Fracture toughness, WRC: Wear resistance co-efficient

Iranian Invited Speakers

A New Generation of Metal-Oxide Varistors

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Abstract:

Zinc-oxide based varistors have been developed to form the core of commercial protective devices used in power transmission and electronic circuits in low, medium, or high voltage applications against unwanted transient signals or power surges. However, they suffer from certain drawbacks such as a complicated microstructure, large amounts of expensive additives, and degradation in their service lifetime. New classes of materials are therefore being investigated and developed to fulfill the requirements of varistor action. They comprise TiO_2, SnO_2, CeO_2, CCTO, and Tb_4O_7. Despite their nonlinear I-V behavior, they do not possess good surge-withstand capability and exhibit degradation. Among these materials, SnO_2 is proving to be a worthy replacement and research is focused on improving its surge withstand capability.

In this presentation, the optimization of both the formula and processing of SnO_2-based varistors to overcome the above-mentioned problems for high-voltage applications is reported. Moreover, a new generation of SnO_2-based varistors for low voltage applications is introduced for the first time. The high voltage varistors exhibited a single- phase microstructure with an average grain size of 2.5 µm having a nonlinear coefficient of 50, a breakdown field of 3kV/cm, a residual voltage ratio of 2.4, and a withstanding surge current density of 5kA/cm^2, measured according to IEC-61843-1-2005 Standard. These values compare quite favorably with those of ZnO varistors. On the other hand, the average grain size of the low- voltage SnO_2-based varistors was 42µm with a breakdown field of 0.3 kV/cm, a nonlinear coefficient of 20, a residual voltage ratio of 10, and a withstanding surge current density of 1kA/cm. In comparison with commercial low voltage ZnO varistors, the SnO_2 varistors enjoy a simpler microstructure, require less additives, do not degrade and have a better energy absorbing capability.

Recent Innovation and Development of Oxide-C Refractories in IRAN

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Abstract:

Modern high-tech refractory materials have evolved into composite forms capable to survive the most severe conditions for extended periods: at temperature often above 1500ºC, in corrosive oxidizing or reducing atmospheres and in contact with extreme fluid and/or penetrative liquids capable to dissolve most solids. Oxide-carbon refractory bricks (OCRBs) such as MgO-C (MC) and Al_2O_3-MgO-C (AMC) are one of the most important classes of smart refractories used in iron and steel industry because of their adaptability. Since the first production of OCRBs in Iranian refractory companies became commercially available in the 2001's, the processing, microstructure and properties of OCRBs have been improved and successively compete with similar products that import from famous foreign companies.

In this presentation, the latest R&D towards development of high quality MC refractory as well as smart AMC refractory bricks has been highlighted. In the first part, current techniques used to improve mechanical properties and corrosion resistance of MC bricks is summarized. New concepts include using nano-carbon particles, modified phenolic resin and development of spinel bonded MC refractory bricks are introduced. It was found that nano-carbon addition and using modified phenolic resin improve corrosion resistance up to 20%. As well as, in spite of common phenolic resin, the crystalline graphite structure formed in the modified resins at 1000˚C that have vital role to increase oxidation resistance and high temperature strength of MC bodies. Also the microstructural observation of corroded samples shown that the formation of in-situ spinel bonding effectively protect the graphite against oxidation, increase oxide phase corrosion resistance with formation of spinel layer on the surface of MgO grains and subsequently improve the wear resistance of MC refractories up to 30%. The second part addresses some important technical issues performed on the AMC refractory bricks that mainly used as molten metal area lining in the steelmaking ladle furnaces. The results of new innovation on processing (particle size distribution and mixing procedure) and spinel bond formation in the matrix with controlling MgO content and its grain size in the AMC

refractories are summarized. Finally, industrial experienced results of new developed AMC refractory bricks showed that average 20% life time improvement in compared to similar previous products.

The Design, Fabrication and Operation of a Ceramic Water Nano-Filtration Pilot-Plant

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Abstract:

This work is a short report of an industrial scale project performed for the Ministry of Power of the Islamic Republic of Iran concerning ceramic membranes. In this project, a pilot-scale ceramic water nano-filtration system has been constructed for the first time in the Islamic Republic of Iran. The different stages of the project are described:

1. Design (ceramic membrane, membrane module and hydrodynamic system)
2. Fabrication of the multi-layer ceramic membranes (including synthesis of the colloidal and polymeric titania sols)
3. Characterization of the membrane layers
4. Investigation of salt rejection properties of the fabricated membranes for the treatment of brackish water

The main point behind this work is that the produced ceramic nano-filtration membrane shows an outstanding nano-filtration characteristic for brackish water treatment with a near neutral pH. It will be shown that the performance of the produced membrane is substantially better than that of those reported in the open literature so far. In addition, the pressure drop of the system is outstandingly low for such a performance.

Study of Densification, Microstructure and Fracture Toughness of ZrB_2-Based Composited Hot Pressed with Various Reinforcements

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Abstract:

Zirconium diboride is striking for its ultrahigh melting temperature, hardness, elastic modulus, low electrical resistivity, and resistance to chemical attack. It has been proposed for a variety of industrial applications including armor, cutting tools, steel processing, molten metal containment, electrodes, and advanced reusable atmospheric reentry vehicles. Because of strong covalent bonding and low grain boundary self-diffusion coefficient, high temperatures and external pressures are required to densify ZrB_2 completely. Recently, many researchers around the world, are trying to enhance its densification as well as mechanical and thermal properties.

Achieving a fully dense monolithic ZrB_2 ceramic was impossible even at 2000 °C, because densification and grain growth happened synchronously, and finally more that 3% pores were remained in the hot pressed sample. Hence, the addition of SiC, the most common additive for ZrB_2-based composites, was necessary to improve the sinterability and densification. Achieving a fully dense composite was possible in the presence of SiC, by activating some densification mechanism such as particles fragmentation and rearrangement, plastic deformation and dominantly grain boundary and lattice diffusion. Then, we focused on obtaining full density at lower hot pressing temperatures. Driving force for sintering was increased using nano-sized SiC (200 nm) particles, as a fully dense composite was prepared at 1850 °C. In addition, addition of ultra-fine ZrO_2 (300 nm) had an effective role on density improvement of the composite, due to the reaction of ZrO_2 particles with SiC and formation of ZrC phase. The addition of carbon reinforcements with different morphologies (carbon fiber, carbon black, graphite and graphene) were resulted in obtaining fully dense ZrB_2–SiC composites at 1850 °C, through removal of oxide impurities (B_2O_3, ZrO_2 and SiO_2) from the surfaces of ZrB_2 and SiC particles.

Fracture toughness of ZrB_2-SiC-based composites have been investigated using the direct crack measurement method after Vickers indentation on polished surfaces.

Highest value of fracture toughness in the ZrB_2-SiC binary composites (5.3 MPa m½) belonged to the sample that had 25 vol% nano-SiC (200 nm), hot pressed at 1775 °C for 90 min under 8 MPa. In the ternary systems, ZrB_2 with 20 vol% SiC and 5 vol% CF, hot pressed at 1775 °C for 60 min under 16 MPa, had fracture toughness of ~6.5 MPa $m^{1/2}$. On the other hand, ZrB_2 with 20 vol% SiC and 5 vol% ZrO_2, consolidated at 1850 °C for 90 min under 12 MPa, reached a fracture toughness of ~6.7 MPa $m^{1/2}$. The fracture toughness of carbon-doped composites reached to ~7 MPa m½, which especially was improved by the incorporation of nano graphite. In conclusion, presence of SiC particles, especially nano-sized type, activates some toughening mechanisms such as crack deflection, crack branching, microcracking, crack bridging, and break of large SiC grains. More improvements in fracture toughness were attributed to the energy dissipation mechanisms of carbon bridging, carbon pullout or phase transformation toughening mechanism by ZrO_2.

Processing of Porous Si_3N_4 Bodies by Gel Casting

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Abstract:

Silicon Nitride is of interest due to its unique thermomechanical properties. Recently, the porous Silicon Nitride bodies have found especial application where the thermomechanical and electromagnetic properties can be tailored via processing. In the present study, the bodies with porosity of about 40% and bending strength of 150 MPa were prepared via gel casting. The effect of fining temperature, solid load and processing parameters were studied. XRD and SEM were employed to determine the phase and microstructural evolution. It was found that the type and amount of additive as well as thermal treatment regime could have a vital influence on the growth of β-Si_3N_4. This phase is playing a key role in controlling the strength bodies with 45 percent porosity and 155 Mpa strength demonstrated desirable tan loss and dielectric constant. The emphasis in this report will be on processing control such as primary mixing, drying, sintering and final heat treatment.

Production, Machining and Surface Modification of Gamma-Titanium Aluminide Intermetallic

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Abstract:

Titanium aluminide intermetallic compounds are a new class of advanced materials with unique thermal properties such as high specific strength, acceptable mechanical properties at high temperature and relatively good oxidation resistance. The research performed in past decade, indicated that titanium aluminides-, in particular γ-TiAl-, based alloys are potentially applicable in high temperature structural applications. However, in order to put this material in operation for wide applications, some challenges must be overcome. The most important challenges are their low toughness in room temperature, technical difficulties in production, relatively high cost and need to increase high temperature oxidation resistance. The technologies such as vacuum arc remelting (VAR) and vacuum induction melting (VIM) were used for titanium aluminides production. These technologies have some limits relating to the control of chemical composition and expensiveness of the final product.

The first attempt was to produce TiAl in an economic way.In new process, KRH, TiAl formed from TiO_2 as a raw material. The non-completed reaction of Al, Ca and TiO_2, resulted in the production of granulates of titanium aluminides of Ti_3Al and other Ti–Al phases as the metallic product and $Ca_{12}Al_{14}O_{33}$ as the non-metallic product. The presence of $KClO_4$ as an additive to the mentioned mixture causes a nearly completed reaction. The products of this reaction were titanium aluminide of TiAl as the metallic product and $CaAl_4O_7$ as the non-metallic slag part. Both metallic products and non-metallic slag are produced in a fused and separated form, resulted in monolithic phase of TiAl.

Due to the mechanical properties, machining of γ-TiAl alloy cannot be done by conventional processes. Electrical discharge machining (EDM) is one of the extensively used nonconventional material removal processes. It can be successfully employed to machine electrically conductive parts regardless of their hardness and toughness. Some main problems in EDM process are increase of surface roughness by increasing pulse current, low material removal rate, much instability in electrical discharge machining in some machining conditions, producing dull surfaces and resulting different kinds of surface and sub-surface defects in machined part. Mixing a

suitable material in powder form into dielectric fluid is one of the latest advancements for improving the capabilities of EDM process. This process is called powder mixed electrical discharge machining (PMEDM). In our study, powder mixed electrical discharge machining (PMEDM) of γ-TiAl intermetallic by means of different powders including aluminum, chrome, silicon carbide, graphite and iron were performed. The output characteristics of surface roughness, shape of electrical discharge pulses and electrochemical corrosion resistance of machined samples were investigated by means of EDS and XRD analyses. The results indicated that aluminum powder produced the best surface finish, followed by silicon carbide, graphite, chrome and iron, respectively. In the defined settings of input machining parameters, aluminum powder improved the surface roughness of TiAl sample about %32. With addition of powder particles, the sparking frequency was increased and multiple discharging paths were created leading to reduction of surface roughness and inequalities. The electrochemical corrosion studies showed that corrosion resistance of the samples which were machined by graphite and chrome powders were about three and two times, respectively more than the sample which was machined without powder.

To improve the oxidation resistance of TiAl alloy, aluminide coating via molten salt bath was applied to Ti-45Al intermetallic. The obtained 15 μm thick Al-rich duplex coating was mainly consisted of $TiAl_3$ with a small percentage of Ti_2Al_5. Some of the aluminized samples were preoxidized for 2 hours at 600ºC. Isothermal oxidation of aluminized, aluminized-preoxidized and bare TiAl at 800ºC in air for 25 hours demonstrated a reduction in the specific weight gain of the coated samples compared to the uncoated one. The results showed that aluminizing resulted in formation of two Al-rich layers of $TiAl_3$ and Ti_2Al_5 of about 15 μm thick, whereas $TiAl_3$ was dominant. High temperature oxidation resistance of Ti-45Al was successfully improved within 3 orders of magnitude by aluminizing.

Also a nickel aluminide coating was developed on γ-TiAl alloy by electroplating a Ni layer followed by an aluminizig process. After microstructural analysis it was found that a multi-layer coating was formed. The coating structure was included the outset layer of NiAl and the sequence of inner layers as: $TiAl_2$(Ni)/ $TiAl_3$/ $TiAl_2$/ Al-enriched TiAl.

Pack siliconizing as one of the effective and convenient methods in improving the oxidation resistance was applied on TiAl-based alloy. The process was conducted at 1050ºC for 5 hours. After microstructural analysis, an adherent coating was achieved. The coating consisted of two layer of an outer layer of Ti5Si3 and the inner layer of Al-enriched TiAl.

Investigation of Garnet Ceramics for Light Downconversion

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Abstract:

Downconversion is a photon doubling mechanism which offers a promising route to increase the efficiency of Silicon solar cells. Here we report on optical downconversion of ceramic garnet-based materials, which are known for their desirable efficiency and scalability properties. We show that under blue-light excitation, as the concentration of its dopants increases, the intensity of the visible emission decreases, while that of infrared emission increases. This indicates that downconversion does take place. Furthermore, we discover a novel synthesis method for the ceramic-based garnet that minimizes the defect formation rate and as a result improves the luminescence properties of the material.

Cooking Ceramics in Seconds

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Abstract:

Dense ceramic bodies are traditionally produced through firing of powder compacts at high temperatures, in a process that is energy intensive, and very time consuming (e.g. several hours), which is called Conventional sintering. In order to overcome these issues, often efforts are made to develop new technologies being capable of decreasing sintering temperatures/ shorten sintering cycle. As example, pressure assisted sintering, such as hot pressing, sinter forging, and hot isostatic pressing were since years developed. Electric field assisted sintering techniques; FAST, have been gaining attentions as new methods of consolidation. The use of electromagnetic radiation -as is in spark plasma sintering (SPS), microwave sintering , and recently developed Flash sintering- exploits various sintering mechanisms. The inherent benefit of these techniques is to reduce sintering temperatures, overall cycle time reduction (see Fig. 1) and reduced grain growth.

Flash sintering is different from SPS. The latter is an energy-intensive process that uses high pulsed DC currents to heat a graphite die, while simultaneously applying high pressure to the sample. The process can expend several tens of kilowatts of energy. In contrast, flash sintering applies electrical fields of a few hundred of volts per centimetre directly to the specimen in a conventional furnace, and no external pressure is needed; wherein the Flash sintering cycle, is in order of seconds. It is while the SPS cycle occurs usually in several minutes. In the present work, sintering behavior of several ceramics, such as Oxides (Alumina, 3Y-Zirconia, 8Y-Zriconia, Zirconia composites with CNTs and Graphen, Titania and Yttira), and non-oxides (SiC, Si_3N_4, HfC-TaC, and Ca-Sialon), consolidated with SPS and Flash sintering were compared with the conventional one. The responsible mechanisms were carefully investigated using sintering models and master sintering curves were developed. For instance, it is shown that local joule heating at grain boundaries increases the grain boundary diffusion in case of Flash sinering of zirconia.

Carbon Materials for Advanced Applications

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Abstract:

Carbon materials are versatile. A wide range of properties and hence the application has made this unique material very interesting for research and technology. So it is difficult for one to present even some aspect of this attractive material. In this review, the author would focus on the recent experiences of his own on carbon composites, EDLC fabrication, some aspects of nanotubes preparation by CCVD and the effect of the catalyst nature on yield and quality of NTs. In the first part a new kind of carbon composite based on cellulosic structure and siliconization of that would be discussed. In the second part some kinetics of densification of carbon composites via gas phase deposition and formation of textures for the resultant pyrocarbon would be presented. In the third part of the talk latest findings of the author on EDLC would be explained. The effect of addition of different types of nano-sized carbon on the development of the graphitic structure of a bulk carbon with HTT up to 2200 degree C would also be presented and in the last part of the talk the role of catalyst on the quality of the nanotubes prepared by CCVD would be emphasized.

The Effect of Additives and Atmosphere on Synthesis and Stability of Al_2TiO_5

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Abstract:

Aluminium titanate (tialite) shows several interesting properties, such as low thermal expansion coefficient, low thermal conductivity and high melting point (1860ºC), that suggest the use of this ceramic material in many different industrial applications. However, industrial applications of this material are hindered due to two major limitations. The first one concerns with its tendency to decompose to α-Al_2O_3 and TiO_2 at temperatures between 800 and 1280ºC. The second is due to its very low fractural strength. In Al_2TiO_5 structure, each Al^{3+} or Ti^{4+} cation is surrounded by six oxygen ions forming distorted oxygen octahedra. The instability of tialite phase has been attributed to the distortion of its crystal lattice caused by radius difference between Al3+ and Ti4+ and existence small aluminium ion in a higher dimension structural site. The decomposition of tialite is expected to be very sensitive to the aging (annealing) environment or atmosphere, crystallite size, cooling rate and temperature. Additives such as Al_2O_3, MgO, SiO_2, Fe_2O_3 and ZrO_2 are employed in the tialite precursor to suppress decomposition of the phases. In this paper the effect of tialite crystallite size, additives such as Fe_2O_3 and talc, cooling rate and atmosphere on the stability of tialite were discussed. In one study the formation and stability of Al_2TiO_5 in two air and reduction atmosphere were studied. In these conditions tialite formation at reduction atmosphere due to transformation of rutile to titanium suboxides such as Ti_3O_5 and Ti_2O_3 were decreased. In other research the effect of Fe_2O_3 addition on the tialite formation were investigated and results showed that addition of 2.5 wt.% Fe_2O_3 to a fine mixture of aluminium hydrate and rutile resulted in decreasing the tialite formation temperature from temperatures over 1280ºC down to 1150ºC. Also the effect of talc on reaction sintering, microstructural and physical properties of Al_2TiO_5 based ceramics were studied. The results showed that the presence of talc significantly reduces the unreacted alumina and rutile.

A Comparison of Dense and Porous Piezoelectric Ceramics (Composition, Microstructure and Properties)

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Abstract:

In this paper, synthesis and characterization of dense and porous PZT and PZT-PCN Piezoelectric Ceramics are presented. Dense and Porous Lead zirconate titanate–lead cobalt niobate, $0.8Pb(Zr_{1/2}Ti1_{/2})O_3$–$0.2Pb(Co_{1/3}Nb_{2/3})O_3$ (PZT-PCN) piezoelectric ceramics were fabricated and porosity was introduced by introducing pore-forming agent. To preserve the interconnection between grains while ensuring full sintering of the porous samples, the heating procedure is determined by the thermogravimetric analysis, TG, of pore forming agents (PFA). Reaching to optimum heating procedure is the most difficult step in sacrificial template technique.

The densities of the dense and porous ceramic were obtained by Archimedes' method and the total porosity was derived from the density. Phase analysis was done by using an X-ray diffraction. Differential scanning calorimetry (DSC) was employed to detect the phase transition temperature of the pore forming agents besides ceramic powders.

The shape and structures of grains and pores were analyzed by field emission scanning electron microscopy (FESEM) (TESCAN MIRA IRQST. Germany).

For measurement the dielectric constant ε_r and the piezoelectric coefficients, d_{33} and d_{31} the sintered samples were ground to remove surface layers, coated with silver paste, and poled by applying a dc field of 2–3 kV/mm for 10min in a silicone oil bath at 120°C. Samples were in the form of disc with silver electrodes on both sides and the dielectric constant ε_r was calculated.

While sintering temperature increased from 1050 to 1250°C, the bulk density and grain size of porous ceramics increased obviously and the value of ε_r and d_{33} of porous ceramics increased. It can be justified by the space charge theory. Therefore the hydrostatic figure of merit of porous PZT-PCN (d_h gh) ceramics with porosity 24% at maximum sintering temperature reached 5379×10^{-15} m^2/N approximately eleven times more than that of dense ceramic. The results agreed with the theoretical predictions.

Synthesis of Sialon by Geopolymer-Carbon (Si) and Ordered Mesoporous (Al-SBA-15)-Carbon Composites by Using CRN(SRN) Methods

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Abstract:

SiAlON ceramics are good candidates for engineering materials, because of their excellent physical and mechanical properties (high fracture toughness, good corrosion resistance, outstanding thermal shock resistance and high strength especially at high temperature. β-SiAlON is an important sialon phase in which some of the silicon in β–Si3N4 is replaced by Al and some of the of N by O, resulting in the general formula (Si6-zAlzOzN8-z where (0< Z<4.2). β-sialon powder can be synthesized by carbothermal or silicothermal reduction and nitridation (CRN 0r SRN) from kaolinite, SiO_2-Al_2O_3.$2H_2O$, SiO_2-Al_2O_3, SiO_2-Al_2O_3-gel and montmorillonite-polymer intercalation compounds. All these process are carried out with the addition of carbon or silicon powder or the carbon that results from decomposition of the polymer in flowing nitrogen at >1350ºC. Since precise control of the Si/Al ratio in the raw materials is difficult, it is difficult to control the z-values of the products; synthesis of high-purity β-SiAlON powder with nominated z-values will therefore require new methods and materials such as aluminosilicate mesoporous (Al-SBA-15) by CRN method .In this regard because of geopolymers can be prepared in a wide range of compositions by both conventional and newly developed methods, aluminosilicate inorganic polymers provide interesting new possibilities as precursors for CRN and SRN synthesis of a range of SIALONs powders and also engineering ceramic bodies.
In the present work effective parameters to synthesize of sialon phase from different precursor (geopolymer and mesoporous aluminosilicate) have been investigated.

Role of Double Layer Characteristics on Deposition Pattern of Ceramic Nanoparticles Under AC Applied Electric Fields

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Abstract:

AC electrophoretic deposition is a new developed method for fabricating electronic devices which is based on using of non-DC electric fields and deposition of ceramic dispersed nanoparticles in liquid media at low frequencies. In the present work, effect of Electric Double Layer (EDL) characteristics on chain formation in the space between the electrodes is investigated using Discrete Element Method (DEM). In DEM, second law of Newton is solved numerically by considering all affecting forces including Brownian, electrostatic, van der Waals, contact and dielectrophoretic force.
Our investigations show that other factors such as impurities or additives could change deposition pattern. Role of washing the initial powder to alter the level of impurities by adding the polymeric additives on the electric double layer conductivity is considered. Based on the results obtained, by some modifications on the surface of nanoparticles, chain formation process can be promoted or varied in a gap between two adjacent in-plane electrodes. Our tests were performed at frequency of 10 KHz and it has been observed that for some oxide powders like WO_3 chain forms while for the others such as TiO_2 did not. Addition of small amounts of impurities causes particles to form chain in the gap between two conductive electrodes. Surface conductance of particle altered when electric double layer around particle is changed and to test this, effect of polyethylenimine (PEI) as an additive on chain formation of TiO_2 nanoparticle was tested. Compatibility observed that chain formation is promoted when PEI is added and in the other hand simulation results show that changing force conductance of particles promote or prevent chain formation in liquid medium.

The Role of Ceramic Materials in Water Purification

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Abstract:

The presence of heavy metals in waste water and beverage water streams has become a problem due to its harmful effects on human health. It is known that legal standards on environment control are becoming strict and, as a result, the discharge of heavy metals into aquatic bodies and sources of potable water is being rigorously controlled. Various methods have been used for removal of heavy metal ions such as chromium, nickel, zinc, bismuth, arsenic, cadmium and lead. Adsorption method and various low cost adsorbents such as corals, natural hydroxyareapatite, reagent grade tricalcium phosphate and red mud used for heavy metals removal.

The aim of the present key speaking is to qualify and quantify the laboratory experiences some heavy metal ions with above mentioned ceramic adsorbent materials. The effect of parameters such as initial concentration ions, adsorbent mass, reaction temperature, crystalline size of adsorbent and pH has been consider for their effective roles. Various thermodynamic parameters, such as $\Delta G°$, $\Delta H°$ and $\Delta S°$ have been calculated for each above mentioned absorbent materials and heavy metals. The thermodynamics of all heavy metal ions onto adsorbent system indicates spontaneous and endothermic nature of the process. The adsorption equilibrium data were plotted by Langmuir, Freundlich and DKR models for all absorbent and heavy metals.

Synthesis of ZnO Nano Powder and Manufacturing of Zinc Oxide Varistor

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Abstract:

ZnO varistors are ceramic parts, which are able to protect electrical or electronic circuits against extra voltages. The microstructure of these varistors contains of zinc oxide semi conductor grains which separate by insulation grain boundaries with different composition.

In order to achieve a real voltage in power line, these varistors are put on top of each other, then a ceramic or polymeric casing is prepared and this casing is put in front of the transformers to prevent any extra voltage in lines.

The resistant and fracture voltage of these varistors intensively depend on microstructure and so, grain size, and microstructure homogeneity are the most important parameters in varistor manufacturing. One approach to achieve these goals is to use homogeneous zinc oxide nano powder for varistor production because it improves the electrical and electronic characteristic.

Therefore, in a research work first, a ZnO nano powder plus different additives of Bi_2O_3, MnO, Cr_2O_3, NiO … was synthesized by sol-gel combustion method. Then, the ZnO varistor was manufactured by milling the nano powder, pressing, and sintering. Based on IEC 60099-4 standard, different tests were carried out on nano ZnO varistors successfully and 30% excess in nonlinear coefficient and 35% excess in fracture voltage was calculated in comparison with conventional ZnO varistors. Finally, 3 arresters are manufactured and installed in a distribution system near Tehran.

The reason of using nanotechnology was to manufacture zinc oxide varistors with improved electrical properties and reduced energy consumption. The manufactured varistors have shown 30% increase in electrical properties compared to traditional ones.

The technical properties of zinc oxide varistor pellet manufactured by nano technology were:

Varistor Pellet hieght: 20 mm

Varistor Pellet diameter: 41 mm

Rated Voltage: 3 kV

And the advantages of zinc oxide varistor pellet manufactured by nano technology were:
Reduction of pellet column in casing
Increase in non-linear ratio from 45 to 62
Leakage current (in order of mA)
Rapid response time (20 ns)
Reduction of energy consumption in manufacturing process

A Review on Nano Ceramic Membranes for Water Applications

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Abstract:

Ceramic membranes are being increasingly used in different technologies as they are very stable chemically, thermally and mechanically, and also are frequently bio inert. As ceramic materials are also ideal materials for many applications in the chemical and pharmaceutical industry particularly in water and wastewater processing. Our research team has worked multiple works on alumina titania and their composite nanostructured membranes for application in water purification. Also multifunctional properties of the membranes were investigated. In the present study a macroporous substrate was synthesized from α-Al_2O_3, then a colloidal alumina, titania and composite sols were used for the preparation of the intermediate layer. Also in some cases the membrane top layer was synthesized by deposition and calcination of titania polymeric sol on the intermediate layer. The characterization for different samples was performed by DLS, TG-DTA, XRD, BET, FESEM, TEM, and AFM techniques. Also, the filtration experiments were carried out based on separation of methyl orange fromaqueous solution by a membrane setup with a dead-end filtration cell. On the other hand photocatalytic properties of nano titania coated membranes were evaluated by methyl orange photodegradation using UV-visible spectrophotometer. Due to the types of the membranes the mean pore size, porous microstructure, physical separation, photocatalytic properties and multifunctional capability of the membrane samples were studied and compared together for water purification applications.

Recent Development of Carbon Based Materials in Iran

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Abstract:

Carbon based materials Have different properties which make them attractive for different application in Iran. Although carbon based material were used from 50 years ago in Iranian industries but only sooty carbon and carbon anodes were fabricated in Iranian factories at that era and other type of graphite brushes and electrodes were imported by two companies and only machining and impregnation of them were done in Iran. From 25 years ago many attempts were done for fabrication of activated carbon, graphite bodies, carbon fibers and carbon- carbon composites. Two dimensional carbon-carbon composites was fabricated in Iran university of science and technology labs and studied well at 1990's,Carbon fiber factory was established in Iran at 2011 and also high strength cheap carbon fiber from commercial Iranian PAN fiber was fabricated successfully in labs by modified heat treatment and its properties were improved by different surface treatments. Research for fabrication of carbon nanotubes by CVD, PACVD and EEW was introduced more than a decade in Iran and carbon nanotube pilot plant is active in Iran now. Recently many studies have been done for fabrication of graphene, carbon nanotube reinforced ceramics and C-SiC composites. Structural studies of carbon based materials have been improved in recent years also.

3D printing of Ceramic Scaffolds for Bone Tissue Engineering Applications

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Abstract:

Scaffolds are three dimensional biocompatible structures which resemble natural extracellular matrix and stimulate bone formation in the living tissue. Pore size, pore volume and mechanical strength are among critical parameters which dictate the performance of a scaffold. Three-dimensional printing (3DP) shows a great potential for production of porous ceramics with complex internal and external structures for bone tissue engineering applications. In 3D printing the complex shape of the scaffold is fabricated layer-by-layer directly from a computer aided design file. The most significant advantage of 3DP is its unique potential for making precise and similar-to-design products.

The major printing parameters studied in this work were layer thickness, delay time of spreading the next layer, and build orientation of the specimens. Scaffold dimensional accuracy, porosity, and mechanical stiffness were systematically explored using a design of experiment approach. Signal-to-noise ratio and analysis of variance (ANOVA) were employed to identify the important factors that influence optimal 3D printed part characteristics. Resulting macro-porous structures were also studied to evaluate the potential of 3DP technology for meeting the small-scale geometric requirements of bone scaffolds. The results showed that samples built using the minimum layer thickness (89 µm) and x-direction of build bed with 300 ms delay time between spreading each layer produced the highest quality scaffold prototypes. Furthermore, this study identified orientation and new layer spreading delay time as the most important factors influencing the dimensional accuracy, compressive strength, and porosity of the 3D Printed scaffold prototypes.

Fabrication of Scandia Thermionic Cathodes in Iran

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Abstract:

Electron emission resulting from the heating of a surface is referred to as thermionic emission.

At temperatures above absolute zero, some electrons have sufficient energy to escape from a cathode surface. As temperature is increased, the number of electrons with sufficient energy to escape increases. In addition to temperature, the nature of the surface of the cathode has an extremely strong effect on the rate at which electrons are emitted. Thorium oxide in a concentration of about 2% is added to tungsten in the process of making the tungsten wire for the cathode. By processing, thorium is brought to the surface of the tungsten. The work function of thorium is well below that of tungsten, so the emission is about 1,000 times higher than for tungsten.

At present, the most commonly used cathodes in the microwave tube industry are impregnated dispenser cathodes. These are fabricated from small grains of tungsten that have been pressed together under high pressure and sintered at a temperature of over 2,000°C for 1 to 2 hours to form porous billets. The volume percent of pores are between12 to 50. From 1950 to 1955, the evolution of the impregnated dispenser cathode occurred with a cathode named A type. The Philips B-type cathode developed in 1955 by Levi is still in use by the microwave tube industry.

The B-type cathode is rugged and relatively impervious to damage and can readily provide emission densities of several A/cm2. At these high densities, the operating temperature must be 1,100°C or higher because of the relatively high work functions of these cathodes. As a result, life is limited to a few thousand hours.

The search for a cathode capable of an emission density comparable to the B-type cathode, but with a lower operating temperature and longer life, led to the development of the M-type cathode in the 1960s. In its simplest form, the M-type is a B-type with a film several thousand Angstroms thick of osmium, iridium, or rhenium applied to the surface. Compared to a B cathode, the effect of the film is to reduce the work function ~ 0.2 eV and the cathode operating temperature ~ 90°C (dependent on film metal).

A problem early in the development of M cathodes was degradation of the enhancing film. At normal operating temperatures, the tungsten substrate and coating metal

would interdiffuse, and an alloy surface was formed with a composition that changed with time. The lowest work function occurs when the alloy is about 50/50 tungsten and coating metal. Thus, during the life of one a cathode, emission would actually increase at first, then degrade, and then eventually revert to that of a B cathode as the surface became tungsten.

Scandate cathodes were developed in 1967. For several years, there has been considerable interest in scandate cathodes. These cathodes have a very low work function (~1.5 eV) and are capable of emission densities on the order of 100 A/cm2 for thousands of hours. These cathodes have better thermal and moisture stability with respect to the other cathodes.

In this talk, the scientific fundamentals of scandia thermionic cathodes along with their applications, fabrication and their future direction in Iran compared to the world will be presented.

Novel Synthesis & Processing of Ceramic Materials

Investigation of the Effect of Li ion on the Synthesis of Aluminum Nitride in the Air in a Coke-Calcium Reduction Bed

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Abstract:

In this study the effect of lithium hydroxide (LiOH) as Li salt on the synthesis of Aluminum nitride (AlN) by nitridating of Aluminum metal powder in the air and coke-calcium reduction bed, was investigated. In order to identify the optimum amount of LiOH salt, firstly Al powder with average particle size 10µm with various amounts of LiOH salt are mixed and heated at 800ºC for 9 hr in the coke-calcium reduction bed and closed crucible. To study the effect of Li^+ on the nitridation temperature of Al powder, three sample of Al powder without Li salt were heated at 800ºC- 1000ºC temperature range for 9 hr and compared with the synthesis samples containing Li salt. The X-Ray Diffraction patterns of samples show that the optimum amount of LiOH for 1gr of Al powder is 0.17gr (equal to 5% (mass%) of Li^+ ion) and this is determined that nitridation in the sample without Li salt occur in the upper temperatures (200ºC- 3000ºC).

Keywords:

Aluminum nitride, LiOH salt, Li ion, Reduction bed

Investigation of Factors Affecting on Properties and Microstructure of Clay Membrane Prepared by Gel Casting

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Abstract:

Gel casting is one of newest method to fabricate complex bodies. Some advantageous of this method are simplicity and easy to fabricate. In this study gel casting is used to produce clay membrane which is applicable in separation and infiltration. Ball clay of Abade SPV1 (calcined at 700ºC) with acrylamide and Methylenebisacrylamide, APS starter and thermal accelerator was used to gelcasting, and then cured at 1000ºC. The compression strength, dry shrinkage percentage and density were investigated. Afterward permeability, percentage of open and closed pores and bulk, apparent and powder density of optimized samples were measured and by XRD and SEM, phase and microstructure were investigated. Finally calcium absorption was measured. The total shrinkage 15%, strength of 97.8 MPa and bulk, powder and apparent density were 1.5, 2.34 and 2.26 g/cm^3 respectively. The open and closed pores were also 33 and 4% respectively.

Keywords:

Clay, membrane, gel casting, acrylamide, Methylenebisacrylamide

Introduce a Modern Printing Technique: Orange Emitted ink Based on ZnS:Mn Fluorescent Ceramic Pigment

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Abstract:

Laser printer is one of the most modern printing technologies and it has been welcomed by users. Toner is a powder mainly composed of polymer and colorant that are used as ink in electrophotographic digital printing. Several methods have been employed for producing toner and one of their newest is emulsion aggregation method. The purpose of this study is using a synthesized ZnS:Mn pigment in the preparation of fluorescent laser printer toner. ZnS:Mn had up to 10 nm spherical particles which was excited under 360 nm UV lamp and emitted at 590 nm. Toner characteristics were analyzed using a photoluminescence spectrophotometer, particle size analyzer, scanning electron microscopy, and differential scanning calorimetry. Fluorescent toners show appropriate characteristics compared to toners of original equipment manufacturer. Photoluminescence spectra of the toner under the exposure of 360 nm UV light illustrate in the figure.

Keywords:

Photo luminescent toner, ZnS:Mn fluorescent pigment, Printing ink, Laser jet printer

In Situ Crystallyzation of $ZnAl_2O_4$ and $ZnAl_2O_4$/ZnO Nanoparticles on Alumina Granules via Microwave Assisted Combustion Synthesis Route for Photocatalytic Wastewater Treatment

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Abstract:

Synthesis of $ZnAl_2O_4$ and $ZnAl_2O_4$/ZnO nanostructure powders and in situ crystallization of $ZnAl_2O_4$ and $ZnAl_2O_4$/ZnO coating layers on sintered alumina granules by microwave assisted combustion method was investigated. The effect of different parameters, such as primary alumina granule mean size, precursor concentration, pH, calcinations temperature on structure, microstructure, and photocatalytic activity of samples was studied. Structure and microstructure analyses of samples were performed using scanning electron microscopy and x-ray diffraction techniques. The photocatalytic activities of the samples were evaluated by degradation of methyl-orange solution as model under UV light source in a prototype photocatalytic agitated reactor. Results showed that photocatalytic activity was be influenced considerable variation of primary alumina granule size, pH and calcinations temperature.

Keywords:

alumina granules, coating, photocatalytic activity, microwave synthesis, $ZnAl_2O_4$, $ZnAl_2O_4$/ZnO

A Novel Method for Fabrication of Alumina Porous Supports with Aligned Oriented Pores

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Abstract:

In this study, fabrication of porous alumina supports with specific orientation and anisotropic properties are considered. Samples with double shape architecture, oriented and rounded pores, were prepared; using the alumina and silica as starting materials by slip casting route. Milled polyurethane foam and fibers were applied as replica materials as well. The effect of fiber type and size on the microstructure and size of the pores was studied. Moreover, different parameters such as porosity, density, orientation, bending strength and compressive strength of the samples were investigated. Results showed that various fibers with different diameters led to forming pores with different pore sizes, microstructure and consequently, changes in physical and mechanical properties such as density, porosity, compressive and bending strength. In addition, the simultaneous presence of fibers and particles led to more porous samples. The porous structure of the samples was investigated by scanning electron microscopy (SEM). Oriented tiny micro-tube and rounded pores were observed in all porous ceramic supports. Mechanical testing showed anisotropy in mechanical behaviors such that higher strengths were observed in oriented pore direction than transverse direction.

Keywords:

Alumina, Porosity, Oriented pores, Rounded pores, Slip casting

Influence of Fuels on Solution Comustion Synthesis of Mullite- Cordierite Composite

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Abstract:

In this Study, solution combustion synthesis of mullite-cordierite composite was investigated. The process is based on the mixing of reactants that oxides easily, such as nitrates and an organic fuel, acting as a reducing agent. In this study, Magnesium Nitrate, aluminum Nitare, and colloidal silica (30wt% solid) were used as raw material for synthesis of composite and Glycin used as a fuel. Effect of Fuel- oxidant ratio was studied. All of synthesis products were amorphous with submicron particle size and changing this ratio could not synthesis this composite without thermal treatment. It should be mentioned that smallest paticle size was obtained when this ratio was less than 1 (rich of fuel). In continue, themal treatment of the syntheies products were carried out at 1200 and 1400ºC in microwave oven. Mullite, cordierite and spinel were characterized after thermal treatment. Only at stochimertic ratio of fuel to oxidizer, mullite and cordierit were detected without spinel. Because of suitable particle size distribution and less agglomoration of this sample, maximum density 2.62 g/cm^3 was obtained.

Keywords:

Mullite, cordierite, composites, solution combustion synthesis

Fabrication of in Situ Sialon Based Ceramics by Silicothermal Reduction and Nitridation of Andalusite on the Basis of Silicon and Nitrogen Reaction Kinetics

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Abstract:

Sialon ceramic have been attracting much attention because of their good corrosion and oxidation resistance, thermal stability, high strength and toughness comparison with other ceramics, so they have many industrial and engineering applications. In this research, in situ fabrication of sialons by silicothermal reduction of andalusite as aluminosilicate sourceunder the nitrogen atmosphere and two different sintering and nitridation schedule until 1550˚C was investigated. Hence, in this investigation, heat treatment temperature and time for in situ synthesis was optimized by direct nitridation of silicon and andalusite compacts. Accordingly, three different temperatures (1300, 1350 and 1400˚C) and four time (0, 60, 120 and 240 min) was utilized as prenitridation schedule. Degree of nitridation wascalculated by weight gain of the compact and peak intensity in XRD analysis. Complete nitridation (100% nitridation) and full synthesis of sialon phases were not achieved by direct nitridation up to 1550˚C and results of the investigation illustrated that the best schedule for in situ synthesis was prenitridation at 1400˚C and 120 min to in situ silicon nitride synthesis and then sintering and nitridation at 1550˚C and 3 hour to sialon phases synthesis.

Keywords:

Sialon, Andalusite, Silicothermal reduction, Silicon Nitride, XRD

Fabrication of Ordered Porous PZT

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Abstract:

Piezoelectric composites with '3-3' connectivity have been developed for several applications such as acoustic transducers, sonar and medical imaging. The first step is the fabrication of porous piezoceramic with 3-D network connectivity. In this study, porous piezoceramic, lead zirconate titanate, with geometrically ordered porosities was fabricated. The traditional method of the fabrication of piezoceramics with burned-out plastic sphere (BURPS processing) was utilized. In order to produce geometrically ordered porosities, the prefabricated regular spheres were arranged in a mold and PZT paste was injected into the polymeric scaffold. The most crucial step in these techniques is the removal of polymeric materials (pyrolysis); therefore thermal treatment must be carried out at sufficiently slow rate to 420ºC based on thermal analysis (DTA) of polystyrene. Eventually all specimens were sintered at 1250ºC. The OM and SEM micrographs of porous piezoceramics showed the presence of a porous structure suitable for polymer injection to promote 3-3 connectivity of both ceramics and polymer, the porous ceramic specimens were then injected by vinyl ester resin while the whole system was in a partial vacuum chamber. Porosities and densities of samples were also studied.

Keywords:

Ordered pores, Porous ceramic, piezoceramic, PZT

Synthesis of Leucite Phase from Feldspar

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Abstract:

Leucite particles were synthesized by solid state reaction method. Different compositions of potassium nitrate and potash-feldspar materials with a weight percent of ranging from 10 to 30 of potassium nitrate in potash-feldspar were prepared. The prepared materials were heated up to 1450ºC for 3 hours until fusion phenomena occurred and then cooled down to room temperature. Calcium fluoride was used to remove kalsilite phase and it also reduced the crystallization temperature. The cooled materials were placed in DTA device in order to determine the crystallization temperature. The differential thermal analysis (DTA) device showed a wide exothermic peak at a temperature between 1000ºC to 1200ºC. Finally X-ray diffractometer (XRD) was employed to reveal the phase formation.

Keywords:

Leucite, potash-feldspar, potassium nitrate, CTE

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Evaluation of Ceramic Bodies' Plasticity Based on Dried Bending Strength as a Function of Die-Pressing Pressure

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Abstract:

Plasticity as an important property in clay-water systems is identified as a permanent deformation with no rupture of the material under a consistent, defined, and external force greater than its critical tolerance, which remains in force even after removal or lessening the applied force. In spite of the introduction of various methods to measure the plasticity and determine the optimum water content in a clayey ceramic body, there is not a general procedure for all the ceramic bodies containing low or high plasticity materials. In this paper, physical properties of ceramic bodies consist of two raw materials, high plasticity Soravejin Bentonite (B-S) and low plasticity Zenouz clayey quartz (Z-Q) in a weight ratio of 100:0, 67:33, 33:67, and 0:100 were investigated. According to the dried strength data as a function of die-pressing pressure, an index named as "plasticity exponent" was defined in order to compare the plasticity of ceramic bodies. This new method, which can simulate actual conditions of processing and production in the wall/floor tile and pressed-ceramic factories, is an easy test route, and obtains the authentic results.

Keywords:

Plasticity, die-pressing pressure, dried bending strength, plasticity exponent

The Effect of Mechanical Treatment on Iranian Bentonite

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Abstract:

In this research, were evaluated the influence of mechanical activation on the structural characteristics of bentonite sample of Iran, in order to optimize the surface properties for various applications. The bentonite powder were analyzed by techniques X-ray powder (XRD), XRF and ICP-AES. XRD analysis of raw sample showed the montmorillonite main phase associated with quartz, cristobalite , feldespar and calcite. Then, the sample were milled with steel balls and ball to powder mass ratio of 20:1 in planetary mill at defferent times. Structural changes caused by activation were studied with analysis techniques XRD, FTIR and SEM. The result showed fine particle of all phases, changes in water adsorption and less of feldspar in all samples and also have showed destruction of the montmorillonite structure , agglomeration of particles and the appearance of new peaks with increase mill time. Finally, 30 minutes and 1 hour samples milled for maximum surface area and less structure destruction of montmorillonite were selected as the best of samples.version yield is 7.1-7.9% in simulated solar light and 12% in diffuse daylight. The l

Keywords:

Mechanical treatment, bentonite, montmorillonite

Investigating the Various Parameters on Synthesis of Alumina-Titanium Diborid Composite Powders by Combustion Synthesis

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Abstract:

In this study, TiB_2-Al_2O_3 composite powders were produced by self-propagating high-temperature synthesis (SHS) method with reductive process from H_3BO_3-TiO_2-Al system. Aluminum and magnesium were used as reductive elements to provide sufficient heat as primary driving force to obtain TiB_2-Al_2O_3 composite. Due to the lower energy release in using aluminum as the initiator of the SHS process, finer microstructure can be achieved. Different stoichiometric amounts of aluminum as precursor were added to the mixture to examine its effect on the reaction progress. To evaluate the complete chemical conversion of the reactants, X-ray diffraction (XRD) and field emission scanning electron microscopy (FESEM) analyses were carried out. The highest conversion ratio was obtained from the sample containing 1.2 stoichiometric amount of aluminum. In ordre to achieve nano scale particles, milling in an inert atmosphere for 2 and 8 hours was performed on the mixture of precursors. The finest particles were obtained from samples milled for 2 hours

Keywords:

self-propagating high-temperature synthesis (SHS), TiB_2-Al_2O_3

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Diffusion Bonded Alumina Bodies Using Al-SR Hydride Nanopowders Interlayers and Structural Investigation of Joint Interface

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Abstract:

In this paper, diffusion bonding of dense alumina bodies using hydride nanopowders mixture as the interlayer was investigated. Mixture of aluminum hydride and Sr alanate was synthesized via mechano chemical activation process. Aluminum and Sr chloride and lithium alanate were used as precursors. Products of milling process were consisted of nano sized alane and Sr hydrides and alanates. Alumina bodies were diffusion boned at 300, 350, 400, and 450ºC, under pressure of 20 Mpa for 30 min dwelling time using custom designed induction hot press. Dissociation of hydride mixture interlayer during diffusion bonding process produced in-situ nanosized alloyed aluminum and Al-Sr intermetallic without any surface oxides. Combination of stoichiometric and non-stoichiometric spinel, oxide, and free metal structures were formed during bonding process. The highest bond strength was about 200 Mpa via formation of Sr-Al spinel oxide during bonding at 450ºC.

Keywords:

Diffusion bonding, Hydride, Intelayer, Alumina, Strength

Influence of different Oxide on Synthesis of Si_2N_2O by Spark Plasma Sintering

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Abstract:

Silicon oxynitride (Si_2N_2O) is the unique compound in the SiO_2–Si_3N_4 system. Si_2N_2O ceramics have natural appropriate properties such as wide band gap, proper dielectric constant and low dielectric loss tangent. These properties introduce an appropriate transparent electromagnetic ceramic. Because of low diffusion coefficient and requiring high sintering temperature, there have been difficulties in synthesizing of full dense Si_2N_2O. In this study, Si_2N_2O was synthesized by spark plasma sintering technique with equal molar ratio of sol-gel produced SiO_2 and Si_3N_4 with Y_2O_3 and MgO as additives. XRD results represent that for the sample containing 2wt% MgO, pure Si_2N_2O Phase can be obtained after sintering at 1750 ºC for 40 minutes. SEM and Archimedes' densitometry test results showed that the density of mentioned sample was near theoretical density.

Keywords:

Silicon oxynitride, sol-gel, spark plasma sintering

New Approach to Prepare Nano/Mono Size Boron Carbide Powder via Magnesiothermic Route

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Abstract:

Boron oxide compound/Mesoporous carbon (CMK-8) composites were reacted in the magnesiothermic reduction in order to synthesize nano-sized crystalline boron carbide with narrow particle size distribution in a relatively low temperature and inexpensive process. Although synthesis of such product have been studied by numerous researchers, but necessity of high temperature parallel with controlled atmosphere of synthesis and expensive raw materials are still a big obstacle. Magnesiothermic reduction of boric acid is a low temperature synthesis method for preparing fine boron carbide powder. In this study effect of two carbon sources including carbon black and mesoporous carbon (CMK-8) on boron carbide synthesis via magnesiothermic reduction have been evaluated. X-ray diffraction (XRD) results proved presence of crystalline boron carbide in the peak position of B4C ($B_{12}C3$). Using CMK-8 to prepare boron carbide (B_4C(MC)) at 750°C is found to increase surface area of boron carbide up to 160%. Scanning electron microscopy (SEM) reveals size and shape uniformity of B_4C(MC) particles from 40 to 80nm in comparison with B_4C(CB) which contains nano sized to several micrometer particles. Growth restriction due to volume limitation in the CMK-8's porosities as synthesis' nano-reactors, as well as ending the boron compounds around the growing grains in local positions are the probable mechanisms for grain growth confinement. High resolution transmission electron microscopy (HR-TEM) images validate formation of well crystalline 40nm B_4C(MC) particles in a smooth bed of CMK-8.

Keywords:

Magnesiothermic route, composites, CMK-8

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Influence of Mechanochemical Treatment on the Pozzolanic Activity of Kaolin

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Abstract:

Use of metakaolin in mortar and concrete as a cementitious supplementary material has found interesting applications during the recent years. This interest is in part due to the technical advantages and related to environmental and energy issues particularly in CO_2 gas emission challenge in another part. This paper reports on mechanochemical activation by intensive grinding as an alternative way to produce pozzolanically reactive metakaolin. The samples were analyzed using PSD, BET, TG, XRD, SEM and FTIR techniques. The physicochemical properties, pozzolanic reactivity and impact on blended cements of two mechanochemically activated kaolins were investigated. Mechanochemical activation of kaolin led to an amorphous hydrous material with increased specific surface area and high water content. By using 10% mechanochemically activated kaolins instead of portland cement, pozzolanic reaction enhanced and the amound of portlandite in the blended cements paste strongly reduced compared to reference portland cement.

Keywords:

Pozzolan, Kaolin, Mechanochemical activation, Blended cement

Synthesis amd Microstructure of TiCu Intermetallic Compound by High Energy Mechanical Alloying

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Abstract:

In this research, nanostructured TiCu intermetallic compound was synthesized by high energy mechanical alloying technique. Morphological microstructural evolution were studied by x-ray diffraction and scanning electron microscope, and hardness of the powder was measurd by Vickers microhardness test. With increasing meechanical alloying time, the metals powders were experienced plastic deformation, cold welding and fracture and homogenious powder with equiaxed morphology were achived. The results showed the synthesis of nanostructured TiCu intermetallic compound with average grain size less than 8 nm with high lattic microstrain and high hardness of 634 Hv by 30h mechanical alloying.

Keywords:

TiCu, Intermetallic compound, Synthesis, High enegy mechanical alloying

The Effects of NH_4F Addition in AlN Whiskers Synthesis by Direct Nitridation

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Abstract:

In this study, AlN whiskers were prepared in a tube furnace at 1000 °C for 1 h under 500 cc/min nitrogen gas flow. Al powders and NH_4F were used as raw materials. SEM, TEM and XRD analyses were applied to characterize AlN whiskers. The diameters of AlN whiskers were from 50 nm to 140 nm by using different ratio of NH_4F and Al powder. In the case of using NH4F more than 60 wt.%, pure AlN without any unreacted Al was formed as final product. By adding NH_4F to Al, thermodynamically spontaneous nitridation-fluoridation reactions in vapor phase were increased and whiskers and pure AlN powder were produced that the formation of whiskers were related to vapor-liquid-solid (VLS) mechanism and vapor-solid (VS) mechanism.

Keywords:

Whiskers, AlN, NH_4F, direct nitridation, nitridation-fluoridation

Comparison of Nano and Micro Alumina in Mullite Bonded Silicon Carbide Ceramics Formed by Pressure Casting Method

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Abstract:

Pressure casting can be used to produce parts with complex shapes. Rheology of silicon carbide slips with different particle sizes is discussed as well as the effect of slip temperature, its solid content and the particle size of alumina as additive and slips with up to 30 vol% solid content were prepared. Results show that the particle size of silicon carbide has a great influence on rheology of slip. Besides, nano alumina as additive increase the strength of product slightly while no difference in phases can be detected by XRD. The strength of samples sintered at 1680ºC reaches up to 130 MPa but the densities are still low.

Keywords:

Pressure casting, silicon carbide, alumina

Carbon & Ceramic Matrix Composites

Effect of Multi-Walled Carbon Nanotube Reinforcements On the Compressive Strength and Microstructural of Cementitious Nanocomposites

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Abstract:

This paper investigates the behavior of reinforced Cementitious composite round bars with multi walled carbon nanotubes (MWCNTs). To study the effects of multiwall carbon nanotubes on the Compressive strength and Microstructural of Metakaolinite-based geopolymer, MCNTs were added to cement paste in concentrations of (0-0/5) % by weight of cement. The geopolymer was made by condensing a mixture of Metakaolin and alkali solution at a fixed ratio at room temperature. The surface-treated multiwall carbon nanotubes were functionalized in a solution of nitric acid (%65) (HNO_3). The multiwall carbon nanotubes were dispersed by using an ultrasonic mixer and Sodium dodecyl benzene sulfonate) SDBS) as a surfactant, then add into cements and then cast mold. Compressive strength of cement pastes after 7-28 days curing at ambient temperature were measured. The microstructure was analyzed by using a scanning electron microscope. Compressive strength tests on the samples showed that the sample made with 0/3 Wt% MCNTs has highest average compressive strength of 485/8 Map after 28 days of curing. From the study, it is shown that in Cementitious nanocomposites, MCNTs can act as effective bridges to minimize and limit the propagation of micro-cracks through the matrix, under the conditions of well dispersion of the MCNTs within the matrix and good bonding between the MCNTs and the surrounding hydrated cement matrix.

Keywords:

Geopolymer, Metakaolin, multiwall carbon nanotubes, Compressive strength, surfactant

Investigation of the Compressive Strength of the Aluminosilicate Geopolymer Composite Reinforced with Saw Dust

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Abstract:

Geopolymers are new class of engineering materials that take into consideration,are used in various fields. In this study, the compressive strength of the aluminosilicate geopolymercomposite reinforced with saw dust, exposed to fire have been studied. Afterdeterming of Factors affecting the final properties of these aterials, like the materials used and the laboratory synthesis, Experiments were conducted using Taguchi method .therefore using with QUALITEK-4 software L32 orthogonal arrays for testing were selected. A total of 192 composite geopolymer samples in 32 tested according to ASTM C893 were prepared. It is worth noting that in the case of not using the Taguchi design method to gather, must approximately 262144 tests were required to do, that it is impossible. Analyze the results of the indirect tensile test do with analysis of variance methods (ANOVA Table). Microstructure of samples was studied with SEM images and disordering of structure was studied with FTIR spectroscopy method. Result shows that The the compressive strength of composites containing luminosilicates geopolymer sawdust particles after heating and rapid cooling decreases. The compressive strength of geopolymer containing saw dust is higher than concrete containing sawdust particles made of ordinary Portland cement. KEYWORDS: composite geopolymers ,compressive strength ,Taguchi method for design,saw dust

Keywords:

composite geopolymers, compressive strength, Taguchi method for design, saw dust

Alumina-Iron Composite Preparation Using Slip Casting Under Magnetic Field

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Materials & Energy Research Center

Abstract:

In this study, alumina-iron composites in two states, dispersed iron and gradient iron particles have been prepared by slip casting. Iron content was 5 and 10 wt.% and the magnitude of magnetic field for gradient were 0.08 and 0.8 T. Three commercially dispersants were examined for the gradient of iron using 65, 70, 75 and 80 wt.% solid loading in slips. Samples were sintered in microwave at the temperature of 1350 and 1400˚C for 30 minutes and at 1500˚C for 1 minute using argon gas. Also, some of the samples were sintered in conventional oven at the temperature 1485˚C for 2 hours. Density and porosity of samples were measured and optical microscope was used to characterize the iron gradient in final composites.

Results were shown that the preparation of alumina-iron composites using PCN as dispersant yielded lower viscosity, and higher density and strength rather than FF7 dispersant. Although FF7 may cause easier casting and much time of wall formation. The desired gradient of iron in composite was attained by 70 wt.% solid loading, however, the gradient can be tailored by 75 wt.% of solid loading, stronger magnetic field or increasing the time of casting. 80 wt.% solid loading brought so high viscosity which no gradient can be obtained. Microwave heating result in short sintering time (1 minute) and appropriate density which it takes longer sintering time (9 hours) using conventional furnace.

Keywords:

Alumina-iron composite, gradient|magnetic field, microwave

Investigating the Behavior of PEDOT: PSS/ Fe (III) Salen Composite Thin Film in Comparison with PEDOT:PSS/SnO_2 Sensor as a CO Gas Sensor

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Abstract:

In this study, the interaction between carbon monoxide (CO) and an iron-salen complex is investigated and applied to detect CO gas. Fe (III) (salen) doped in PEDOT:PSS and the thin film is produced by spin coater. Effect of adding the Fe (III) (salen) into the polymer is characterized by different techniques such as UV–vis and FTIR spectroscopy and AFM. The optimized weight percent of the Fe (III) (salen) (0.1wt. % Fe(III) (salen)) was gained to the improvement of sensitivity and selectivity of CO gas sensor. The effect of temperature on the sensor response to CO gas was studied. Results show that PEDOT:PSS/Fe (III) (salen) composite thin film exhibits higher response and it has good operate in comparison with SnO_2 doped PEDOT:PSS and has short response-recovery time to CO gas. Keywords: Chemical sensor, Fe (III) (salen), PEDOT:PSS, Thin film, Carbon monoxide.

Keywords:

Chemical sensor, Fe (III) (salen), PEDOT: PSS, Thin film, Carbon monoxide

Fracture Toughness of Hot Pressed ZrB_2-Based Composites with Different Reinforcements

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Abstract:

This article has conducted to increase the fracture toughness of hot pressed ZrB_2-based composites by addition of reinforcement phases of micron/nano-sized silicon carbide, carbon species (carbon fiber, nano graphene and nano graphite) and nano-sized zirconia. In this way, the different composites were hot pressed at 1700-1850 °C for 30-90 minutes under the relatively low pressures of 8-20 MPa. The fracture toughness values were estimated by the direct measurement of the cracks' length caused by the Vickers indenter on the polished surfaces of the samples. The maximum fracture toughness of ZrB_2-SiC binary composites was related to the sample which had been reinforced with 25 vol% nano-sized SiC (hot pressed at 1775 °C for 90 min under 8 MPa) and its value was 5.3 MPa.m$^{1/2}$. A fracture toughness of 6.2 MPa.m$^{1/2}$ was achieved for a ternary composite containing 20 vol% SiC and 10 vol% carbon fibers, which was hot pressed at 1850 °C for 30 min under 16 MPa. In addition, a fracture toughness of 6.7 MPa.m1/2 was achieved for a composite containing 20 vol% SiC and 5 vol% ZrO_2 by hot pressing at 1850 °C for 60 min under 12 MPa. The highest fracture toughness (7.1 MPa.m$^{1/2}$) was obtained for a composite which was reinforced with 20 vol% SiC and 10 vol% graphite nano-flakes by hot pressing at 1850 °C for 60 min with 20 MPa.

Keywords:

ZrB_2, fracture toughness, hot pressing, reinforcement phase, toughening mechanisms

Effect of Composition and Temperature on the Type and Amount of the Final Phases in Alumina- Zircon System

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Abstract:

Alumina- mullite- zirconia (AMZ) Refractories are formed from mullite and zirconia particles distributed in the body and at room temperature show a high strength and fracture toughness .mullite- zirconia ceramics are particularly useful since They have a good resistance to thermal shock, as well as chemicall inertness and low chemical attack- corrosion by metallic melt. In addition zirconia dispertion in the mullite matrix improves the thermo- mechanical properties and reinforced composite body and strengthens. AMZ composite can be produced by zirconium silicate ($ZrSiO_4$) that is cheaper than pure zirconia. In this study, Four combination of alumina and zircon with Zircon to alumina ratio of 0/100, 15/85, 30/70, 45/55 selection, and material weighing after 24 hours Milling and than forming with Pressing. prepared Samples were sintered at temperatures of 1550, 1600, 1650. All Samples in four components at three temperatures were studied by using of the X-ray diffraction and phases percent were identified. to identify the phases formed in the any composition and sintered temperature that the phases formed in: The relationship between the ratio of alumina to zircon and formation of mullite and zirconia phases, The relationship between temperature and the amount of Phases composed of any combination And percentage changes and the type of them was studied by The temperature Changes. Porosity percentage of all samples Measuring and effect of composition, temperature and final phases were studied on these characteristics.

Keywords:

Alumina, mullite, zircon, AMZ

Influence of Starting Material on the Wear Performance of NiTi-Al_2O_3 Composites

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Abstract:

Two different kinds of starting materials, including elemental Ni/Ti and prealloyed NiTi powders are used to fabricate NiTi-based composites with a hot isostatic pressing method. The wear resistance of the samples was investigated with a ball-on-disc tribometer. The test results showed that the composite sample which consolidated from elemental powders exhibits better wear resistance which originated from better mechanical properties and hardness in this sample.

Keywords:

composites, wear resistance, Al_2O_3, NiTi

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Effect of Adding Ceramic Fibers on Mechanical Properties of Silica Cores

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Abstract:

Nowadays using fused silica based ceramic core in investment casting of gas turbine blades has been increased significantly. Dimensional stability, good fracture toughness and adequate strength are important characteristics which should be considered. In this study, the effect of two type of aluminosilicate (AS) and high zirconia aluminosilicate fibers with two different diameters (2-3 μm and 7-8 μm) on the shrinkage after sintering, apparent porosity, bending strength and fracture toughness of fused silica cores are investigated. Finally, microstructure of the bodies studied using Scanning Electron Microscope (SEM). The samples containing two weight percent of fiber were shaped by injection molding. After debinding, samples were sintered and characterized. The uniform dispersion of fibers in fused silica matrix can be seen in SEM image. The result showed that adding fibers in reference sample caused a noticeable decrement in shrinkage and increment in porosity. Among the samples, the one containing sample that containing high zirconia aluminosilicate with 2-3 μm diameter had maximum strength of 11 MPa and fracture toughness of 4 MPam1/2.

Keywords:

ceramic core, ceramic fiber, injection molding

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Effect of Graphite Substrate on FGM SiC Coatings Created by Pack Cementation

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Abstract:

Carbon materials such as the graphite has been widely used as a high-temperature structural material. On the other hand, graphite can easily react with oxygen even at temperatures as low as 400 °C. The graded silicon carbide (SiC) characterized by compositional gradation over microsopic distances, is considered to be the most promising coating material. In this paper, SiC coating has been developed on five kinds of graphite substrates using a pack cementation method. The relationship between the microstructure and property of SiC coating and graphite substrates was investigated experimentally and theoretically. X-ray diffraction (XRD) and scanning electron microscopy (SEM) analysis show that the coating obtained by the pack cementation is a dense structure consisting β-SiC. It was found that the kind of graphite has marked effect on the microstructure and property of SiC coating. SiC gradient coating is expected to form on the surface of graphite with high density, good graphitized and appropriate porosity.

Keywords:

pack cementation, silicon carbide coating, graphite substrate

Effect of Powder Composition on SiC Coating on Graphite Produced by Pack Cementation

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Abstract:

The advantages of graphite for to use it in high temperature structural materials, follows from the facts that it has excellent thermal conductivity, low-thermal expansion coefficient, stability under high temperature and light weight. However, the use of graphite materials has been greatly restricted due to the poor oxidation resistance at high temperature in an oxidizing atmosphere. On the other hand, graphite can easily react with oxygen even at temperatures as low as 500 °C. In order to prevent graphite from oxidation, a gradient silicon carbide coating has been produced by a single-step pack cementation technique. The relationship between the composition of raw materials and microstructure of SiC coating was investigated. In addition, the anti-ablation property is evaluated under an oxyacetylene torch flame at about 2500 °C for 100 s. The structures of the coatings were characterized by X-ray diffraction (XRD), scanning electron microscopy (SEM) and EDS analysis. Results show that the coating obtained by the pack cementation is a dense structure consisting β-SiC. It was found that the composition of raw materials has not marked effect on the microstructure of SiC coating. It can be seen that the coated graphite can endure high-temperature ablation.

Keywords:

pack cementation, silicon carbide, oxyacetylene torch

Effect of SiC Coating on Oxidation Protection of C/C Composite and Graphite

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Abstract:

In this research, SiC coating was applied by pack cementation method at 1600°C in order to protect graphite and C-C composite from high temperature oxidation. SiC coating has good physical and chemical compatibility with carbon substrate and excellent oxidation resistance. Powder pack was consisted of 50%Si, 40%SiC and 10%Al_2O_3. The specimens were heat-treated at 1600°C in Argon atmosphere for 2 hours. Then, the oxidation resistance of coated substrates was investigated at 1500°C for 3 hours. The phase microstructure and element distribution of the coating before and after oxidation were investigated by X-Ray diffraction and SEM and formation of SiC diffusion coating was confirmed, including compositionally gradient of C and Si elements on the substrates. The oxidation results of SiC coated specimens show that the amount of SiO_2 phase formed on the graphite is much more than C-C composite. Furthermore, because of high viscosity of SiO_2, it can seal most of the pores on SiC surface formed on the graphite. Finally, the oxidation test resulted in 40 mg/cm^2 and 7.5 mg/cm^2 weight changes for C-C composite and graphite specimens, respectively.

Keywords:

SiC, Pack cementation, graphite, C-C composite, oxidation resistance

Investigation on Effect of Chemical Vapor Deposition (CVD) Conditions on Deposition Kinetic and Growth Morphology of B-SiC on Carbon-Carbon Composite

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Abstract:

In present study, the effect of chemical vapor deposition (CVD) condition on deposition kinetic and growth morphology of β-SiC on carbon-carbon composite has been investigated. In order to investigate the phases of β-SiC, growth morphology and surface elements, XRD analyses, FE-SEM analyses and EDS analyses respectively have been conducted. In this regard, after design and construction of CVD setup, in addition to thermodynamics calculation and investigation of deposition kinetic, the effects of temperature and time on growth morphology have been studied. The results show that, increase of temperature, change of enthalpy (ΔH) and change of reaction entropy (ΔS), cause a severe the decrease of Gibbs free energy (ΔGo) of SiC formation reaction. As temperature increases from 900 to 1100°C, controlling factor of deposition changes from chemical surface kinetic to mass transport kinetic and growth morphology has been affected.

Keywords:

CVD, kinetic, β-SiC, carbon-carbon composite

Electrophoretic Deposition of CNTs on the Surface of Glass Texture: An Improvement Technique in Production of Fiber Reinforced Nanocomposites

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Abstract:

Multi walled Carbon nanotubes (MWCNT) have been innovatively incorporated in production of glass fiber reinforced composites. Electrophoretic Deposition (EPD) was performed in order to constitute an active load transferring agent in composite structures. Experimental parameters in smoothly deposition of MWCNTs on non conductive glass textures have been studied and the effect of field strength and CNT concentration has been investigated. Current- time and deposition mass diagrams derived from experiments and measurements result in optimum field strength and CNT concentration of solution in EPD process. For EPD of carbon nanotubes on glass textures it is not suggested to go for higher fields to reach better deposition of CNTs on glass textures. Among applied fields in this paper, 200 V/cm showed better and more stable results. The most efficient concentration was found in 0.6 g/L. More than 580% higher deposition has been observed through concentrated solutions from 0.2 to 0.6 g/L in fixed field strength. The deposition enhancement through field alteration was about 400% by changing fields from 100 to 200 V/cm in fixed CNT concentration. Having analyzed derived diagrams and also visual inspection of formed CNT layer on the glass texture result in using 0.6 g/L concentration in 200 V/cm field strength to achieve better deposition of CNT on glass textures.

Keywords:

Electrophoretic Deposition, Carbon nanotube, Glass fiber, Nanocomposite, Deposition mass

Study of the Effect of Tungsten Oxide and Carbon Mesoporous CMK-1 on Increasing Photocataliotic Activite

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Abstract:

One of the newest methods of eliminating pollutants is using materials that are activated by sun light and ultraviolet radiation, called photocatalyst materials. Due to having exclusive properties, TiO_2 is considered as a prominent material in photocatalystic applications. Since $Ti)_2$ cannot be used under visible light, extensive research has been done in the past decades for its applications under visible light. In the present study, first TiO_2 mesoporous was synthesized by the use of titanium tetra isopropoxide pre-structureand surfactant P123 in cell gel method. Then, by using acid tungstenic pre-structure (H_2WO_4), the nano composite of TiO_2/WO_3 was prepared with different rates of WO_3 (2, 4, 6% moli) and the optimized sample of WO_3 4%mol was identified among them with regards to the most rate of destruction in fixed time that in 90 minutes caused 60% of destruction of methyl orange under visible light. By using CTAB surfactant and silicate pre-structure, MCM-48, TEOS was prepared in the next stage to be used for synthesizing carbon mesoporous (CMK-1). The carbon mesoporous obtained with 10, 30 and 70% of weight was mixed mechanically with TiO_2/WO_3 4% mol. The activity of the obtained TiO_2/WO_3/CMK-1 nano composite was analyzed by the rate of destruction of methyl orange, and the results showed that adding CMK-1 to TiO_2/WO_3 nano composite destructs methyl orange completely in the first few minutes of radiation of visible light. Yhe results of XRD analysis showed that TiO_2/CMK-1 mesoporous structure is properly established and SEM, TEM<, BET results confirmed that, too. Also, the results of destructing methyl orange (after 24hours of rest in dark for finishing surface absorption of methyl orange molecules) under visible light and in presence of TiO_2 mesoporous, TiO_2/WO_3 nano composite and TiO_2/WO_3/CMK-1 nano composite proved that both preventing mechanisms of recomposing electron – pore and reducing gap band energy could be the mechanism for increasing the photocatalyst phenomenon of the obtained powder (FT-IR analysis was done for separating destruction from absorption) Key words: TiO_2 mesoporous, TiO_2/WO_3/CMK-1 nano composites, photocatalyst material, destruction

Keywords:

mesopore TiO_2, TiO_2/WO_3/CMK-1 composites, photocatalist

Investigation of Synthesis, Al_2O_3-Ti(C,N) Composite Using Alumino Carbothermal Reduction

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Abstract:

Ceramics matrix composites (CMC) are widely used in different applications, namely cutting tools and wear resistant coatings. This study was set out to investigate synthesis of Al_2O_3-Ti(C,N) composite from Al, TiO_2 and C via alumina-carbothermic process in a bed of calcium and coke. The initial materials, either pure or with additives (including NaCl and extra carbon), were mixed, pressed and thereafter, heated inside a closed crucible in a furnace at 1100-1300ºC. The synthesized composite were characterized via XRD, SEM. The XRD spectra approves formation of Al_2O_3-Ti(C,N) composite at 1200ºC; moreover, it shows that the amount of carbon rises through increasing the heating temperature. SEM images indicate that Ti(C,N) phase forms in alumina, and also, porosity of the samples with NaCl additive is more than that of the samples with extra carbon.

Keywords:

Al_2O_3-Ti(C|N) Composite, Synthesis, Alumino carbothermal reduction, NaCl, C

Effect of Mechanical Alloying on the Microstructure of Al_2O_3-Mo Nanocomposite

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Abstract:

Alumina matrix composites for the excellent resistance to oxidation at high temperatures, good strength, hardness and toughness are relatively good, with the second phase, are highly regarded. One of suitable candidates for the second phase of alumina matrix,is molybdenum. Therefore, in this paper producing Al_2O_3-Mo nano composites using mechanical alloying was investigated. For this purpose, the raw material contains molybdenum and alumina powders were placed under mechanical alloying process using high-energy ball milling technique and at different times of the sampling was performed.to evaluate the Milled powder the XRD system was used.The results showed that milling has been successfully used to form the composite. Crystal size of the milled powder is in nanoscale and With increasing milling time the size decraese.

Keywords:

Alumina matrix composites, mechanical alloying, molybenum

Synthesis, Microstructure and Mechanical Properties of Yttria Stabilized Zirconia (3YTZP) – Multi-Walled Nanotube Nanocomposite, by Sol gel Method

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Abstract:

Reinforcing the ceramics based on zirconia by carbon nanotubes is under widespread investigation, due to their specific applications. Since the development of nanotechnology, methods based on solution chemistry routes have proved to be promising in tuning of the structural characteristics of advanced materials. In the present research work,Tetragonal zirconia–carbon nanotube composite was synthesized by alkoxide precursor sol-gel method. The functionalized carbon nanotubes, subsequent synthesized nanocomposite powders and finally fabricated composites were characterized by XRD, FTIR, STA, SEM and TEM analytical techniques. Sintered nanocomposite samples with 0.5, 1 and 2 wt-% MWCNT fabricated by Spark plasma sintering (SPS) process at temperature of 1400°C and their density, hardness and fracture toughness values were measured. The results showed that the density and hardness deceased with addition of MWCNTs whereas; the fracture toughness increased 24% in the nanocomposite containing 0.5 wt-% MWCNTs as compared to pure tetragonal zirconia. The fractography studies indicated the toughening mechanism of pull out and crack bridging.

Keywords:

Sol gel, Zirconia, Carbon nanotube, Spark plasma sintering

Investigation on the Fabrication of 2D-C/SiC Composites by Polymer Infiltration and Pyrolysis (PIP) Method

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Abstract:

Two dimensional carbon fiber-reinforced silicon carbide (2D-Cf/SiC) composite are widely used in brake disks, heat exchanger, advanced aerospace engines. Several rousts are used to fabricate C/SiC composites that one of them is polymer infiltration and pyrolysis (PIP). Cf/SiC composite was prepared through two cycles of infiltration of polycarbosilane (PCS)/divinylbenzene (DVB) under an inert atmosphere. The effects of infiltration process and atmosphere on the microstructure and physical properties of the Cf/SiC composite fabricated by a new method using pressing and curing separately were investigated. Comparing Acheson method, by this method the temperature of the fabrication of SiC and consequently Cf/SiC composite reduced. The results showed that increasing the cycles of infiltration and temperature could increase the density and decrease porosity. The SiC crystals were also made at 1400oC and have filled the porosity between matrix and carbon fibers.

Keywords:

Cf/SiC composite, Polymer Infiltration and Pyrolysis (PIP), Polycarbosilane, physical properties

Making Activated Carbon Body by Extrusion Method

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Abstract:

Activated carbon as an adsorbent is important and critical applications and refers to materials that have the high internal surface area, porosity and ability to absorb gases and chemical liquids. An appropriating method forming is extrusion for obtaining optimal adsorbent. The purpose of this study, making body of the activated carbon by extrusion method and achieve an appropriate combination and extrudable, and also properties such as strength and adequate porosity of the filters are very important, were studied. The results showed that the combination of 80 and 85 wt% carbon and 15 and 20 percent by weight of phenolic resin is extrudable and the strength increases with increasing temperature drying and then almost constant and does not change significantly. The results of carbonization at different temperatures is shown by the SEM images presence of the porous carbon body structure is confirmed.

Keywords:

Extrusion, Activated carbon, Adsorbent, porosity

Effect of SiC Content and Particle Size on Pressureless Sintering Behavior and Mechanical Properties of ZrB_2-SiC Composites

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Abstract:

ZrB_2 is one of UHTC materials, with high melting temperature above 3040°C that has unique properties. The highly covalent nature of bondings of these ceramics results in superior mechanical properties such as hardness and strength and oxidation resistance. Zr-based systems were found to possess superior high-temperature oxidation resistance due to its high-melting point and low-vapor pressure of oxides and sub-oxides. The improvement in properties is making these ceramics suitable for use in thermal protection systems. In the present paper, ZrB_2-SiC composites were prepared by pressureless sintering at temperatures of 2000-2200°C for 1 h under argon atmosphere. In order to prepare composite samples, ZrB_2 powder was milled for 2 h, then the reinforcing particles including of micron and nano-sized SiC powder were added. The mixtures were formed and, after the pyrolysis, they were sintered. Desification, microstructural and mechanical properties of ZrB_2-SiC composites were investigated. The shrinkage of samples was measured both before and after the sintering, and the microstructure of samples was examined using scanning electron microscopy (SEM), equipped with EDS spectroscopy. Both mass fraction and size of SiC powder have a great effect on relative density, porosity, shrinkage, hardness and microstructure of these composites. The highest relative density and hardness were 98.12% and 15.02GPa, respectively, in ZrB_2-10wt%SiCnano composite sintered at 2200°C.

Keywords:

ZrB_2-SiC composites; Pressureless sintering; Microstructure; Mechanical properties

Effect of Acrylate Gel Maker Factors on Properties of B_4C Preforms for the Fabrication of RBBC Ceramics

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Abstract:

In this study, acrylate gel maker monomers (MAM and MBAM) were utilized in gel-casting process to fabricate boron carbide porous preform. In this research, by investigation of rheological behavior of the suspension, the effects of dispersant quantity on the viscosity of B_4C slurries were examined. It was found that optimum amount of TMAH was about 0.2 Wt.% of ceramic powder in such a low-toxic system. The green bodies were pyrolyezed at 600°C and infiltrated by molten silicon at 1600°C for 1 h under vacuum. The influence of the amount of monomers (MAM+ MBAM) and also the ratio between monomers (MAM/MBAM) on the strength of dried green body was evaluated. The flexural strength of the green body is highest at an optimum value of the monomers ratio (RM=5), and increases with increasing monomer content, reaching 32 MPa when monomer content is 25 Wt.%. The results show that molten silicon infiltration in porous B_4C preforms produced by gel-casting process is possible and fully dense RBBC ceramics were fabricated by this method. The microstructure of the RBBC ceramics consists of boron carbide particles with a core-rim structure, β-SiC and some residual silicon. The SiC carbide particles have a polygonal shape in composites fabricated in the presence of free carbon.

Keywords:

Gel-casting, Preform, Boron carbide, Infiltration, RBBC ceramics

Investigation of B_4C Effects on Microstructure and Mechanical Properties of Porous Silicon Carbide Preforms Due to the Liquid Silicon Infiltration

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Abstract:

Reaction bonded silicon carbide (RBSC) composites are fully dense materials fabricated by infiltration of compacted mixtures of silicon carbide and carbon by molten silicon. Free carbon is formed as a result of the pyrolysis of an organic resin and carbon additive reacts with molten silicon to form secondary SiC grains that precipitate on the original SiC particles. The environmentally unfriendly pyrolysis process and the presence of residual silicon are serious drawbacks of this process. The study describes an alternative approach that minimizes the residual silicon fraction by making use of a different percent of boron carbide. The addition of boron carbide provides an alternative source of carbon, thereby eliminating the need for pyrolized organic compounds. The hardness and young's modulus increased and fracture toughness, residual silicon and density of the composites decreased with increasing boron carbide content up to 15 wt.%. The maximum value of fracture toughness of 3.7 MPa.m$^{1/2}$, young's modulus of 401 GPa, and hardness of 2137 HV was obtained in minimum residual silicon content (9%).

Keywords:

Silicon carbide, Boron carbide, pyrolysis, RBSC ceramics

Effect of Particle Size on the Microstructure and Mechanical Properties of RBBC Ceramics

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Abstract:

In this study, B_4C/SiC ceramic was prepared by infiltration of molten silicon into porous preform containing boron carbide and free carbon produced by uniaxial pressing under pressure of 100 MPa in a graphite furnace under vacuum 3×10^{-5} torr. Here, effect of boron carbide particle size on the microstructure and mechanical properties such as hardness, fracture toughness and flexural strength of reaction bonded boron carbide (RBBC) ceramics were investigated. After reaction bonding with molten silicon, the experimental results show that ceramics comprise a mixture of original B_4C particles, ternary boron carbide phase B_{12} $(B,C,Si)_3$ at the surface of the original boron carbide particles (core-rim structure), β-SiC within a residual silicon. Boron carbide powders with mean particle size of 25.61 mm, 43.27 mm and 46.15 mm were chosen for the RBBC ceramics. The experimental results show that hardness increases from 2050.45 kg/mm^2 to 2545.70 kg/mm^2 and fracture toughness drops from 6.1 MPam$^{1/2}$ to 4.2 MPam$^{1/2}$. However, flexural strength decreases from 455.40 MPa to 320.15 MPa with the increase in particle size. Smoothness for fracture surface increases with decreased particle sizes too. Thus, Maximum extent of non-planarity is observed at fracture path of RB-1, medium for RB-2 and lowest for RB-3, and concurrently same type of behavior is observed in the deformation of silicon.

Keywords:

RBBC ceramics, Boron carbide, Infiltration, Particle size

Optical & Transparent Ceramics

Influence of the Bath Temperature and Complexing Agent Concentration on the Optical Properties of CdS Thin Films Deposited by Chemical Bath Deposition

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Abstract:

CdS thin films were deposited onto glass substrate by the chemical bath deposition (CBD) method, using cadmium chloride ($CdCl_2$) as a source of cadmium, thiourea ($CS(NH_2)_2$) as a source of sulfur, ammonium nitrate (NH_4NO_3) as complexing agent and ammonia as pH controller. The influence of the deposition temperature (room temperature-800ºC) and NH_4NO_3 concentration (0.5-2.5M) on the structural, morphological, and optical properties was investigated. The CdS thin films deposited at room temperature and 500C showed amorphous structure. Crystallite sizes were increased from 40 to 50 nm as the bath temperature increased from 650ºC to 800ºC. The crystallite sizes were decreased from 32 to 23nm by the increase of ammonium nitrate concentration from 0.5 to 1.5M, and increased from 23 to 42nm by the increase of ammonium nitrate concentration from 1.5 to 2.5M. The optical band gap was decreased from 3.3 eV to 2.45eV as the bath temperature increased from room temperature to 800ºC. The optical band gap was in the range of 2.75-2.45, which was decreased by the increase of the ammonium nitrate concentration. The increase of ammonium nitrate concentration decreased the packing density of the films.

Keywords:

Cadmium sulfide, chemical bath deposition, bath temperature, complexing agent concentration, optical properties

IR-Transparent Y_2O_3 Fabricated by Spark Plasma Sintering

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Abstract:

In the present work, transparent yttria (Y_2O_3) specimens were produced by spark plasma sintering at identical temperature and heating rate but with different pressures. Relative density of the sintered body was measured by the Archimedes method. Both sides of the sintered bodies were mirror-polished. Afterward they were annealed in an electrical furnace in air atmosphere at 1050ºC for 6 hours. Optical properties of mirror-polished samples were measured before and after annealing by Fourier transform infrared spectroscopy (FTIR). Y_2O_3 sample which was sintered at 1300ºC and annealed at 1050ºC has 99.94% theoretical density, showing 61.26% at a wavelength of 5.39 μm.

Keywords:

Y_2O_3, spark plasma sintering, transparent ceramics, optical properties

Combustion Synthesis of ZnO Nanostructure for Prepare ZnO Nanofluids and Its Optical Properties

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Abstract:

Zinc Oxide as a kind of very important semiconductors with interesting optical and electric properties has a lot of applications in optics, photonics, and electronics fields. In the present work, nano-crystallite ZnO particles were synthesized via combustion method to prepare nano- fluid. The effect of different parameters, such as fuel type and concentration on the structure and microstructure of particles, and optical properties of zinc oxide nano fluid were studied. Structure, microstructure and optical characterization of samples were performed using x-ray diffraction, scanning electron microscopy, PL and UV techniques. Results show that synthesis parameters affect stability optical properties of final nano- fluids. Moreover, Modelling of the nano ZnO particles revealed that intrinsic optical properties of nano particles affect strongly optical properties of matter.

Keywords:

Zinc Oxide, Combustion synthesis, fuel, optical properties

Synthesis and Investigation of Optical-Morphological Properties, Luminescence Nanoparticles $BaMnAl_{10}O_{17}$: Eu in the Presence of Mn and Tb by Combustion Method Under Microwaves

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Abstract:

In this study, $BaMnAl_{10}O_{17}$: Eu nanoparticles are synthesized by Combustion method under microwaves and their Spinel structures are determined by using x ray diffraction pattern. The main objective of this study was to investigate the morphology and optical properties of the synthesized particles and to Control of particle size in the Nano scale by changing parameters such as fuel type, fuel quantity, dopant type and percentage of dopants. Accordingly, without the need to heat treatment in revival atmosphere and with emphasis on the use of revival fuels such as urea and glycine. Blue emission, the compound of $BaMnAl_{10}O_{17}$ and Eu^{2+} dopant was detected in the range of 440-480 nm and The optimal values of the excitation by ultraviolet radiation was evaluated. Also, the heat treatment caused a red light in the 612 nm in oxide atmosphere which resulted Eu^{2+} turning to Eu^{3+}. Presence of secondary dopants like Mn^{2+} and Tb^{3+} causes peak displacements in emission of $BaMnAl_{10}O_{17}$: Eu compound. Adding Mn^{2+} dopant result in creating new sub-levels and emission of green color in the composition. In contrast Tb^{3+} ions turned Emission range from red to orange by avoiding Eu^{3+} turning into Eu^{2+} during combustion. All dopant weights were optimally examined. The morphology of the particles synthesized by combustion synthesis was analyzed by TEM which indicated a rod structure and Narrow fields which were in the range of 50 to 100 nm. This was due to high speed combustion and Particle growth conditions. Stability in organic and aqueous environments for $BaMnAl_{10}O_{17}$: Eu composition was possible by this morphology. Also, it makes it possible to produce films with high density of this fluorescent.

Keywords:

Nanoluminescence materials, Combustion synthesis, Spinel structure

The Effect of Electrophoretic Deposition Parameters on Deposition Density of Nano Alumina Using Full Factorial Experimental Design Method

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Abstract:

In this study, the Electrophoretic deposition of nano-alumina slurry on the stainless steel substrate was performed using iodine dispersant. The dispersant concentration relative to the solid phase, the concentration of suspension, electric potential and deposition time on the final density were investigated. Full factorial experimental design and analysis of variance (ANOVA) was used for data analysis. Raw and the final precipitate density were considered as the logical response. The samples raw density ranged from 1.9 to 3.1 g/mm3. The final density after two step sintering at 1750˚C (2h) - 1550˚C (10h) was between 3.5 - 3.8 g/mm3, respectively. raw density of deposition was increased due to increasing of deposition time. Simultaneously increasing iodine concentration by the deposition potential or with decreasing of the solid concentration also increases the raw density of the deposition. Effect of Increase in the potential was more only at low concentrations and no effect was observed in high concentrations. Effect of each parameter on the raw density and regression coefficients in the final results were as followed: iodine (-0.03125, +0.01250), time (-0.2438, +0.0750), Potential (+0.0062, +0.0125) and Alumina concentration (-0.04375, -0.0125).

Keywords:

Electrophoretic deposition, ethanol, alumina, coating, optic

Synthesis of Pure YAG Nano Powders by Co-Precipitation Method

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Abstract:

Nano-sized powders of aluminum yttrium garnet (nano-YAG) have been successfully synthesized by regular co-precipitation method using ammonium hydrogen carbonate (AHC) as the precipitant solvent. To investigate the effect of calcination time, the dried powders were calcined in a conventional furnace at 1100°C for various durations i.e. 15, 30, 45, 60 and 120 min. The phase transformation and micro-structural features of the crystalline samples were characterized by X-ray powder diffraction and field emission scanning electron microscopy (FESEM) techniques, respectively. Thermal analysis of samples was investigated by differential thermal analysis and thermal gravimetric analysis (TG/DTA). It was found that calcination time play an important role in the aluminum yttrium garnet synthesis process. X-ray powder diffraction pattern indicated that the pure YAG phase was synthesized via calcination at 1100°C for 1 hour. Shorter calcination time leaded to appearances of YAM ($Y_4Al_2O_9$) and YAP ($YAlO_3$) peaks (accompanied by strong peaks related to crystalline YAG phase). The phase transformation and decomposition stages of precursor powders were proposed based on TG/DTA results during heating process up to 1200°C. Moreover, FESEM images revealed that the average particle size of pure YAG (after 60 min of calcination) was about 50-60 nm.

Keywords:

YAG, Nano-sized powder, Synthesis, Co-precipitation method

Investigation of Hydrothermal Time and Temperature on Upconversion Emissions and Property of $NaYF_4$: Yb^{3+},Tm^{3+} Nanoparticles

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Abstract:

In this paper, effects of hydrothermal time and temperature on $NaYF_4$: Yb^{3+}, Tm^{3+} upconversion particles have been investigated. Fluoride based upconversion particles with different morphology from cubics to micro-rods have been driven in various time (6, 12 and 18 hr) and different temperature (160, 180 and 200 °C). Crystalline phase and structures were well characterized by XRD and relative morphology by SEM analysis. Upconversion luminescence were studied using and spectrophotometer coupled to a 980 nm laser as excitation source. Particle size were influenced by hydrothermal time and crystal phase to hydrothermal temperature. Upconversion emission of as prepared samples were at UV ($^3P_6$-$^3F_4$, $^1D_2$-$^3H_6$), Blue-violet ($^1D_2$-$^3F_4$, $^1G_4$-$^3H_6$), red ($^1G_4$-$^3F_4$) and near IR ($^1G_4$-$^3H_5$) region of electromagnetic spectra, due to energy transfer among lanthanide ions from Yb^{3+} to Tm^{3+}.

Keywords:

upconversion nanoparticles, hydrothemal synthesis, upconversion emission

Manufacturing of Graphen-ZnO Composite Sensor for Ultra Violet Light Detecting

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Abstract:

Herein, the constructive effects of graphene in improvement of photoresponsivity, sensitivity, time of response (and recovery), and signal to noise ratio of bare ZnO thin film has been evaluated. As the UV-detecting mechanism of a MSM UV-detector depends on ads- and des-orption of oxygen atoms, we continued further research to evaluate the graphene effects in the powder type (with higher surface area) UV-detector by changing the morphology of ZnO micro/nano particles. The micro/nano stars, nanorods, and nanoflowers were prepared by wet-chemical methods, admixed by 0.5 wt.% GO and ultrasonicated for 30 min to produce a homogenous ZnO-GO composites. It was discerned from the results of XRD, Raman, FT-IR that a heterointerface between rGO and ZnO is formed. Also, on the base of UV-detecting results, the ZnO NR-rGO composite shows the optimum parameters (photosensitivity, responsivity, time of response and recovery) to be applied as a practical UV-detector.

Keywords:

Ultraviolet, Photodetection, Composite, Reduced Graphene Oxide, ZnO, Sensor, Nanorod, Nanostars, Nanoflowers

Magnetic
&
Electro-Ceramics

The Effect of Sintering Process on Electrical and Microstructural Properties of Barium-Strontium-Titanate

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Abstract:

Effect of sintering parameters on the microstructure of the $Ba_{0.5}Sr_{0.5}TiO_3$ ceramics was investigated. BST green compacts were sintered at various temperatures ranging from 1250 to 1400 ºC in air for time periods varying from 1 hour to 2 hours. A dielectric sputtering target comprising BST sintered body having a high density, purity and a fine-grained microstructure has been also fabricated. Optimized sintering condition was obtained by controlling sintering temperature and time to fabricate single phase, high relative density sintered body. A relative density of up to 92% and mean grain size of below 10 µm were reached at the sintering temperature of 1300 ºC. However the maximum density of the samples was related to the sample sintered at 1400 °C, but in this condition the mean grain size of the samples was larger than 50µm which is not desirable for sputtering. The prepared target has been used in a laboratory made sputtering system to deposit thin film of BST on Mo coated soda lime glass. The dielectric constants of the BST thin films have been calculated from measured value of capacitance of fabricated MIM capacitors in various frequencies ranging from 10KHz to 1MHz. The dielectric constant of thin films at 10 KHz was around 4000. Characteristics of the body were analyzed by X-ray diffraction (XRD), and optical microscopy.

Keywords:

Barium Strontium Titanate, Sputtering Target, High Dielectric Material

Lead-Free BNKT Piezoelectric Actuator

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Abstract:

An actuator is a device that converts input energy into mechanical energy. According to various types of input energy, various actuators have been advanced. Displacement in the electromagnetic, hydraulic and pneumatic actuators achieve by moving a piston via electromagnetic force or pressure, however the piezoelectric actuator (piezoceramic plates) displace directly. Therefore, accuracy and speed in the piezoelectric device are higher than other types of actuators. In the present work, the high-field electromechanical response of high-quality $(1-x)(Bi_{0.5}Na_{0.5})TiO_{3-x}(Bi_{0.5}K_{0.5})TiO_3$ samples abbreviated to BNKTx with x = 0.18, 0.20, 0.22 and 0.24 ceramic materials across its MPB was investigated. The piezoelectrics and actuation characteristics were characterized. Our results indicate that x = 0.20, indeed, constitutes the best choice for the MPB composition in the system. Maximum of remanent polarization (37.5 μC cm^{-2}) was obtained for x=0.20. High-field electromechanical responses were also obtained for BNKT0.20 samples. This material exhibited giant field induced strains of 0.13% under 1 kV mm^{-1} at room temperature.

Keywords:

Piezoelectrics, Lead-free, BNKT, Actuator

Study of Phases and Magnetization of Glass-Ceramic in Na_2O-Fe_2O_3-CoO-B_2O_3-SiO_2 System After Heating Under Nitrogen Atmosphere

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Abstract:

The effect of nitrogen atmosphere on the phase formation and magnetization of glass-ceramic in Na_2O-Fe_2O_3-CoO-B_2O_3-SiO_2-ZnO system were investigated using X-ray diffractometer (XRD) and Vibrating sample magnetometer (VSM). Glass ribbons were prepared via cooling the melts between steel rollers. X-ray diffraction demonstrated the Amorphous structure of these ribbons. In order to crystallize cobalt ferrite, glass ribbons were heat treated at 670 ˚C for 2 hours in a graphite bed. $FeCoBO_4$, Na_2 B_6 O_{10}, Na_2 Si_2O_5, $CoFe_2$ O_4 and Na_4 B_5 O_{10} phases were identified in XRD pattern. Magnetization value of crystallized sample was 12 emu/g. the glass-ceramic was reduced in hydrogen atmosphere at 650 ˚C for 1 hour. Magnetization of reduced sample was 65.2 emu/g. nitridation of reduced glass-ceramic was performed in Ammonia atmosphere at 650 ˚C. XRD pattern demonstrated the crystallization of Iron nitrides and cobalt nitride. Magnetization of this sample was 53.13 emu/g.

Keywords:

glass-ceramic, cobalt ferrite, nitriding atmosphere, iron nitride, magnetization

Synthesis of NiCuZn Ferrite Powder by Sol-Gel Auto-Combustion Method

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Abstract:

In this study a copper substituted nickel–zinc ferrite nano particles with composition $Ni_{0.5}$ $Cu_{0.1}$ $Zn_{0.4}$ Fe_2O_4 were prepared by sol-gel combustion method. The effect of Cu substitution on phase formation and crystal structure of sample were investigated by X-Ray diffraction (XRD), field emission scanning electron microscopy (FESEM). Also the saturation magnetization of samples was studied by vibration sample magnetometer (VSM). The sintered ferrite was characterized for saturation magnetization. The powder is suitable for the application in multilayer chip inductor due to its low temperature sinterability, good magnetic properties.

Keywords:

Cu substituted nickel–zinc ferrite, nano particles, sol-gel combustion and magnetic properties

The Effect of Different Stoichiometric Ratio of Fe and Co on the Properties of $CoFe_2O_4$ Black Ceramic Nano-Pigment Synthesized by Co-Precipitation Method

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Abstract:

In this study, a nano ceramic black pigment based on cobalt ferrite was synthesized using coprecipitation method.
The purpose of this study was to investigate the properties of nano black pigments along with reference sample. The different stoichiometeric ratios of cobalt ferrite nano pigments were investigated. Pigments were applied with certain amount on the glazed tile by dropping method. Identifying the phases of the synthesized nano-pigments and reference along with determining the crystalline size was performed by X-ray diffraction pattern. To study the microstructure of the particles, scanning electron microscope was used. The color parameters of the samples were obtained by spectrophotometer system (CIE-Lab).
The results showed that by co-precepitation method could achieve a particle size smaller than 100 nm. On the other hand, according to the color parameters, the best results belong to the nano pigments calcined at 800 ºC with the stoichiometric ratio of Co^{2+} 1: 2 Fe^{3+} ($CoFe_2O_4$). This nano black pigment had better intensity of pure black shade than Nano commercial black pigment.

Keywords:

Nano Pigment, Co-precipitation, Cobalt ferrite, Colorimeteric parameters

An Invetigatin of Electrochemical Properties of Nickel Cobaltite Oxides

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Abstract:

In this study, metal compounds with different amounts of cobalt and nickel are precipitated using sodium hydroxide method. In the next step, the precipitated structures are heated in 250℃ in order to produce the metal oxides. The properties of these oxides including Phase analysis, specific surface area and the pore size distribution and their electrochemical properties are also examined. The results reveal that nickel oxide has the optimum specific capacity, while this oxide has lower special level than nickel cobaltite oxides. These results are attributed to the smaller crystallite size of nickel oxides compared to other oxides. Moreover, the presence of two redox reactions in the synthesized nickel oxides in this study can be another crucial factor for significant improvement of the specific capacity properties of this oxide.

Keywords:

Supercapacitor, Electrochemical Properties, Nickel Cobaltite Oxides

The Effect Of Zr^{+4} and Mn^{+2} Substited on the Structrual and Magnetic Properties of $SrFe_{12}O_{19}$

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Abstract:

In this study nano particles of $SrFe_{12-x}(Mn,Zr)_{x/2}O_{19}$ (x=0,2,3) have been synthesized by sol-gel auto combustion process. The effect of the substituted Zr^{+4} and Mn^{+2} on structure and magnetic properties of $SrFe_{12-x}(Mn,Zr)_{x/2}O_{19}$ have been investigated. The samples were characterized by various experimental techniques including X-ray diffraction (XRD), Fourier Transform Infrared Spectrometry (FTIR), Transmission electron microscope (TEM), Field emission gun scanning electron microscopy (FE-SEM) and Vibrating sample magnetometer (VSM). The results showed that M-type strontium hexaferrite phase for all samples have been formed. The presence of Zr-Mn substitution in the structure, decreased the coercivity (HC) from 5593.60 Oe to 3282.46 Oe and maximum magnetization (Mmax) from 62.60 emu/g to 46.15 emu/g, respectively. The mechanism of formation and variation in magnetic properties of the nano powders had been explained.

Keywords:

Strontium hexaferrite, sol-gel auto-combustion, magnetic properties

Structural and Magnetic Properties of $Sr_2Co_{1.7}Mg_{0.3}Fe_{11.2}Sn_{0.4}Zn_{0.4}O_{22}$ Hexaferrite Synthesized by Auto Combustion Sol-Gel Method

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Abstract:

A single phased Y-type hexagonal ferrite $Sr_2Co_{1.7}Mg_{0.3}Fe_{11.2}Sn_{0.4}Zn_{0.4}O_{22}$ was synthesized by the sol–gel auto combustion method. Structural and magnetic properties of this composition of Y-type hexagonal ferrite have been investigated. The X-ray diffraction (XRD) patterns confirm single phase Y-type hexagonal ferrite and various parameters such as lattice constants and cell volume have been calculated from XRD data. The morphology and size distribution of the particles have been studied using high resolution field emission scanning electron microscopy (FESEM). The Fourier transform infrared (FTIR) spectra show the characteristics absorption ferrite peaks of the sintered sample. The thermo gravimetric (TG) and differential thermal analysis (DTA) are used to study the systematic weight loss and subsequent transformation during heat treatment. Magnetic properties were determined using a vibrating sample magnetometer (VSM). Single phase Y-type ferrite powders were obtained after calcinations at 1000 °C. The XRD results showed that the crystallite size of particles is 44 nm. The microstructures of the pure powders appeared as a hexagonal platelet-like structure. The saturation magnetization (Ms) and the coercivity (Hc) of the samples were in the range, 26.58–50.42 emu/g and 546-1108 Oe, respectively. The effect of the heat treatment temperature was to increase the magnetization, following a slight coercivity decrease due to replacing of intermediate phases by single Y-type hexaferrite. Which it can be used as soft magnetic materials for multilayer inductors for high frequency applications.

Keywords:

Y-type hexaferrite, sol-gel auto combustion, magnetic properties, calcination temperature

Investigation of Phase Formation, Structural and Magnetic Properties of Mg Doped and Mg/Zn Co-Doped $CoFe_2O_4$ Nanoparticles Synthesized by Pechini Sol Gel Method

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Abstract:

This study was conducted to investigate Structural and magnetic properties of $CoFe_2O_4$, $Mg_{0.1}Co_{0.9}Fe_2O_4$ and $Zn_{0.1}Mg_{0.1}Co_{0.8}Fe_2O_4$ nanoferrites synthesized by pechini sol gel method. X-ray powder diffraction patterns have confirmed the pure cubic crystalline phase of the synthesized nanoparticles. In this survey X-ray powder diffraction and Field Emission scanning electron microscopy (FESEM) were employed to characterize the crystallite sizes and structure properties of these ferrite nanocrystals. The morphology and stoichiometric ratio of the compositional elements were analyzed by FESEM which equipped with energy dispersive spectroscopy (EDS). EDS showed that the elemental ratios were stoichiometric. The particle size was calculated by using the Scherrer formula. The observed and calculated size of particles lie within the range 20–50 nm. The lattice constant increases and the crystallite size decreases by adding Mg to the cobalt ferrit. Also, The lattice constant decreased and the crystallite size increased by adding Zn to $Mg_{0.1}Co_{0.9}Fe_2O_4$ sample. Magnetic properties were explored using vibrating sample magnetometry. The maximum saturation magnetization and coercive fields recorded for the pure cobalt ferrite and $Mg_{0.1}Co_{0.9}Fe_2O_4$ sample respectively. The obtained data was interpreted also on the basis of redistribution of iron ions between the two sublattices. The as-prepared samples were promising candidates for various applications.

Keywords:

Pechini sol gel, Cobalt Ferrites, Nanoparticles, Magnetic properties

Structural and Magnetic Properties of $Sr_2Co_{1.5}Mg_{0.3}Fe_{11.2}Zr_{0.4}Cd_{0.4}O_{22}$ Hexaferrite Synthesized by Sol-Gel Auto-Combustion Method

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Abstract:

The type hexagonal ferrite samples of a chemical formula $Sr_2Co_{1.5}Mg_{0.3}Fe_{11.8}Zr_{0.4}Cd_{0.4}O_{22}$ were synthesized via wet chemical sol–gel auto-combustion method. The X-ray diffraction (XRD) patterns confirm single phase Y-type hexagonal ferrite and various parameters such as lattice constants and cell volume have been calculated from XRD data. The Fourier transform infrared (FTIR) spectra show the characteristics absorption ferrite peaks of the sintered sample. The microstructure was studied by field emission scanning electron microscopy (FESEM). All the ferrites show a hexagonal platelet-like shape which is a most suitable shape for microwave absorption. The results revealed that single Co_2Y hexaferrite phase was obtained at relatively low temperature 1050 °C for 3h compare with common solid state reaction. Magnetic properties of the samples were also studied as a function of heat treatment temperature and it showed large saturation magnetization (Ms) ranging from 32.65 to 42.00 emu/g and coercivity decrease from 910 to 637 Oe depending on the heat treatment temperature. The very weak saturation magnetization at relatively lower temperature (say 1000 °C) is due to the presence of some impurities, such as SrO and Fe_2O_3. The saturation magnetization increases with increasing heat treatment temperature above 1050 °C, while the coercivity showed a reversed order.

Keywords:

sol-gel auto-combustion, nano particle, phase formation, Y-type hexaferrite

Effect of Calcination Temperature on Crystallite Size and Tetragonality of the Barium Titanate Nano Powders Synthesized by Chemical Co-Precipitation

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Abstract:

With the rapid developing of electronic industries, high purity nanopowders of barium titanate ($BaTiO_3$) with suitable size distribution and morphology are required greatly for manufacturing electronic devices. Thus, it is meaningful work to investigate new routes at low temperature to prepare ultra-fine particles of $BaTiO_3$. In this way, Chemical co precipitation has been applied to synthesize high purity barium titanate powders. A barium titanate was prepared from $TiCl_4$, $BaCl_2$. $2H_2O$ and NaOH, then calcined for 4 hours at 600, 700 and 800˚C. Phase transformation and crystallite size of the as synthesized powder and calcined powders were investigated as a function of the calcination temperature by X-ray diffraction (XRD) methods. In addition particle morphology and size were studied by field emission scanning electron microscopy (FESEM). With increasing calcination temperature pure $BaTiO_3$ obtained and transformed from the cubic to the ferroelectric tetragonal phase. The tetragonality (c/a) increases with increasing calcination temperature and increasing crystallite size, respectively. Higher temperature clearly favoured particle growth and formation of large and hard agglomerates. The crystallite size of the tetragonal phase increased from 46-75 nm at 700˚C to 50-350 nm at 800˚C according to FESEM images. This means increasing temperature has been lead to less homogeneous particle distribution.

Keywords:

Barium titanate, co-precipitation, calcination, nano powder, tetragonality

A Novel Route to Synthesis $LiNbO_3$ Nano particles via Mono Precipitation and Solid State Reaction

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Abstract:

a novel technique has been employed to produce $LiNbO_3$ nano particles with near stoichiometric composition (Li:Nb ratio 1:1), using Nb_2O_5 and Li_2CO_3 as starting materials. $Nb(OH)_5$ was precipitated from NbF5 solution and after mixing with stoichiometric amount of Li_2CO_3 it was well grounded until having a uniformly distributed powder. In order to study the effect of calcination time and temperature in addition to optimize the synthesis conditions on phase purity and particle size of synthesized powders, the mixture of NbF5 and Li_2CO_3 powders was calcined in conventional furnace in air at 500, 600, 700 °C, from 1 up to 4 hours. The calcination temperatures and the lattice parameters were determined by thermal gravimetric analysis (TGA) and X-ray diffraction method (XRD) Respectively. The average particle size and morphology was studied by Field emission scanning electron microscopy (FESEM). The results showed that single phase $LiNbO_3$ has been obtained. The XRD patterns demonstrates that the best condition to produce $LiNbO_3$ is at 600 °C for 3 hours, which were subsequently confirmed by FESEM observations, due to finer average grain size. The $LiNbO_3$ powders produced by the novel route, has an uniform morphology with an average grain size of about 110 nano meter.

Keywords:

$LiNbO_3$, Lithium Niobate, Synthesis, Nanoparticle, Precipitation

Synthesis of Pure Phase $Bi_2Fe_4O_9$ Submicron Particles via Chemical Co-Precipitation Method

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Abstract:

Ternary bismuth ferrites (perovskite $BiFeO_3$, Mullite $Bi_2Fe_4O_9$, and $Bi_{25}FeO_{40}$ with Sillenite crystal structure) are important functional materials due to their applications in the field of memories, sensors and catalysts in various forms such as single crystal, thin film, nano particle. $Bi_2Fe_4O_9$ (BFO) shows at room temperature a crystallographic structure with orthorhombic symmetry, which belongs to the space group Pbam, No. 55. Several procedures such as hydrothermal process, sol–gel (for example: EDTA route, glycerin method and PVA process) and solid-state reaction have been developed to synthesize single-phase BFO. No work has been reported concerning the synthesis of $Bi_2Fe_4O_9$ via chemical co-precipitation. BFO nanoparticles were successfully synthesized by chemical co-precipitation method at room temperature. The pH value in this experiment was fixed on 8, 10 and 12. The as-prepared powders, characterized by X-ray diffraction (XRD), field emission scanning electron microscope (FESEM) and vibration sample magnetometer (VSM). Kinetic of reactions increase with increasing pH value and result in non-homogeneity in precipitate that causes impurities. Cubic shape of particles indicates pure phase formation of $Bi_2Fe_4O_9$. The size of crystallites was 120 nm calculated from Scherer equation. The magnetic hysteresis loop shows the anti-ferromagnetism (AF) ordering in synthesized BFO.

Keywords:

$Bi_2Fe_4O_9$, Co-precipitation, Electroceramic, Synthesis

A study on the Effects of Surfactant Type on Iron Oxide Nanoparticles Morphology

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Abstract:

The aim of this study is to synthesize the iron oxide nanoparticles by hydrothermal method. In addition, the effects of various surfactants i.e. urea, oleic acid and triethanolamine on the morphology and size of the pigment was investigated. X-ray diffraction (XRD) analysis and field-emission scanning electron microscope (FE-SEM) analyses were utilized to investigate the phase structure and morphology of the nanoparticles, respectively. Results obtained revealed that the iron oxide nanoparticles with the same particles size but having flower like, polygon, quasi-spherical and octagon morphologies were produced using different types of surfactants.

Keywords:

nano magnetite, hydrothermal, morphology

Effect of Humidity on the Processing and Electrical Characterization of Potassium Sodium Niobate Piezoceramics- a Comparative Case Study

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Abstract:

Effect of humidity on the processing and electrical characterization of potassium sodium niobate piezoceramics- A comparative case study Mahdi Feizpour and Touradj Ebadzadeh Materials and Energy Research Center, Karaj, Alborz, Iran feizpour@gmail.com Abstract: Among different groups of lead-free piezoelectric ceramics, potassium sodium niobate (KNN) has some interesting properties which make it a promising substituent to lead-based piezoelectrics. One major drawback in dealing with KNN is its sensitivity to the moisture. The aim of this study is to find out how the moisture affects the properties of stoichiometric (K0.50Na0.50) NbO_3. The results are based on the experiences of working in two different research institutes, 1) Materials and Energy Research Center, Karaj, Alborz, Iran and 2) Jožef Stefan Institute, Ljubljana, Slovenia, with average annual relative humidity of 53 and 78 % in 2014, respectively. The average relative density and dielectric loss at 1 kHz at room temperature of sample synthesized/sintered/measured in Iran were 94.0 % and 3.4 % respectively, while they were 91.5 % and 30.1 % for the sample synthesized/ sintered/ measured in Slovenia. In order to ensure the removal of the adsorbed water from the compacted sample, a pre-annealing step at 450 ˚C for 4 h was introduced to the sintering curve in Slovenia, and sintering was carried out in a completely open crucible configuration. These caused the density of sample to increase to 93.4 %. However, the problem of humidity was still available for the electrical characterization in Slovenia. Measuring the dielectric loss versus temperature showed a remarkable increase upon cooling from 100 ˚C to room temperature. The results of this study showed that choosing a less-humid environment will allow easier handling in the process and less difficulties in the electrical characterization of final KNN products. Keywords: Humidity, Piezoelectric, Potassium Sodium Niobate.

Keywords:

Humidity, Piezoelectric, Potassium Sodium Niobate

Factors Controlling Magnetic Properties of $CoFe_2O_4$ Nnanoparticles Synthesized by Chemical Co-Pericipitation

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Abstract:

Chemical co-precipitation method is proposed for the synthesis of $CoFe_2O_4$ nanoparticles with high coercivity (H_C) and moderate saturation magnetization (MS). Cobalt ferrite nanoparticles possess unique properties such as strong magneto-crystalline anisotropy, moderate magnetization, high coercivity and good mechanical hardness, which made this ferrite a promising candidate for high density recording media. The applications of cobalt ferrite are limited due to the lack of synthesis technique to produce nanoparticles with high crystallinity and particle size close to the single domain size. It is well known that the degree of crystallinity and particle size can be controlled by adjusting the supersaturation condition during the nucleation and crystal growth processes. Based on this premise, the effect of reaction temperature, reaction time, pH value, reactant concentration, and feeding rate of reactant solutions were evaluated. X-ray diffraction analysis (XRD), Fourier Transform Infrared (FTIR), scanning electron microscope (SEM), particle size analyzer (PSA), and Vibrating Sample Magnetometer (VSM) were carried out at room temperature to study the structural and magnetic properties of nanoparticles. X-ray patterns revealed the production of single cubic phase with the average particle sizes of 4 to 25 nm for pH change from 8 to 13, respectively. The FTIR measurements between 400 and 4000 cm-1 confirmed the intrinsic cation vibrations of spinel structure. M–H measurements verified the strong influence of synthesis conditions and crystal size on the magnetic properties of ferrite nanoparticles. The coercivity values increased from 0 up to 2300 Oe under optimum synthesis conditions.

Keywords:

Coercivity, $CoFe_2O_4$, ferrites, nanoparticles

Ultra High Temperature Ceramics

Sinterability Improvement of ZrB_2-Cased Ceramics Fabricated by Hot Pressing

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Abstract:

Because of strong covalent bonding, low bulk and grain boundary diffusion rates, high melting point and high vapor pressure, the sintering of ZrB_2 usually needs high temperature and external applied pressure. At the first stage of this research, monolithic ZrB_2 was hot pressed without using any sintering aid or secondary phase as the obtained relative density was about 92%. In this case, the final microstructure of ceramic faced with a fanatic grain growth. Hence, SiC particles was used to increase the density and improve the sinterability, which is the most common additive in ZrB_2-based composites. Due to the presence of SiC, some densification mechanisms such as mechanical interweaving, particles fragmentation and rearrangement, plastic deformation of grains and diffusion processes were activated and resulted in a higher density at 1850 °C. Using 200-nm SiC particles increased the driving force of the sintering as the theoretical density was obtained at 1850 °C. The addition of 200-nm ZrO_2 particles caused to an increased density through the reaction of ZrO_2 and SiC which led to the formation of dense ZrC. The addition of carbon additives (graphite and graphene) led to achieving the full density at 1850 °C via the chemical reactions with the surface oxide impurities on the starting powders.

Keywords:

Zirconium diboride, Sinterability, Hot pressing, Additive, Relative density

Spark Plasma Sintering of Ultra-High Temperature Ceramic carbides: From Conventional Methods Toward Nano-Engineered Composites

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Abstract:

Tantalum and hafnium carbides are classified as Ultra High Temperature Ceramics (UHTC) because of their extremely melting temperatures (above 3900 ºC). Therefore, these materials can safely operate in the range of temperature that any other materials could hardly be existing. However, these applications can be strongly restricted due to (1) processing difficulties and (2) low fracture toughness. In this work to address these two difficulties we have used two additives, which are multi-walled carbon nanotubes (CNTs) and molybdenum disilicide ($MoSi_2$). The CNTs were added aimed to improve the fracture toughness of the composites, and the MoSi2 to facilitate sintering. Application of such sintering aid, add to the novel SPS technique, allowing quick processing at relatively lower temperature, results in (1) fully densified specimens (>99%) and (2) well-surviving CNTs after sintering. Moreover, microstructural analysis points out fair-enough dispersion of the CNTs within ceramics particles, in the both green and sintered bodies. Also the specimens phase characterization shows inter dissolution of TaC and HfC and formation of binary carbides solid solution.

Keywords:

Tantalum Carbide, Hafnium Carbide, Carbon Nanotubes, Spark Plasma Sintering, Microstructure

Characterization and Densification of $La_2Zr_2O_7$ Powders Prepared by Coprecipitation Method

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Abstract:

Pyrochlore-type lanthanum zirconate ($La_2Zr_2O_7$) has been recently received considerable attention due to its unique physical and thermal properties, including high melting point (>2000˚C), low thermal conductivity, relatively high thermal expansion coefficient, good thermal stability and the ability to accommodate defects. However, its low sinterability has made it difficult to fabricate a dense body at relatively low temperatures. A number of methods can be employed to prepare lanthanum zirconate powders: among them, coprecipitation method is a simple technique which allows the preparation of fine powders with compositional homogeneity and high sintering ability. This paper reports preparation and characterization of $La_2Zr_2O_7$ powders at different pH values through the simple coprecipitation technique and investigate the densification behavior of powders Therefore, $La_2Zr_2O_7$ was synthesized at various pH values by using $La(NO_3)_3.6H_2O$ and $ZrOC_{l2}.8H_2O$ as the starting materials. The initial pH was adjusted to the values of 8, 10 and 12 by the addition of ammonium hydroxide. In order to investigate the influence of pH value on the phase evolution and morphological property of powders, X-ray Diffraction (XRD) and Scanning Electron Microscopy (SEM) were employed. The XRD results revealed that the pure single phase $La_2Zr_2O_7$ powders were formed at pH values of 10 and 12. The SEM micrographs showed that a gradual increase in the initial pH contributes in micron-size agglomerates. After sintering the optimum powders at 1550˚C for 2 h, bodies with the relative density of 80 % were obtained

Keywords:

lanthanum zirconate, coprecipitation, pH

Effect of SiC Reinforcement on the Microstructure and Mechanical Properties of TiB_2-Based Composite

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Abstract:

In recent years, titanium diboride has widely used in the industries because its unique properties such as high hardness and high melting point. In this study, TiB2-based composites with different amounts of SiC reinforcement were prepared by hot pressing process at 1850 ˚C under a pressure of 20 MPa for 60 min. The microstructural observations and the density measurements indicated that an improved densification (near full density) and a fine-grained structure is achievable by the addition of SiC. Moreover, it was concluded that the highest hardness and fracture toughness were obtained in the composites reinforced with 15 and 25 vol% SiC, respectively.

Keywords:

TiB_2–SiC composite, Hot pressing, Grain growth, Mechanical properties, Microstructure

Effect of Temprature and Molten Salt Compositions on Synthesis of ZrB_2 Power via Molten Salt Synthesis

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Abstract:

ZrB_2 has excellent properties such as high melting point, high chemical resistance and high electrical and thermal conductivity. Zirconium diboride was synthesis by molten salt method with ZrO_2 and B_2O_3 as starting material and Mg as reluctance spice with $MgCl_2$ as molten salt media in the desired temperature. For investigation the effect of temperature on morphology and purity of synthesized ZrB_2 blend mixture of starting material was heated to 800, 1000 and 1200 ˚C temperature and the obtained powder characterized with XRD and SEM with DTA/TG analysis possible reaction at different temperature in this system was studied. Results shows that temperature has critical effect on purity of synthesized ZrB_2. Base on thermodynamic data and similarity of ZrO_2 particle with ZrB_2, template growth mechanism was proposed for ZrB_2 synthesis from molten salt approach.

Keywords:

Zirconium Diboride, Molten salt, Magnesiothermic, template growth mechanism, morphology

Synthesis and Characterization of HfB_2 Nanopowder

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Abstract:

Many efforts have been made to develop ultrahigh temperature ceramics (UHTCs). Hafnium diboride (HfB_2) is a leading material in the category of UHTCs due to very high melting point (3380˚C), high thermal and electrical conductivity, good thermal shock resistance, low coefficient of thermal expansion, retention of strength at elevated temperatures and stability in extreme environments, high hardness and chemical stability in corrosive environments. In this work HfB2nano powder was synthesized in via borothermal reduction. The designated solid-state reaction was the result of modification of conventional carbo/borothermal reduction, to eliminate impurities such as HfO_2 and HfC in the final product. Thereby, reduction of HfO_2 was occurred in the presence of B_4C. HfO_2 and B_4C powders as precursors were ballmilled up to 6h. Subsequently, the powder mixture specimens were heat treated at 1200-1500˚C for 1-2h in argon atmosphere. To study the effects of ballmilling and heat treating on synthesis, the powder phases were investigated by X-ray diffraction and the particle size and morphology was observed by scanning electron microscopy. The results of XRDindicates that pure HfB_2 has prepared at 1500˚C. SEM images show the fine and uniform morphology of synthesized powder, particle size has reduced to lower than 100nm in 6h ballmilled specimens. Also, the presence of undesired elements was distinguished by X-Ray fluorescence spectroscopy. Qualitative results exhibit that the specimen heat treated at 1500˚C for 2h has reached to more than 99% purity.

Keywords:

HfB_2 nanopowder, HfO_2, B_4C, Borothermal reduction

Ceramics Thin Films & Coatings

Study the Photocatalytic Degradation of Oleic Acid on TiO_2 Thin Film

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Abstract:

TiO_2 thin film on glass surface was synthesized by a sol gel method using tetra-isopropyl orthotitanate (TiPT) and ethanol solution as precursors and dip coating method. UV-Visible spectrum of TiO_2 thin film shows a transparent film has been formed. Morphology, uniformity and the thickness of thin film was investigated by Scanning Electron Microscopy (SEM) images and the thickness of thin film was measured about 285 nm. X-ray diffraction (XRD) confirms TiO_2 nanoparticles were formed in anatase crystalline structure and the crystallite size was calculated using Deby-Scherrer formula about 12 nm. Photo catalytic property of TiO_2 nano layer was studied using photo degradation of methylene blue and oleic acid on the surface under UV light irradiation, it was observed a 70% reduction of methylene blue concentration after 4 hours UV irradiation. The water droplet contact angle has been measured by Dino-Light Digital Microscope. Contact angle measurement for water droplet after 24 hours UV irradiation, shows decreasing from 75 to 45 degree for coated TiO_2/glass by oleic acid, while it increased from 43 to 67 for coated glass by oleic acid.

Keywords:

Contact angle, Glass, Oleic acid, Photocatalysis, TiO_2

Investigation of Silicon Carbide Nanoparticles Suspension Stability and Coating on Carbon- Carbon Composite by Electrophoretic Deposition Method

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Abstract:

Oxidation resistant coatings are suitable solution for protection of carbon materials at high temperatures. Silicon carbide (SiC) coating is one of the best coatings for this purpose. One of the methods of nanoparticles coating is Electrophoretic deposition (EPD). In this method, charged particles dispersed in liquid medium, in the presence of an electrical field, are attracted on a conductive substrate with opposite charge.
The aim of this research is investigation of stability of silicon carbide nanoparticles suspension in alcoholic solvents and coating it on carbon- carbon composite by electrophoretic deposition method. In order that, different suspensions in ethanol, methanol and isopropanol solvents were prepared without and in presence of poly ethylene imin (PEI). Stability of suspensions was investigated by photographs after 24 h and measurement of zeta potential and particles size distribution of the suspensions. Results showed that suspension of silicon carbide nanoparticles in ethanol at pH=10 and in presence of 6%wt PEI has better stability. Subsequently, the coating from optimum suspension was applied on the substrate with voltages of 20, 30, 40 and 50 V in 2 min. Quality and thickness of the applied coating was investigated by scanning electron microscope (SEM). The coating with optimum suspension at voltage of 30 V has better quality and homogen and pitless surface. Also, it was seen that by increasing of the voltage to 40 V, thickness of the coating increases and at higher voltages its value decreases.

Keywords:

electrophoretic deposition, SiC nanoparticles, carbon-carbon composite, suspension stability, particle size

Influence of Sol Concentration on Properties of ZnO thin Films Synthesized by Dip- Coating Method

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Abstract:

There are many parameters which can affect sol-gel dip coated thin film properties. ZnO thin films were deposited on glass substrates by using a sol–gel dip coating technique with varying precursor concentrations. The sol was prepared by using zinc acetate dihydrate (ZAD) as precursor, triethylamine as additive, and 1-propanol as solvent. X-ray diffraction (XRD), field emission scanning electron microscopy (FESEM), and UV-Vis spectroscopy were used to investigate the effect of sol concentrations on the crystallinity, surface morphology, and optical properties of the films. XRD spectra show that the films are polycrystalline with a wurtzite crystal structure and exhibit highly c-axis preferred orientation along (002) plane. FESEM images show that the mean grain size and porosity of ZnO film increase by the ZAD concentration. However, the transmittance and optical band gap of ZnO films remain unchanged with sol concentration.

Keywords:

ZnO thin film, Sol-gel dip coating, Sol concentration, Preferred orientation.

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Effect of the Various Synthetic Parameters on the Silica Film Formation

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Abstract:

In this research work, we used one-step sol-gel method to prepare the hydrophobic silica films on glass substrate. Silica alcosols were synthesized by tetraethoxyortosilicat (TEOS) as a precursor, phenyltriethoxysilane (PTES) as a co-precursor, ethanol (EtOH) as a solvent in the presence of ammonium hydroxide as a catalyst. We investigated the influence of the sol-gel reaction parameters, such as catalyst, solvent and water content and their effects on the morphology and hydrophobic properties of silica films. For preparing coating solution with different hydrophobicity, the molar ratio of TEOS: PTES was kept constant at 1:1 and concentration of ammonium hydroxide, solvent and water content were varied. The silica films were characterized by atomic force microscopy (AFM), field emission scanning electron microscopy (FE-SEM) images, contact angle measurement (CA). The results revealed that by controlling the sol-gel reaction parameters such as NH_4OH, H_2O and EtOH, it would be possible to achieve transparent hydrophobic silica coatings with different hydrophobicity from 100º to 120º. The FE-SEM images showed that by changing the catalyst concentration, water and alcohol content in the silica alcosol, different size of silica nanoparticles ranging from 24.33 to 34.23 nm were obtained.

Keywords:

Sol-gel parameter, PTES, Hydrophobic surface, Silica film.

Mullite Oxidation Resistant Coating for SiC-Coated Graphite by Plasma Spraying

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Abstract:

To improve the oxidation resistance of graphite materials, mullite coating was prepared on the surface of SiC-coated graphite by plasma spraying. The efficiency of the coating against oxidation was characterized by means of heat treatment of the coated specimens at 1100, 1250 and 1450°C. X-ray diffraction analysis (XRD) and Scanning Electron Microscope (SEM) were used for characterization of mullite coating. The XRD analysis shows that the phase of the outer-layer coating is composed of mullite, and the inner-layer coating is mainly composed of SiC. Results of oxidation tests indicated that, mullite coating exhibited good oxidation resistance. After 9 h oxidation at 1450°C, the weight loss of the coated specimen was only 11%.

Keywords:

SiC/ Mullite coating, plasma spray, oxidation resistance

Evaluation of Nano Bioactive Calcium Phosphate Glass-Ceramic Coatings on Zirconium by Sol-Gel Method

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Abstract:

In this study the glass-ceramic SiO_2-P_2O_5-CaO was coated as a bioactive ceramic on Zirconium substrate by sol-gel technique. The rate of bioactivity of produced coatings was investigated in simulated body fluid (SBF) solution. Prepared samples were characterized by X-ray diffraction (XRD) and Infrared transmission spectroscopy (FTIR) before and after immersion in SBF solution. In addition, quality and morphology of coatings were analyzed by Scanning Electron microscopy (SEM). The results show that the main part of formed phase has been remained amorphous and also crystalline wollastonite ($CaSiO_3$) and apatite ($Ca_{10}(PO_4)_6(OH)_2$) phases have been formed. By increasing the immersion time of glass-ceramic coatings in SBF solution, the content of wollastonite has been reduced and the content of carbonated hydroxyapatite has been increased. This dissolution and re-deposition lead to decreasing roughness and porosity of coating and stability of coating surface is get more uniform with time.

Keywords:

Zirconium, sol-gel, glass-ceramic

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Investigation of Photocatalytic Activities of Nanostructured Nitrogen Doped TiO_2 thin Films Under Visible Light Prepared via Sol-Gel Method on Type 304 Stainless Steel

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Abstract:

Nowadays photocatalyst materials especially TiO_2 are widely used in different fields and industries such as self-cleaning surfaces, water purification, solar cells and biomaterials. A great drawback about TiO_2 as a practical photocatalyst material is its wide band gap energy. TiO_2 can only cause photocatalytic reactions under UV light; therefore its indoor applications as a photocatalyst material are restricted due to the lack of UV light in such places. In this research, nanostructured nitrogen doped TiO_2 films were prepared on type 304 stainless steel by sol-gel method using an airbrush to apply the sol on the surface of the steel, then samples were calcined at various temperatures between 400°C and 600°C. Grazing incidence XRD and conventional XRD were used to determine the phase composition of the samples, the thickness of films were measured by ellipsometry, also UV–Vis spectra analyses (in diffuse reflectance mode) was utilized to estimate their band gap energy. Results showed that films thickness was 150nm and due to doping of nitrogen into TiO_2 structure, its band gap energy reduced to 2.85 eV which was completely shifted toward visible region. Measurement of methylene blue degradation under visible light was used to investigate the photocatalytic activities of thin films. The sample that was calcined at 500°C showed the best photocatalytic performance and it degraded 22% of methylene blue after 2 hours under visible light.yield is 7.1-7.9% in simulated solar light and 12% in diffuse daylight. The l

Keywords:

Visible light activated TiO_2, Nanostructured thin film, Photocatalysis, Sol spraying

Effect of Deposition Temperature on the Deposition Mechanism of Chemically Deposited Nanostructured PbS Thin Films

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Abstract:

Lead sulfide have been the subject of the considerable research due to the technical importance in crystalline and polycrystalline forms as infrared radiation detectors, infrared emitter and solar control coatings. Chemical solution deposition offers a simple, cost effective and industrially scalable route for the fabrication of high-quality semiconductor films.

The two principal deposition mechanisms in which CBD proceed are known as cluster mechanism and ion by ion mechanism. By controlling the deposition conditions such as time or temperature it is possible to control the active deposition mechanism. Each mechanism has specific deposition rate and morphology. So evolution in mechanism results in changes in the final film thickness and morphology.

In this work, PbS thin films were deposited from solution containing $Pb(NO_3)_2$, $CS(NH)_2$ and NaOH on glass substrate at different temperatures. The films were characterized by several structural technique including X-ray diffraction, atomic force microscopy, scanning electron microscopy.

The results of present study suggest that the transition in the active deposition mechanism occur with increasing in deposition temperature and affect the films properties such as thickness and morphology.

Keywords:

PbS thin film, Chemical Bath Deposition, Deposition Mechanism

The Effect of Titania on the Micro-Scratch Behavior of HA-TiO_2 Nanostructured Composite Coatings Fabricated by Electrophoretic Deposition

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Abstract:

In the present study, the HA/TiO_2 nanostructured composite coatings with 0, 10 and 20 wt% TiO_2 were fabricated by electrophoretic deposition to reduce thermal expansion coefficient mismatch between hydroxyapatite and Ti substrate. Micro-scratch tests in progressive load mode, were examined based on the linear elastic fracture mechanics for evaluation of adhesion strength, tribology and fracture toughness of coatings. The critical loads in micro-scratch test for crack initiation (L_{c1}) and delamination (L_{c2}) were increased by the addition of TiO_2 content in the coating. The maximum critical scratching distance and normal load were obtained for the HA-20 wt% TiO_2 composite coating. According to Hertz theory, the critical contact pressures (P_{c1}=3.71 GPa and P_{c2}=5.18 GPa) were obtained for HA-20 wt% TiO_2 sample. Moreover, the calculated fracture toughness of coatings was increased by the addition of TiO_2. The scratch grooves were characterized by scanning electron microscope (SEM). The phase and structural agents of the coatings were analyzed by X-ray diffraction (XRD) and FT-IR, respectively.

Keywords:

Micro-scratch, Electrophoretic deposition, Hydroxyapatite, Titania, Fracture toughness

Enhancements of Corrosion Behavior and Bioactivity in HA-TiO_2 Nanostructured Composite Coatiings Fabricated by Electrophoretic Deposition

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Abstract:

In the present study, the HA-TiO_2 nanostructured composite coatings with 0, 10 and 20 wt% TiO_2 were fabricated by electrophoretic deposition at 20 V for 3 min. Electrochemical corrosion behavior of the samples was conducted in SBF solution at 37ºC by potentiodynamic polarization tests. The corrosion parameters were obtained by Tafel extraploation. For the effect of titania on apatite formation, electrochemical impedance spectroscopy after in-vitro tests were conducted on coatings. The recorded impedance spectra were modeled by fitting the data with an equivalent circuit. Based on the electrochemical corrosion behavior of samples in SBF solution at 37ºC, the corrosion current density and corrosion rate significantly decreased by implementation of TiO_2 while corrosion potential and linear polarization resistance were increased. Also, the EIS analysis revealed that the total resistance of HA-20 wt% TiO_2 sample is higher than that of other samples. The accelerated apatite formation on HA-20 wt% TiO_2 sample corresponding to ICP analysis was attributed to the higher wettability of the coating surface.

Keywords:

Corrosion behavior, Electrophoretic deposition, Bioactivity, Hydroxyapatite, Titania

Fabrication and Characterization of Electrophoretically Deposited Functionally Graded HA/TiO_2 Nanostructured Coatings

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Abstract:

The Ti-6Al-4V alloy with favorable mechanical properties has been widely used in fabrication of bioceramic coatings on metallic substrate. Hydroxyapatite, the main constituent of the bone and teeth, is known as a biocompatible ceramic material with high osseoconductivity. In this work, functionally graded coatings of HA/TiO_2 nanoparticles were fabricated by electrophoretic deposition on Ti-6Al-4V substrate. The sharp variation in thermal stresses at coating-substrate interface was reduced by using graded structure of coating. The functionally graded structure of HA/TiO_2 coatings was formed by gradual addition of HA suspension into the deposition cell containing TiO_2 nanoparticles. The results of micro-scratch tests and potentiodynamic polarization measurements showed that the graded structure of the coating could efficiently increase the bonding strength between coating and substrate as well as corrosion resistance. The microstructure and chemical composition of coatings before and after sintering were characterized by scanning electron microscope equipped with energy dispersive spectrometry. The X-ray diffraction was used for phase analyses of coatings before and after sintering.

Keywords:

Functionally graded materials, Electrophoretic deposition, Hydroxyapatite, Titania, Microstructure

Investigation on the Surface Chemical Properties of Carbon Nanotubes on Its Electrophoretic Deposition Process

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Abstract:

In this study the deposition of the multi layered modified nanotube by electrophoresis method (EPD) with DC is investigated. Carbon nanotubes' functionalization leads to their stabilization in the aqueous and organic environments. The deposition using electrophoresis process has many applications for the functionalized carbon nanotubes in manufacturing of solar cells, polymeric batteries, electrical sensors and display electrodes (SED). The surface of the carbon nanotubes was modified with three different functional groups such as -COOH, -SOCl, -NH by using wet chemical method. FTIR peaks have determined the functional groups of carboxyl, chlorine and amine on the surface of carbon nanotubes. The electrophoretic behavior of each of the modified samples was determined. After this part some amounts of the carbon nanotubes was stabilized in pure ethanol by ultrasonic waves for the deposition. Then in a constant 10-minute time, each of the three groups was deposited on aluminum electrodes with 60, 120 and 180 voltages. The deposition of carboxyl and amine-labeled samples was on the positive pole while the accumulation of particles in the chlorinated sample was on the negative pole. The quality of the obtained coatings in the images taken by the optical and electronic microscopes was determined. The best mass deposition and the coating accumulation were for carboxyl, chlorine and amine samples respectively. The maximum current density is related to amine sample which indicates the presence of the impure ions in the system. The slope of the current density plots shows the stability of modified nanotubes in the ethanol solvent.

Keywords:

CNTs, surface modification, electrophoresis, composites

The Growth of TiO_2 Based Nanotubes via Anodization with Emphasis on Photocatalytic Activity

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Abstract:

In this work, TiO_2 nanotubes were grown via anodizing of titanium substrates in HF containing electrolytes. The samples were characterized in detail by XRD and SEM techniques. Besides, photocatalytic characteristics were evaluated through measuring the degradation rate of 4-chlorophenol under UV-irradiation to establish a correlation between structure and photochemical properties. We were able to control morphology and growth mode of nanotubes from a porous to a tubular structure by changing the voltage, HF concentration and time. We showed that a complete tubular structure with a 75 nm diameter and a 300 nm length formed when the samples were anodized under applied voltage 20 in 0.5% HF for 60 min. In order to get a defined crystalline structure, thermal annealing was carried out at 550°C in air for 1.5 hours at a heating and cooling rate of 10 °C/min. The samples possessed an anatase-rutile matrix where the anatase/rutile ratio was found to decrease with the concentration of HF in the electrolyte. The formation of TiO_2 nanotubes enhanced the photocatalytic activity, mainly due to a larger surface area caused by tubular structure. In the end, a correlation between structure and photocatalytic characteristics of nanotubes was established.

Keywords:

TiO_2 nanotubes, Anodization, Photocatalyst

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Electrophoresis of MWCNT for Developing the Counter Electrode in Electrochemical CO Gas Sensor

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Abstract:

Design and development of alarm system for CO gas poisoning has an undeniable necessity in related technologies. Electrochemical gas sensors in respect to other sensors for detection of CO gas has extra advantages such as working at low temperature, fast respond and better selectivity. The fundamental mechanism is based on oxidation of target gas and generating electrical current. Oxidation of input gas at working electrode is completed by reduction of water at counter electrode. In this research a new method for developing the carbon counter electrode based on electrophoresis of MWCNT (Multi Wall Carbon Nano Tube) is demonstrated. Best deposition voltage found to be 150 V for 10 minutes run. The result of liner-voltammetric analysis showed that during the purge of CO gas the reduction of water at counter electrode easily occurs. Then, with the help of Pt film as working electrode a demonstrating sensor has been set upped which is used for dynamic gas analysis. The response level to CO gas was 8.35 micro-Amper while the response time was 35 seconds. The electrophoresis of MWCNT for developing the counter electrode was found to be a new, unique, powerful and easy use method as an application in electrochemical CO gas sensor production line.

Keywords:

Electroporetic deposition, Electrochemical gas sensor, CO, MWCNT, cyclic-voltammetric, dynamic gas analysis

The Role of Environmental Parameters and Preparation Techniques on Electrophoretic Deposition Process

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Abstract:

Electrophoretic Deposition (EPD) is one of the forming and preparation techniques for thick layers which has been noted and mentioned in lab research projects and academic researches; but still it's not been favored to most of the expensive techniques in industries for the same process despite the wide range of endeavors, activities and reports about EPD. While the simple and low-cost apparatus and overcoming the problems of working with nano-particles are known as the strength points of this technique. This research is an endeavor to find the answer of what are some of the factors affecting this process. Environmental factors which can affect the process and are not easy to control in compare with lab sizes are probed. This research is based on testing with ceramic oxides specially ZnO. Organic liquids like Acetone, different alcohols and etc. are used to prepare the suspensions. We have worked with DC electricity and the layering process is done on metal electrodes. Besides, the role of factors like changing the level of impurity of the suspension, the manner of elution, keeping the suspension for a period of time, the differences in different powders behaviors in layering and the substance which is used as electrodes are probed by comparing the layering weight.

Keywords:

Electrophoretic Deposition, Nano Ceramics, Ceramic Coating, DC Electric Fields, Organic Based Ceramic Suspensions

Nano
Bio
Ceramics

Fabrication, Characterization, and Cytotoxicity Evaluation of the Bioactive Glass and Hydroxyapatite Nanoparticles in Hard Tissue Engineering

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Abstract:

Because of biological properties, high bioactivity and osteoinduction properties, bioactive glass (bioglass) have been favored in recent years. On the other hand, the application of Hydroxyapatite (HA), mineral phase of the bone, has been expanding in types of natural and synthetic kinds. This study aimed at preparation and bioactivity evaluation of nanobioglass and hydroxyapatite nanoparticles. Bioglass and HA nanoparticles were obtained by sol-gel process. Bioceramic specimens were characterized by X-ray diffraction (XRD), scanning electron microscopy (SEM) and energy dispersive X-ray analysis (EDX). As an index of bioactivity, HA formation ability on bioceramic specimens was evaluated in simulated body fluid (SBF). Toxicology and biocompatibility of specimens in contact to the bone marrow stem cells was carried out by conventional MTT method. The results showed that biocompatibility and bioactivity of bioactive glass is higher than hydroxyapatite. These findings confirmed by SBF and toxicology tests.

Keywords:

Nano bio-ceramic, Bioactiveglass, Hydroxyapatite, Cytotoxicity

Preparation, Characterization and Evaluation of Mechanical Properties of Hydroxyapatite/Boron Carbide Bioceramic Nanocomposite

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Abstract:

Matineh Atrian1, Fatemeh Tabatabaei1, Fahimeh Mirzaei1, Ali Doostmohammadi2* 1- B.S. Student, Materials Department, Engineering faculty, SHahrekord University, SHahrekord , Iran 2- Assistant Professor , Materials Department, Engineering faculty , SHahrekord University, SHahrekord , Iran Alidstm@gmail.com Abstract: In recent years, the application of bioceramics in bone repair and tissue engineering has been taken into consideration. Beside the excellent biological properties of bioceramics, improper mechanical properties have limited their applications.The aim of this work was preparation and characterization of hydroxyapatite/boron carbide (HA-B4C) nanocomposite with improved mechanical properties.B4C was added to nano hydroxyapatite in different weight percentages and after cold pressing, the samples were heated at 1100 C for 2 h in a vacuum furnace.The phase analysis, microstructure and composition evaluation of samples was investigated using XRD (X-ray Diffraction), SEM (Scanning Electron Microscopy) and EDAX (Energy Dispersive X-ray Analysis), respectively.Compressive strength and bioactivity of nanocomposite samples were also evaluated.The results showed that HA-5%B4C had the best mechanical and biological properties and can be a suitable choice for load bearing application.

Keywords:

Bioceramics, Nanocomposite, Hydroxyapatite, Boron carbide

Synthesize and Characterisation of Ti Substituted Hydroxyapatite

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Abstract:

Titanium containing hydroxyapatite (TiHAp) with molar ratio of X_{Ti}=Ti/(P+Ti)= 0.05 was synthesized through precipitation method following by a hydrothermal stage at 100ºC for 6 hours by using titanium complex as titanium source. XRD analysis carried out for samples after calcinations at 650ºC for 1 hour and the result confirmed the sample was pure hydroxyapatite. Investigation of the different binds in the titanium hydroxyapatite (TiHAp) structure was performed using Raman and FTIR spectroscopy. By adding titanium no new peak was observed in Raman spectrum but results of the fitting process show the changes in position and FWHM of the phosphate v_1 peak. Addition of titanium into HAp results broadening of the phosphate peak in Raman spectrum and also shifting the position of the peaks to lower wavenumber. Broadening and shifting of the Raman peaks is due to disorder structure and microscopic strain in the structure. pure apatite structure has negative charge equal to -5mv on the surface and by introducing titanium it become +1.5.In pure HAp anions such as HPO_4^{2-} lead to negative charge of the surface. By adding titanium some part of the titanium ions absorb on the surface of HAp.

Keywords:

Titanium hydroxyapatite, nanostructures, mechanism

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Porous Scaffolds of Polycaprolactone Diacrylate Reinforced with Hydroxyapatite for Bone Tissue Engineering

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Abstract:

Bone tissue engineering is gaining popularity as alternative method for treatment of osseous defects. Polycaprolactone (PCL) is a synthetic biodegradable polymer that has been approved for bone tissue engineering purposes. In this study polycaprolactone diacrylate (PCLDA) was obtained by the reaction of polycaprolactone diol with acryloyl chloride. Afterwards, porous scaffolds made of (PCLDA) / hydroxyapatite (HA) biocomposite were developed for bone tissue engineering applications. The composite scaffolds were fabricated by cross-linking of PCLDA in the presence of HA and particulate leaching method using sodium chloride particles as porogen. The chemical structures of PCLDA/HA networks were characterized using Total Reflectance Fourier Transform Infrared (ATR-FTIR) spectroscopy. The cross-section morphology of the scaffolds was examined by Scanning electron microscope (SEM). Moreover, the compression stress-strain curves of scaffolds were carried out by a universal testing machine. The compressive modulus was evaluated from the initial linear region of the stress-strain curve. The obtained scaffold presents a porous structure with interconnected pores. The incorporation of HA into PCLDA led to the improvement of compressive modulus of scaffolds. This might be attributed to a higher degree of crystallinity caused by the presence of HA. Cytocompatability of the composite scaffolds were assessed by direct contact test. Results indicated no toxicity, and cells attached and spread on the pore walls offered by the scaffols.

Keywords:

Tissue engineering, scaffold, Polycaprolactone diacrylate, Hydroxyapatite

Synthesis of Rutile Yellow Nano Pigment Based on Sb,Cr by NH_3 Co-Precipitation Methode for Digital Printers Applications

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Abstract:

The purpose of this investigation was to synthesize rutile yellow nano pigment based on (Sb ,Cr)TiO_2 by NH_3 Co-precipitation method. after required studies, the stoichiometric composition was chosen as $Sb_{0.045}$ $Cr_{0.015}$ $Ti_{0.94}$ O_2. Then particles size distribution and morphology of generated phase was characterized by X-Ray diffraction, Scanning electron microscope and Transmission electron microscope and l ,a and b parameters of obtained sample measured by CIE l*a*b* colorimeter . The results showed that ,the particles sizes of calcined powdered sample was less than 100nm at 400ºC. the particle sizes was about 20 to 70 nm, mostly. Also, the best yellow color obtained at this temperature. Furthermore, l, a and b parameters are reported as (39.6/17.5/60.3).the XRD patterns showed pure rutile phase at 1100ºC.

Keywords:

Nanopigment, yellow, rutile, co-precipitation

Synthesis of Strontium Aluminate Phosphor Powder Fine Doped with Eu^{2+} ($Sr_{0.97}Al_2O_4$: $0.03Eu^{2+}$) by Sol-Gel Method Using Microwave

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Abstract:

Double oxides containing Sr and Al are of interest in materials science because of their uses as long duration photoluminescence or thermoluminescence pigments. As one of the most promising phosphors, Eu^{2+}-doped $SrAl_2O_4$ shows strong luminescence and especially long persistent luminescence in green region. In this project, $SrAl_2O_4$ nanopowders were synthesized by sol–gel method and thermally treated at 700, 800, 900ºC and 1000ºC. The characteristics of synthesized powder were investigated by DTA, TG and XRD. The XRD patterns present strong reflections of samples calcinated from 900 to 1000 C indicating the $SrAl_2O_4$ monoclinic phase .In addition, Eu^{2+}-doped $SrAl_2O_4$ powder ($Sr_{0.97}Al_2O_4$:$0.03Eu^{2+}$) was synthesized and to reduce Eu^{3+} to Eu^{2+} was placed at microwave . The crystallite size of the final phosphore (calcinated at 900ºC) is about 37 nm as determined by Scherrer's formula. Fluorescent spectrophotometer results of the phosphor powder revealed that two excitation peaks are appeared at 238 and 339 nm and an emission peak at 515 nm. FESEM was used to study the morphology of the final powder.

Keywords:

strontium aluminate ($SrAl_2O_4$), monoclinic phase, nanopowder, phosphorescence, europium ion, Sol-gel method

Effect of Surface Modifiers on the Precipitation Synthesis of Copper Oxide Quantum Dots

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Abstract:

This investigation has been focused on synthesis of nanostructured copper oxide via precipitation process. Different surface modifiers (SMs) such as polyvinylpyrrolidone (PVP), Polyethylene glycol sorbitanmonooleate (Tween 80) and Cetyltrimethylammonium bromide (CTAB) have been selected for optimizing the size and shape of nano CuO. The characterization of copper oxide nanoparticles was performed using X-ray diffractometer (XRD), scanning and transmission electron microscope (SEM and TEM) and Uv-Visible spectrophotometer techniques. The results revealed that SM type should be noticed as a critical parameter in the synthesis of up to 10 nm CuO. Although, all SMs caused the formation of ordered spherical shape of CuO nanoparticles, but the size of nanoparticles was changed in the range of 5-30 nm due to the chemical nature of SMs. The smallest nanoparticles obtained in the presence of CTAB. However, concentration of CTAB introduced as the main effective parameter on size, shape and band gap of CuO.

Keywords:

Copper oxide, Precipitation, surface modifiers, Band gap, Morphology

Synthesis and Characterization of Electrospun Bioactive Glass Fibers Scaffolds for Bone Tissue Engineering

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Abstract:

Over the past decades, bioactive glass (BG) has been of a great interest in the bone regeneration field, due to its excellent biocompatibility, bioactivity and osteoconductivity. Herein, fabrication of bioactive glass as one-dimensional fibers by employing an Electrospinning process is reported. The Sol-Gel method was chosen considering the final fibers smoothness and homogeneity. Starting sol was prepared by mixing Tetraethyl orthosilicate (TEOS), Triethyl phosphate (TEP) and Calcium Nitrate as precursors in an adequate solvent. Fibers were obtained via Electrospinning the mixture of different ratios of BG and polymer solutions. Biocompatible Polyvinyl alcohol (PVA) was used in order to investigate the polymer effect. Furthermore, Electrospinning parameters such as voltage and working distance were examined. Following the heat treatment and depolymerization, X-ray diffractometery (XRD) was done. Besides, fibers morphology before and after calcination was observed in detail employing Optical Microscopy and Field Emission Scanning Electron Microscopy (FE-SEM). XRD patterns revealed the presence of bioactive glass. Results indicated that the fibers diameter and homogeneity were reduced after calcination showing an intensification as polymer increased.

Keywords:

Fibers, Bioactive Glass, Electrospinning, Bone Tissue Engineering

Chemical Synthesis and Characterization of Physical and Magnetic Properties of Cobalt Doped Hydroxyapatite Nanoparticles

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Abstract:

Synthesis of HAp is of considerable interest because of its similariity to mineral component of bone. It has good biocompatibility and bioactivity for bone tissue therapy. In this project, we looked at the effect of calcium substitution with cobalt divalent cation on the structure and magnetic property of HAp. Cobalt- doped HAp nanoparticles was synthesized via hydrothermal condition. First, Calcium nitrate and Cobalt nitrate was mixed. Then di- ammonium hydrogen phosphate was added drop by drop and finally Co-HAp was precipitated from the solution. The precipitate was heated at 200°C under hydrothermal condition. XRD pattern analysis verified the substitution of cobalt in HAp structure by showing a shift in the peak positions in the pattern. Furthermore, broadening and reduction in the peak intensities of the peaks with cobalt substitution was also observed in this study. The presence of functional groups related to HAp structure (PO_4^{3-}, OH-) were confirmed by FTIR analysis. The size and morphology of nanoparticle HAp particles were evaluated by FESEM analysis. Calcium substitution with cobalt induced size reduction and morphology change in HAp particles. VSM analysis was carried out to investigate the magnetization of HAp and Co-HAp nanoparticles. The results showed that cobalt substituted nanoparticles displayed paramagnetic properties, as opposed to the diamagnetism of pure HAp. Cobalt doped HAp, a biomaterial with magnetic properties, could be used in a variety of biomedical applications, including magnetic imaging, drug delivery and hyperthermia based cancer treatment.

Keywords:

Hydroxyapatite, Cobalt- hydroxyapatite, hydrothermal condition, nanoparticle, diamagnetic, paramagnetic

Synthesis and Investigation of Bioglass-Ceramic Containing Zirconium Oxide

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Abstract:

Bioactive glass- ceramics have ability to create chemical bonding with live tissue and used in hard tissue surgery. In this research, glass- ceramic based on the SiO_2-CaO-P_2O_5- ZrO_2 system, stabilized with yttrium, was prepared by the sol-gel method. After heat treatment at 700ºC, The prepared glass was partially crystallized. The structure and phase formation of synthesized powders were investigated using x-ray diffraction (XRD) and Fourier transform infrared spectroscopy (FTIR). The surface morphology and topography of powders was investigated by scanning electron (SEM). The presence of zirconium ions in the glass composition caused more growth of carbonated hydroxyapatite and zirconia on the surface of glass-ceramic. Also, this ion inhibits the growth of radical particles and smaller particles and homogenous particles have created.

Keywords:

Glass-ceramic, Sol-gel, Zirconia

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Synthesis of TiO_2 Nanoparticles Stabilized by Aromatic Capping Agent

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Abstract:

In recent years, the synthesis of titanium dioxide (TiO_2) nanoparticle has attained great attention due to its chemical stability, biocompatibility, photocatalytic reactivity, strong oxidizing power and low cost. In order to protect nanoparticles from aggregation, to manipulate the optical, electronic and catalytic properties, as well as to control interfacial properties, nanoparticles are generally capped by an organic layer. A novel preparation method for nanocrystalline titanium dioxide using an aromatic capping agent was introduced in this paper. XRD results exhibited that the obtained nanoparticles composed of anatase phase.

Keywords:

aromatic capping agent, titanium dioxide, anatase

In-vitro Evaluation of Layered Double Hydroxide/HA Composite Scaffolds for Bone Tissue Engineering Applications

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Abstract:

Pure layered double hydroxide (LDH), and Layered double hydroxides/ hydroxyapatite nanocomposite (LDH/HA ratio=75/25) powders were synthesized via a co-precipitation method. Aluminumnitrate, calciumnitrate and calcium hydrogen phosphate were used as starting materials, the reactions were carried out under controlled pH at the alkaline range, and after 22h aging were washed and dried. XRD, FTIR, and SEM techniques were used to characterize the chemical composition and microstructure of resulted powders. The results verified the presence of nanocrystals of HA and Ca-LDH. Gelatin was added to the powders using solvent casting method, and then the produced composites were freeze-dried. The resulting materials were exposed to glutaraldehyde 1% solution for 24h to become cross-linked, then the scaffolds were thoroughly washed with graded alcohols and distilled water three times. The porosity of the scaffold was measured by Archimedes' method. To evaluate the cytotoxicity of samples, the powders and scaffolds were immersed in a RPMI cell culture medium for 3, 7 and 14 days and the resulted extracts encompassed in exposure of the human osteosarcoma cell line (G-292) for 24h. The MTT-assay showed that not only the samples have no toxicity, but also the show a better cellular response in comparison with the CTRL sample; and statistically viability increased. The results of in-vitro evaluation confirmed biocompatibility and surface bioactivity of LDH. After 48h of exposing of the cells into scaffolds surfaces, the SEM images

showed well-behaved adhesion and spreading of cells and the scaffolds degradation. Based on this research's results, these novel composites have promising potential for bone tissue engineering applications.

Keywords:

Layered double hydroxides, Hydroxyapatite, Scaffold, Nanocomposite, Bone tissue engineering, Biological evaluation

Preparation of Aminomodified Mesoporous Silica as Insulin Drug Delivery System

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Abstract:

The aim of this study was to investigate the feasibility of insulin loading and drug-delivery behavior of aminomodified SBA-15 mesoporous silica. Morphological and structural characterization of SBA-15 and aminomodified SBA-15 were accomplished by different analytical techniques such as Scanning Electron Microscope (SEM), X-Ray Diffraction Analysis (XRD), Fourier Transform Infrared spectroscopy (FTIR) and Brunauer–Emmett–Teller (BET). The drug-loading capacity and drug release of the particles were investigated under simulated gastrointestinal conditions and phosphate-buffered saline (PBS) solution using FTIR and UV-Vis spectroscopy. Analytical and morphological studies performed on the samples showed the amorphous structure of both SBA-15 and SBA-15-NH2 with hexagonal cylindrical channels and open pores structure. Also, it was shown that morphology of SBA-15 was nearly wheat-like with almost homogeneous size distribution. Furthermore, it was revealed that SBA-15 particles have large surface area and pore volume and that SBA-15-NH2 has better capacity for loading insulin molecules. These prominent structural and morphological properties make mesoporous silica nanoparticles of SBA-15-NH2 structures promising materials as drug carrier for insulin delivery.

Keywords:

insulin, mesoporous silica, SBA-15

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Comparison of Copper Chromite Nano Particles Synthesized by Direct and Indirect Co-Precipitation Methods

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Abstract:

In this study, at first copper chromite ($CuCr_2O_4$) nanoparticles were prepared by inverse and direct co-precipitation methods. In these methods, cupric nitrate trihydrate, ($Cu(NO_3)_2.3H_2O$) and chromium nitrate nonahydrate, ($Cr(NO_3)_3.9H_2O$) with a mole ratio of 1:2 were used. Characterization of copper chromite was performed by X-ray Diffraction Spectroscopy (XRD), Fourier Transform Infrared Spectroscopy (FT-IR), and Field Emission Scanning Electron Microscopy (FE-SEM). The nature of metal oxides and carbon nanotubes were confirmed. The average crystallite sizes of obtained copper chromite were 18 nm and 23 nm for inverse and direct co-precipitation methods, respectively. The results showed that approximate size of copper chromite nanoparticles was 39 nm by inverse co-precipitation method while it was 61nm in direct co-precipitation method.

Keywords:

Nanocomposite, Copper chromite, Inverse, Co-precipitation, Direct

Study on Chitosan/PVA/MWNT Conjugated to Cefalexin Nano Composite Film for Drug Delivery Application

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Abstract:

Nanocomposite film of Chitosan(Cs)/Polyvinyl alcohol(PVA)/Multiwalled carbon nanotube conjugated to cefalexin was prepared with electrospining technique and the parameters that affects was studied to use as a wound dressing aimed to control surgery and skin infections. CNTs demonstrate properties such as nanometer size, high specific surface area and electrospinability that make them good candidate for drug delivery agent in this system. Covalant cojugation of cefalexin antibiotic to the surface of MWNT via Poly (ethylene glycol) as a linking agent has been done. The prepared solution of Chitosan/PVA/MWNT conjugated to Cefalexin with weight ratio of Cs/PVA: 30/70 and 0.5% MWNT-Cefalexin is most preferred for fiber formation and electrospinability. Different characterization techniques such as FTIR spectroscopy, Thermo gravimetric analysis (TGA) proved the presence of antibiotic on the MWNT surface and In-vitro tests proved the biocompatibility of the nanocomposite film. Given the simple, inexpensive procedures of our synthesis method, the Cs/PVA/MWNT-Cefalexin nanocomposite film has the potential to be used for skin infection treatment and surgeries.

Keywords:

Chitosan, Carbon nanotube, Cefalexin, electrospining, drug delivery

Synthesis of Nano Brown Spinel Pigment $Zn(Fe,Cr)_2O_4$ by Combustion Method

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Abstract:

The aim of this study was to synthesize spinel brown nano-pigment based on Zinc, Iron and Chromium, $Zn(Fe,Cr)_2O_4$, using combustion method by Urea as the fuel. The original ink sample was investigated as reference and characterized by XRD and XRF techniques. according to the observed analysis, metal nitrates was picked out as precursor reagents, the stoichiometric composition was specified and considered sample was synthesized. The calcination temperature was chosen about 450 using obtained results prepared by DTA technique and the powder heated for 8 hours. So, shape, particles size distribution and morphology of final generated phase were characterized by SEM, TEM and XRD analyzers and l, a and b parameters measured by CIE l*a*b* colorimeter. the obtained results prepared by X-Ray diffraction pattern showed zinc, iron, chromium spinel phase, mostly. observed particles size was about 10 to 40 nm and colorimetric parameters reported as (34,24.8,24.8). finally ,the spherical morphology was evident using transmission electron microscope (TEM).

Keywords:

Nano-pigment, Brown, Spinel, Combustion

Effect of Suspension Rheology on Nanostructured Al_2O_3 Green Body by Polyelectrolyte Dispersant

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Abstract:

The homogeneity of green bodies is of outstanding importance for sintering advanced ceramics. The uniform packing of particles in green (unfired) bodies is well known as a critical precondition for the preparation of dense, defect-free ceramics with superior optical and mechanical properties. With the investigation of the influencing factors on de-agglomeration of the received powder by ultrasonic process and also optimization of effective parameters on the stabilization of suspension, the researcher has tried in this research to observe the effect of these parameters on the level of sinterability and the distribution of pore size of the green samples. The results of the study show that, with the optimization of conditions, the samples made by basic suspensions (pH=9.5 and 0.8wt% related to alumina of dispersant), in spite of similar green densities, had a greater sinterability in comparison to samples made by acidic suspensions and uniaxial press samples.

Keywords:

Al_2O_3, sintering, slip casting, dolapix

Wear properties of mechanically alloyed and hot-pressed Al_2O_3-Al Nanocomposite

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Abstract:

In this study, Al matrix composite (AMC) powders containing 10 wt% of nano-size Al_2O_3 as reinforcing particles were mechanically alloyed by high energy planetary ball mill. Microstructure of produced composite powder at different milling times was investigated by X-ray Diffraction techniques and scanning electron microscope. A uniform distribution of the Al_2O_3 reinforcement in the Al matrix was obtained after 15 hours milling time at 250 rpm. The powders were then hot pressed at 400°C for 40 minutes by uniaxial pressing at 600 MPa. The results revealed the hardness and wear resistance of the composite increase by increasing of milling time, whereas relative density and grain size decrease. Wear test was carried out and resulted weight losses for various milling times at 20N were studied.

Keywords:

nanocomposite, aluminium, alumina, wear, mechanical alloying

Alumina-Hydroxyapatite Nanopowder Promote Proliferation and Osteogenic Differentiation of Mesenchymal Stem Cells

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Abstract:

Hydroxyapatite (HA) is a promising bioactive bioceramic for bone tissue regeneration due to its good chemical and biological similarity to mineral phase of natural bone. These positive traits are tempered by its low toughness and strength that limits its application in load-bearing conditions. A good approach for improving the mechanical properties of this bioceramics is fabrication of hydroxyapatite based composites with reinforcements such as alumina, titania and zirconia. Although investigation on the mechanical properties of this composites has shown good effects of alumina as reinforcement, less attention has been paid to its biological properties. In this study, HAp-Al_2O_3 nanocomposite powder with 10, 20, 30 wt. % of alumina was synthesized via sol-gel method. Mesenchymal stem cells (MSCs) derived from bone marrow of neonatal rabbits were cultivated in the culture medium containing a concentration of 100 µg/ml of powders for up to 14 days. Cytotoxicity, proliferation and differentiation of MSCs into osteoblast cells were determined using MTT assay, live/dead assay using fluorescence dyes, alkaline phosphatase (ALP) activity and alizarin red staining. After 14 days of culture, the sample containing 20% alumina showed the highest cell viability in comparison with others (103.6 %). The highest ALP activity was observed in HAp-30% Al_2O_3 and HAp-20% Al_2O_3 sample, respectively. Moreover, the formation of mineralized nodules in MSCs upon treatment with HAp-20% Al_2O_3 sample could produce more bone nodules. These findings are of important interest to develop materials for critical bone repair.

Keywords:

Hydroxyapatite, Alumina, nanopowder, mesenchymal stem cells, differentiation

Synthesis and Investigation of Anti-Bacterial Properties of SiO_2@Cu Nanorods with Core-Shell Structure

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Abstract:

Although the experimental study of spherical Silica has been extensive, similar studies on rodlike particles are rare because suitable model systems are scarcely available.In this study, the synthesis of silica nanorods with the ability to control the size and the effect of temperature on the particle size, coating it with copper and anti-bacterial properties have been evaluated. For the coating of nanorods copper sulfate as a source of Cu, ascorbic acid as a reducing agent and the PVP as surfactant were used.Prior copper deposition surface of nanorods were modified with APTES and surface coating were compared with not modified nanorods. Both procedures were performed in aqueous solutions and at 70 °C. The resulting particles were characterised by X-ray diffraction (XRD). Particle size by SEM and TEM study shows nanorods with diameters of 90 to 250 nm and a length of 2 to 40 micrometers. Nano-sized copper particles on the surface of the nanorods are between 5 and 25 nm. E. coli (Escherichia coli), S.aureus (Staphylococcus aureus) and C.albicans (Candida albicans) were used to test the antibacterial properties of coated particles. Antibacterial effect of the coated nanorods on S.aureus is far less than C.albicans and E.coli. The results shows copper particles on silica nanorods and good antibacterial properties of these particles.

Keywords:

nanorods, silica, Cu, antibacterial properties, core-shell

Preparing Hematite Nanomaterials for Photoelectrochemical Water Splitting

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Abstract:

A new nanostructured α-Fe_2O_3 photo electrode synthesized through chemical vapor deposition is presented. The α-Fe_2O_3 films consist of nano platelets strongly oriented perpendicular to the conductive glass surface. This hematite morphology was never obtained before and is strictly linked to the method being used for its production. Structural, electronic, and photocurrent measurements are employed to disclose the nano scale features of the photo anodes and their relationships with the generated photocurrent. α-Fe_2O_3 films have a hierarchical morphology consisting of nano branches. The process parameters mainly affect the microstructure, the density, the roughness, and the photoelectrochemical (PEC) activity. The highest photocurrent is shown by the photo anodes with the best balance between the platelets density and roughness. The so obtained hematite hierarchical morphology assures good photocurrent performance and appears to be an ideal platform for the construction of customized multilayer architecture for PEC water splitting.

Keywords:

photoanodes, α-Fe_2O_3, CVD process, photoelectrochemical (PEC) activity

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The Effect of Pore Expander on the Properties of Mesoporous Hydroxyapatite Nanoparticles Synthesized at Low Temperature

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Abstract:

Mesoporous hydroxyapatite nanoparticles are being considered as potential drug carriers in biomedical applications. Various methods have been utilized in the synthesis of this type of powders. In this study, the role of pore expander on the pore characteristics of mesoporous hydroxyapatite nanoparticles synthesized at low temperature has been investigated. 1-dodecanethiol (pore expander) and Cetyl trimethylammonium bromide (CTAB), a cationic surfactant were used as dual templates in this work. Samples with different pore expander/surfactant mass ratio (R) were synthesized through self-assembly method at 60 °C. The resulting samples were assessed by X-ray diffraction (XRD), Brunauer-Emmett-Teller (BET) surface area, small angle X-Ray diffraction and Fourier transform infrared spectroscopy (FTIR). The results revealed larger pore diameter, lower surface area and pore volume with the increase in R values. 1-dodecanethiol acted as a pore expander by diffusion into the micelle core with a swelling effect on the micelle structure. The field emission scanning electron microscopy (FESEM) micrographs indicated rod-like morphology for the synthesized particles with a decrease in rod length/diameter ratio with an increase in the R values. This was attributed to the presence of 1-dodecanethiol which caused a decrease in dielectric constant of water and therefore an increase in the repulsive force between the counterions of cationic surfactant. In conclusion it may be stated that the use of 1-dodecanethiol as pore expander or swelling agent can have a profound effect on the pore structure as well as morphology of the mesoporous particles.

Keywords:

mesopore, hydroxyapatite, CTAB, 1-dodecanethiol

Effect of Calcination Temperature on the Structural and Optical Properties of Zirconia Nanoparticles

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Abstract:

Among advanced ceramics, zirconia is attracting increasing interest due to its excellent chemical resistance, good mechanical strength, high fracture toughness and hardness, high coefficient of thermal expansion, low thermal conductivity together with relatively high coefficient of thermal expansion, resistance to thermal shock, and wide band gap. In this work, zirconia nanoparticles with average particle size of 27 nm were prepared by a facile, rapid, and cost-effective microwave-assisted method using zirconyl nitrate as the starting material. The synthesized nanoparticles were calcined at temperatures ranging from 100 ˚C to 600 ˚C. The samples were characterized by X-ray powder diffraction, transmission electron microscope, and Ultraviolet-visible absorption spectroscopy. The band gap energy of zirconia samples was found to be 5.5 eV. The effect of calcination temperature on the structural and optical properties of zirconia nanoparticles was investigated as well. The results clearly showed the presence of purely monoclinic phase of zirconia when the calcination temperature exceeds 400 ˚C.

Keywords:

Zirconia, calcinations, microwave-assisted method, band gap

The Effects of Nano-Sized Al_2O_3 on Properties of Magnesia-Doloma Refractories

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Abstract:

Magnesia-Doloma refractories has advantages such as stability in alkaline environments, clean steel production, resistance to acid slag, good cement kiln coating flexibility, low production cost. It also has some weaknesses such as low resistance to thermal shock and quick hydration. In the present study using Birjand Mines Magnesite powders and Dolomites from Zefreh, Esfahan, Magnesia-Doloma clinkers were pressed under the pressure 90 MP and prepared at 1650ºC in furnace under air atmosphere. The effect of adding 0, 2, 4, 6, and 8% of the Nanoparticles of α-Alumina on microstructure, Sintering behavior and properties was studied. Phase analysis of samples using X-ray diffraction (XRD) and the microstructure examined by Scanning electron microscope (SEM) was performed. The results show that by adding additives, physical properties such as bulk density, cold compaction strength (CCS) and Thermal shock resistance improved and samples of hydration resistance declined. Finally, according to the results obtained and the relationship with the microstructure, the optimal amount of nanoparticles of α-Alumina as an additive was determined.

Keywords:

Magnesia-Doloma, Nano α-Alumina, Refractory, hydration resistance

Sol-Gel Synthesis of Titanium Diboride Nano-Particles

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Abstract:

In this research, TiB_2 nano-particles have been prepared by sol-gel method. The phase and structural transformation were characterized using X-ray diffraction (XRD) and FTIR spectroscopy. The microstructure of products was evaluated by scanning electron microscopy (SEM) and transmission electron microscopy (TEM) techniques. Al_2O_3/TiB_2 nano-composite powder was prepared from TTIP and boron oxide using a sol-gel method followed by mechano-chemical reduction in the presence of Al. Optimum weight ratio of B_2O_3: TTIP in solution was 1:3. The XRD results reveal that mechano-chemical reduction mechano-chemical reduction of the zerogel resulted in the formation of TiB_2 and Al_2O_3 after 30h milling. As a result of leaching the Al_2O_3-TiB_2 nano-composite in 10M NaOH, Al_2O_3 has been removed and TiB_2 nano-particles with mean particle size of 20 nm remained.

Keywords:

Titanium diboride, sol-gel, mechano-chemical, nano particles

Protein Adsorption onto Surface of Polycaprolactam- Non Stoichiometric Hydroxyapatite Nanofibers

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Abstract:

Sorption processes have significant roles in many sciences and industries especially in biomedical application. In this study, the electrospun Nylon fibers was incorporated with positively charged zinc doped hydroxyapatite (HAp) nanoparticles to study the adsorption of negatively charged proteins, namely bovine serum albumin (BSA). Nanoparticles and nanofibers were prepared via chemical precipitation method and electrospinning process respectively. Biocompatible zinc cations were used to change the stoichiometric and electrostatic charge of HAp particles. Average of fiber diameter, porous size, porosity as well as thickness of nanocomposite membranes were measured 275±62 nm, 339±50 nm, 75% and 0.5 μm respectively. Results showed that the surface of membrane modified by ceramic nanoparticles could adsorb 70 percent more than nylon based membrane while both sockeing in protein solution for 5 h. The amount of BSA adsorbed onto the modified surface was 12 mg/cm2, it was because of creation of positively charged sites on the nanofibers.

Keywords:

Non- stoichiometric Hydroxyapatite, Nylon fibers, Surface adsorption

Synthesis of $ZnWO_4$ Nano Particles by Co-Precipitation for Manufacturing of X-Ray Scintillation

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Abstract:

In this study $ZnWO_4$ nano particles were synthesized through co-precipitation method with sodium tungstate dyhydrate ($Na_2WO_4.2H_2O$) and zinc nitrate hexahydrate ($Zn(NO_3)_2.6H_2O$) as starting materials. In order to optimize conditions to obtain smallest mean particle size, central composite design (CCD) was used and three parameters of temperature, weight ratio of precursors, and pH value in five levels were studied. Using CCD and Design Expert Software, a table of 20 experiments were performed. In this table, minimum and maximum of temperatures were 25 and 85, respectively. Minimum and maximum of precursor weight ratio were 0.5 and 1.5, respectively. Finally minimum and maximum of pH were 5 and 13, respectively. The obtained $ZnWO_4$ nano particles were characterized by scanning electron microscopy (SEM), powder x-ray diffraction (XRD), and differential scanning calorimetry (DSC). The results showed that optimal condition for smallest mean spherical nano particles with particle size of 42.04 nm were temperature =25, weight ratio of precursor equal to one and pH=7

Keywords:

$ZnWO_4$ nano particles, co-precipitation method, centeral composite design (CCD)

Synthesis and Electrical Properties Evaluation of Three Dimensional Graphene

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Abstract:

In this research, three-dimensional graphene (3DG) was synthesized via thermal CVD method by using nickel foam in a tube furnace. This method consists of graphene growth on the nickel foam using Ar and H2 gases and ethanol carbon precursor, followed by removal of nickel foam by chemical etching. Finally, the synthesized graphene was characterized by SEM and Raman analyses. The electrical conductivity and work function of 3DG were determined by Van der Pauw method and UPS technique, respectively. The results indicated that the high porosity and good quality three-dimensional graphene was formed. The electrical conductivity and work function of 3DG were measured 0.6 s.cm-1 and 5 eV, respectively.

Keywords:

Three-dimensional graphene, Electrical conductivity, Work function, CVD

Glass
&
Glass-Ceramics

The Effect of CaO Additive on the Structural and Crystallization Characteristics of Cordierite Glass Ceramics Prepared by Melting Process

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Abstract:

Cordierite ($Mg_2Al_4Si_5O_{18}$) as a ceramic material has a wide range of uses and applications because of its low dielectric constant, high electrical resistivity and low thermal expansion. In this work, the cordierite based glass ceramic was synthesized by the method of crystal growth from a homogenous glass. The effects of CaO additive on the glass traits and the crystallization behavior of glass specimens of stoichiometric cordierite composition were determined by the methods of differential thermal analysis (DTA), X-ray powder diffraction (XRD), fourier-transform infrared (FTIR), vickers hardness and scanning electron microscopy (SEM). XRD results showed that α-cordierite is the main crystalline phase in the crystallized glasses. In addition, small quantities of anorthite for the crystallized glass obtained from the CaO containing glass while μ-cordierite is not detected in this heat treated glass. With the adding of CaO, the crystallization temperature (Tp) of α-cordierite evidently decrease from 1098°C to 1044 °C. Also, CaO containing glass exhibited the highest Vickers hardness that is resulted from more crystallization of α-cordierite phase in this specimen.

Keywords:

glass ceramic, cordierite, anorthite

The Effect of CaO and B_2O_3 Additives on the Crystallization Behavior and Structure of $MgO–Al_2O_3–SiO_2$ Glass-Ceramics Produced by Melting Process

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Abstract:

Because of outstanding thermo-mechanical, chemical and dielectric properties of cordierite glass ceramics, they have been used in various fields ranging from radomes to kiln furniture and heat exchangers .In this work, the α-cordierite based glass ceramic was synthesized by the method of crystal growth from a homogenous glass. The effects of CaO additive on the glass traits and the crystallization behavior of glass specimens of stiochiometric cordierite composition with and without a boron oxide additive were determined by differential thermal analysis (DTA), X-ray powder diffraction (XRD), fourier-transform infrared (FTIR), vickers hardness and scanning electron microscopy (SEM) methods. It was attempted to crystallize only α-cordierite as a main crystal phase without μ-cordierite by adding CaO and B_2O_3. In presence of B_2O_3, the crystallization temperature (Tp) of α-cordierite evidently increased from 1044°C to 1058 °C. Also, CaO containing glass (with the lack of B_2O_3) exhibited the highest vickers hardness that is dependent on high crystallization value of α-cordierite phase in this specimen.

Keywords:

glass-ceramic, cordierite, dielectric properties

Ionic Conductivity of Fe_2O_3-Doped Lithium Titanophosphate Glass and Glass-Ceramic

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Abstract:

During the past two decades, many new glass-based solid electrolytes with high Li^+ conductivity have been developed. In the present paper, preparation and characterization of Fe_2O_3-doped lithium titanium phosphate glass and glass-ceramic were studied on the basis of two strategies of enhancing Li^+ conductivity: the precipitation of super ionic crystals through careful heat-treatment and optimization conduction pathway of Li^+ ions by replacing Ti^{4+} by Fe^{3+} ions. Li_2O-TiO_2-P_2O_5-(Fe_2O_3) glasses were prepared and converted into glass-ceramics through heat-treatment at crystallization temperature. The differential thermal analysis (DTA), X-ray diffraction (XRD), field emission scanning electron microscopy (FESEM) and impedance spectroscopy (EIS) were employed to study the thermal, structural and electrical properties. The results showed that $LiTi_2(PO_4)_3$ and Li_3PO_4 phases were formed in glass-ceramics. SEM results confirmed that glass-ceramics contained some grains with hexagonal-like morphology. Lithium ion conductivities were increased in glass and glass-ceramic with addition of Fe_2O_3. The highest ionic conductivity of glass and glass-ceramic was obtained as 3.34×10-4 S/cm and 1.38×10-3 S/cm, respectively at 25 ºC. The high conductivity, dense structure and easy fabrication of the Fe_2O_3-doped Li_2O-TiO_2-P_2O_5 glass-ceramics suggest them as promising candidate for inorganic solid electrolyte for lithium batteries or other devices.

Keywords:

glass, glass-ceramic, ionic conductivity

Modeling and Optimization of Radiation Heat Transmission in Heat Treatment of Float Glasses

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Abstract:

Heat transmission to glass according to calculation methods with compared to experimental methods has lower cost and higher accuracy. From another viewpoint, attention to ever increasing of softwares and numerical methods development's is needed comparing and recognizing of various methods for problem solving. In this article, thermal behavior of float glasses in the radiation heat transmission was investigated with using numerical modeling and semi experimental parameters and radiation heat transmission was analyzed in two type glasses. Required semi experimental parameters such as softening point temperature, heat transmission coefficient, chemical component, thermal behavior and phase analysis were determined with diffractional thermal analysis (DTA), X-ray fluorescence (XRF), X-ray diffraction (XRD) and were used in numerical model. The conclusions of this modeling method have acceptable conformity with industrial tests. In addition to these results, consumed energy for bending glass in tunneling furnace (Glaston, ECU) was optimized using this concluded model.

Keywords:

radiation heat transmission, float glasses, diffractional thermal analysis (DTA), X-ray fluorescence (XRF), X-ray diffraction (XRD)

Ionic Conductivity and Microstructure of Li_2O-TiO_2-P_2O_5-SiO_2-Cr_2O_3 glass-ceramics

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Abstract:

Conductive glass-ceramics based on the Li_2O-TiO_2-P_2O_5-Cr_2O_3-SiO_2 system were fabricated by heat-treatment at the temperature interval of 630 to 830 °C for 2 h. In this system, a considerable enhancement in conductivity was observed by partial substitution of Ti^{4+} by Cr^{3+} ions due to increasing of charge carrier number. The major crystallized phase was $LiTi_2(PO_4)_3$ in these glass-ceramics. The crystallization behavior of glass-ceramics was monitored by differential thermal analysis (DTA), X-ray diffraction (XRD) and the field emission scanning electron microscopy (FESEM) methods and their conductivity behavior was evaluated by complex impedance technique. In this work, the effect of heat treatment conditions on the ionic conductivity of the prepared glasses has also been explored. It was shown that, the ionic conductivity of the glass-ceramic was enhanced by increasing the heat treatment temperature from 630 to 780 °C. This tendency was attributed to the growth of $LiTi_2(PO_4)_3$ crystals. The highest room temperature conductivity of 25 ×10-2 S/cm was obtained after crystallization at 780 °C for 2 h. By increasing the heat treatment temperature above 780 °C, the conductivity was decreased, probably due to the microcracking of the specimen as the result of grains growth and the crystallization of $LiTiOPO_4$ minor phase.

Keywords:

Glass-ceramics, Phosphate glasses, Ionic conductivity, Impedance spectroscopy| Crystallization

ZrO_2 Dependence of Microstructure of Phase Separation of Borosilicate Glass Containing 4% wt. MgO

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Abstract:

Macroporous alkali resistant glass has been developed by making additions of zirconia (ZrO_2) to the sodium borosilicate glass system SiO_2-B_2O_3 -Na_2O containing 4 wt.% MgO. The 0 wt.% is the base composition and 1-3 wt.% ZrO_2 was added to investigate its influence on phase separation and chemical resistance of the samples. Differential thermal analysis (DTA) was carried out to identify the glass transition temperature (Tg). X-ray diffraction (XRD) was used to identify any crystal phases present in the as-quenched and heat-treated glasses. After leaching, a silica-rich skeleton with an interconnected pore structure and a uniform pore distribution was observed through SEM microscope. Pore characterization was measured by BET and BJH, which prove a great deal of positive effect of ZrO_2 on chemical durability of borosilicate glasses containing MgO in comparison to 0 wt.% ZrO_2.

Keywords:

glass membrane, phase separation, chemical resistance, zirconium oxide

Structural and Optical Properties Investigation of BK7 Glass Containing $ErCl_3$ Additive

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Abstract:

In the present papare, the effects of different amount of $ErCl_3$ additives doped in the BK7 glass is studied. BK7 glasses having composition SiO_2-67.5, B_2O_3-12, Na_2O-9.5, K_2O-8.5, BaO-2.5(Wt%) with varying amount of ErCl3 prepared by normal melting and casting process. Structural studing of glasses were done by x-ray diffraction pattern and Fourier transform infrared (FT-IR) . In order to calculate the absorption coefficient, glass transmittance spectra were measured at room temperature in the range of 200-1100 nm. Optical characteristics including the direct and indirect forbidden bands, Fermi energy level and Urbach energy were calculated by using the linear area of Tauc s plot, Fermy- Diract distribution function and the exponential curve of the absorption coefficients, respectively. Also physical properties (density measured by the Archimedes method), thermal behavior (Tg temperature by DTAs scan) and mechanical properties (microhardness) of the studied glasses were measured. Variation in the optical parameters are reference atributed to change in the structure and physical properties such as density and the molar volume. According to the results of FT-IR, increasing the concentration of erbium ions has caused decreased in the non-briding oxygen concentration. As a result, the connection of borate and silicate networks increased which is observable as the increasing of density from 2.52 to 2.55 (g/cm^3). While more increasing of $ErCl_3$, non-bridging oxygen concentration increased which is eventuated the decreasing of connections and density. On the other hand, increases of Er^{3+} ions with increasing of $ErCl_3$ concentration, direct and indirect forbidden band initially decreased then above parameters increased. These changes can refer to two different network former and network modifier role of Er^{3+} ions which is dependent on the percentage of $ErCl_3$ doped in the glass.

Keywords:

BK7, absorption coefficient, direct and indirect forbidden band, Fermi energy level, Urbach energy, FT-IR, $ErCl_3$

Investigation and Preparation of Glass-Ceramic Glazes Composed from $CaO-Al_2O_3-SiO_2$ and $ZnO-MgO-Al_2O_3-SiO_2$ Systems for Application as Tile Glaze

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Abstract:

The present work purposes to obtain glass-ceramic glazes for floor tile application. In this regard, two different glass-ceramic systems ($CaO-Al_2O_3-SiO_2$ and $ZnO-MgO-Al_2O_3-SiO_2$) and their combination with 30:70 weight ratio (glaze G) were fabricated and characterized. This characterization was performed by using thermal analysis (DTA), X-ray diffractometry (XRD) and Scanning electron microscope (SEM). According to the obtained results, Anorthite and Gehlenite were identified as the major and minor crystalline phases of glass-ceramic A, respectively. However, in the case of specimen B, Spinel and Mullite were considered as the major and minor crystalline phase. However, glaze G contained anorthite as the dominant crystalline phase. By increasing temperature up to 1180ºC, spinel was slightly crystallized owing to the decreased content of MgO. All glass-ceramic glazes presented appropriate sinterability in the selected temperature interval. According to the SEM observation, anorthite and gehlenite had plate like morphology in the starting glass-ceramic glazes prepared from CAS and ZMAS glass-ceramic systems. However, in the case of glaze G, needle like crystals of spinel was observable as well as anorthite crystals.

Keywords:

glass-ceramic glaze, crystallization, anorthite, spinel

The Effect of Glass Additives MgO-CaO-SiO_2 on Microstructure, Density and Phases of Liquid Phase Sintered Al_2O_3

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Abstract:

In this study, the effect of addition of MgO-CaO-SiO_2 glass on density, microstructure and formed phases in high purity alumina ceramics have been investigated. Results indicated that, the CaO/SiO_2 ratio had an effect on sintered density so that at the ratio of less than 0.5, density was significantly decreased. The results of XRD showed that the MgO/CaO ratio influenced on formed crystal phases. At the ratio of 2, formation of MgO-rich phases such as spinel ($MgO.Al_2O_3$) and magnesium aluminosilicates increased, while at the ratio of less than 1, the CaO-rich phases such as hibonite ($CaO.6Al_2O_3$) formed. SEM images showed that formation of elongated grains due to the presence of CaO and SiO_2.

Keywords:

alumina, LPS, AGG

Production and Microstructure Investigation of Dual Phase Vitreous Enamel Containing Aluminum Powder

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Abstract:

In this investigation, vitreous enamel cermet was prepared for protection of steel substrates. Design of the enamel coated onto steel substrates is based on enhanced mechanical strength and toughness. At the first stage, the type of steel sheet was determined and then the enamel was prepared from ceramic and metallic components corresponding to glass derived from frit and aluminum powder, respectively. These components were mixed with a definite composition ratio in a non-aqueous suspension. In the next stage, the effects of temperature, sintering time and particle size distribution of aluminum powder were studied on adhesion and surface smoothness. Mechanical strength and adhesion of coating to the base metal was also determined under tensile stress. Finally, microstructure investigation of the coating was carried out by SEM/EDX.

Keywords:

Vitreous enamel, Aluminum powder, Cermet, Steel substrate

Synthesis of Hydrophobic Glasses by Sol-gel Method Using Silylating Agents

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Abstract:

In this research work, in order to study the effect of iso-octyltrimethoxysilane (iso-OTMS) and phenyltriethoxysilane (PhTES) as hydrophobic agents on the water repellent properties of the silica coatings, the coating films on the glass substrates were prepared by two-step sol-gel dip coating process using alkoxide solutions. In this work, the influence of different organosilanes was discussed on the hydrophobic properties and surface modification of the silica films. Silica alcosol was prepared by keeping the molar ratio of TEOS:H_2O:EtOH constant at 1:6.35:30.3 respectively, and the percentage of hydrophobic agents was varied from 0 to 8 vol.%. The iso-OTMS modified film showed the higher contact angle (140º) in comparison of the PhTES modified film. The silica films were characterized by the field emission scanning electron microscopy (FE-SEM), atomic force microscopy (AFM), percentage of optical transmission and static contact angle measurement (CA). The obtained results showed that the hydrophobic character and morphology of the silica nanoparticles are completely dependent on the organic moiety nature of organosilanes. The iso-OTMS modified film showed the higher contact angle (140º) in comparison of the PhTES modified film. The FE-SEM images showed that the better coverage of nanoparticles in iso-OTMS modified film caused the higher contact angle than that of PhTES modified film.

Keywords:

Surface properties, Thin films, Atomic force microscopy (AFM), Organosilane

The Effect of Heat-Treating Temperature on the Sintering, Crystallization and Bioactivity Behaviors of $CaO-SiO_2-P_2O_5-MgO$ System Glass

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Abstract:

Sintering, crystallization and bioactivity behaviors of a $CaO-SiO_2-P_2O_5-MgO$ system glass having 0.5 %wt Fe_2O_3 nucleant were studied. The frit powder obtained from the molten glass quenching, grinding, wet milling and sieving was uniaxially cold pressed, followed by heat treating at temperatures of 700, 775, 850, 925, 1000, 1075 and 1130˚C for 240 min dwell time with the 20˚C·min-1 rate heating rate. Physical properties of the glass ceramics were measured. Bioactivity of glass-ceramic heat-treated at 1075˚C and soaked 14 days at 37˚C in Simulated Body Fluid (SBF) solution was confirmed by Infrared Attenuated Total Reflectance (ATR-IR) method. It seems that due to the bioactivity, high mechanical strength and relatively good machinability, the studied glass-ceramic having 0.50 %wt Fe_2O_3 can be as a good candidate for biomedical engineering applications.

Keywords:

Glass-ceramic, $CaO-SiO_2-P_2O_5-MgO$ system, sintering, crystallization, bioactivity

Investigation of Glass Forming Ability and the Structure of CaO (K_2O)- TiO_2- P_2O_5 (B_2O_3) Glass System

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Abstract:

In the present work, CaO-TiO_2-P_2O_5 glass was studied to examine the effect of the B_2O_3 and K_2O on the Glass forming ability (GFA) and the structure of the CaO-TiO_2-P_2O_5 glasses system. After formulation and adding water, homogeneous slurries were made. Dried batches were melted and poured into a preheated carbon mould. After annealing, differential thermal analyzer (DTA), X-ray diffraction (XRD), scanning electron microscopy (SEM), FT-IR and 31P magic angle spinning NMR method were applied for characterization of the samples, focusing on the effects of B_2O_3 and K_2O contents on the base glass structure. The results indicated that the ultraphosphate units and Ti-O-Ti bonds were observed by adding B_2O_3 to base glass which implies the formation of crystalline phases such as $Ca_3(PO_4)_2$ and rutile (TiO_2). Based on semi-quantitative evaluations, the amounts of these crystalline phases were decreased by increasing B_2O_3. The results showed the increase of BO_4 units with increasing B_2O_3 content and by adding K_2O this effect was promoted. With depolymerization of phosphate networks, the BO_4 units have been able to link neighboring phosphate anions and incorporate into the chain-like phosphate which results in decreasing of P-O-P bonds and forming relatively strong covalent B–O–P bonds. Such finding was in consistent with the decrease in molar volume and increase in density of the samples with more than 6wt. % B_2O_3. It seems to us that K_2O helps to have more rigid glass network and prevents crystallization by providing the oxygen supply of boron and titanium atoms for the formation of BO_4 and TiO_6 units. GFA of the CaO-TiO_2-P_2O_5 system has been worsened with the increase of B_2O_3; but it seems that the sample with 14% wt. B_2O_3 along with 2% wt. K_2O showed the best GFA of all except B0.

Keywords:

DTA, NMR, FT-IR, Glass forming ability

Investigation of Sintering and Crystallization of CaO-MgO-Al_2O_3-SiO_2 Glass Ceramic Composite by Al_2O_3 as Reinforcement

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Abstract:

CaO-MgO-Al_2O_3-SiO_2 glass- ceramics has suitable mechanical properties. These glass-ceramics were used in some parts of rockets. In order to achive to more sinterabillity, Al_2O_3 nanoparticles were used as reinforcement.

CaO-MgO-Al_2O_3-SiO_2 glass-ceramics containing Cr_2O_3, TiO_2 and Fe_2O_3 as nucleation agent were prepared using conventional melting Of batch powders, quenching the molten glass in water and crystallization of sintered glass powder. Alumina nanoparticles were used as reinforcement. Alumina nanoparticles were used in 5, 10, 15 & 20 %wt values that were prepared in a solution environment. Composites prepared by sintering and crystallization. Sinterabillity were measured via measuring relative density, Linear shrinkage and water absorption percent. Crystalline phases were introduced by XRD. X-ray diffraction patterns introduced two crystalline phases, Diopside and Akermanite as two main crystallized phases of sintered glass-ceramics. Microstructures were studied by Secondary electron Microscopy. Glass-ceramics with 5%wt Al_2O_3 nanoparticles had maximum relative density=89% and maximum linear shrinkage=14.18%, was compared with Glass-ceramic. measured porosities in the composites were zero.

Keywords:

glass-ceramic, diopside, alumina nanoparticle, composite

Glass-Ceramic Glazes Production for Single-Fired Wall Tile With Two Glass-Ceramic System CAS and LZAS

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Abstract:

In this study, the frit-based glaze compositions belonging to the CAS (CaO-Al_2O_3-SiO_2) and LZAS (Li_2O-ZrO_2-Al_2O_3-SiO_2) glass–ceramic system were prepared. The aim of the study is to develop frit-based, glossy opaque glass–ceramic glazes for wall tiles by mixing theses glass ceramics. Thermal expansion coefficient values of glazes were determined by a dilatometer. Characterization of single fast-fired glass–ceramic glazes was made by X-ray diffraction (XRD). Colour and gloss analyses of the final glazes were measured with a spectrophotometer and a gloss meter, respectively. The prepared glaze from mixing of theses glass-ceramics applied on a single fired wall tiles and were fired at 1120ºC.finally, the optimum amount of mixing ratio was obtained 80% wt of CAS (23.53%CaO-42.84% Al_2O_3-33.63% SiO_2) and 20 %wt LAZS (11.8% Li_2O-8.6% ZrO_2-10.50% Al_2O_3-69.1% SiO_2) regards to high glossiness, suitable α and whiteness.

Keywords:

glass-ceramic, zircon, tile, glaze

Investigation into the Processing of Transparent Oxyfluoride Glass and Glass Ceramics Containing CaF_2 Nanocrystals in Presence of K_2O Additive

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Abstract:

During the last few decades, oxyfluoride glass ceramics containing fluoride nanocrystals have received more attention in photonic applications due to their low phonon energies (~500 1/cm) and favorable mechanical, thermal and chemical stability. Main purposes of the present research are investigation of the K2O role on their processing, crystallization behavior structure and transparency. Glasses in the SiO_2- Al_2O_3- CaO- CaF_2 system with different amounts of K_2O additive (1.5, 3 and 4.5 weight ratio) were prepared by convenient melting process. DTA curves exhibited two exothermic peaks, one related to CaF_2 crystallization (~ 700 °C) and the other which had not been interpreted clearly before (~ 900°C). XRD patterns, SEM images and EDX analysis confirmed the DTA results and revealed that the second exothermic peak was related to crystallization of anorthite. Glass ceramic samples were prepared on the basis of crystallization temperatures derived from DTA. The only precipitated crystalline phase in the glass samples heat treated on the basis of the first peak of DTA, was CaF_2 With the aim of studying the transparency and structural changes of glass samples with different amounts of K_2O content, transmittance in UV- Vis region and FT-IR spectra of them were studied. According to the better crystallization behavior and higher transparency in UV- Vis region (~87%), the glass containing 4.5 (weight ratio) K_2O additive has been introduced as the best basic glass.

Keywords:

Oxyfluoride glass ceramic, CaF_2 crystals, K_2O additive

Comparative Evaluation of Crystallization Behavior, Microstructure Properties and Biocompatibility of Fluorapatite-Mullite Glass-Ceramics

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Abstract:

The growing trend for restorative glass-ceramic materials has pushed on to the development of the novel dental glass-ceramic systems. Improved biocompatibility, adequate strength, chemical and wear resistance and excellent aesthetic are the main criteria that make these materials clinically successful. The aim of the present study was to investigate the effect of small additions of TiO_2, ZrO_2, BaO and extra amounts of silica on the microstructural changes and biological properties of an apatite- mullite base glass-ceramic system. Glass transition temperatures and crystallization behavior were investigated using differential thermal analysis (DTA). Addition of TiO_2, ZrO_2, BaO and extra amounts of silica to the base glass led to some changes in the crystallization temperatures and morphology of the crystalline phases. DTA results showed that while TiO_2 and BaO were effective in decreasing the crystallization temperature of the fluorapatite and mullite crystalline phases, ZrO_2 and the extra amounts of SiO_2 increased the crystallization temperature. X-ray diffractometry (XRD) and scanning electron microscopy (SEM) revealed that the precipitated crystalline phases were fluorapatite [$Ca_{10}(PO_4)_6F_2$] and mullite [$Al_6Si_2O_{13}$], which apart from the extra bearing SiO_2 specimen had rod-like morphology in the other specimens. The rod-like crystalline phases' lengths were small, i.e. <20 µm, in the TiO_2 and BaO containing glass-ceramics, but small addition of ZrO_2 enhanced the length of crystalline phases to approximately 50 µm. MTT assay was used for cell proliferation assessment. The toxicity of glass-ceramic samples was assessed by seeding the osteosarcoma cells (MG63) on powder extracts for 7, 14 and 28 days.

MTT results showed that glass-ceramic samples were almost equivalent concerning their in-vitro biological behavior.

Keywords:
Apatite, mullite, glass-ceramics, microstructure

Ceramics in Energy & Environmental Applications

Synthesis, Structure and Electrical Properties of $Na_3Zr_2P_3SiO_{12}$ Solid Electrolyte Ceramics

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Abstract:

For the first time, Hong and Goodenough et al. proposed a framework structure with suitable tunnel size for Na migration in three dimensions named as NASICON (Sodium (Na) Super (S) Ionic (I) Conductor (CON)). These compounds with the general formula $Na_{1+x}Zr_2P_{3-x}Si_xO_{12}$ ($0 < x < 3$) are a class of structurally isomorphism 3D framework compounds possessing high conductivity, often comparable to that of liquid electrolytes at higher temperatures. The high ionic conductivity of these materials is used in making devices such as membranes, fuel cells, and gas sensors. High ionic conductivity, due to movement of sodium ions, depends upon the size of bottleneck, activation energy required for the movement of ions and lattice parameters whose value can be modified by changing compositions. The bottleneck size is related to the variation in the lattice parameters a and c. A large range of compositions was studied and the best conductivities were obtained for x values close to 2. Most of these studies assess the relation between composition, structure and electrical conductivity. In this Study, $Na_3Zr_2Si_2PO_{12}$ solid electrolyte compound was synthesized by solid state reaction and studied by x-ray diffraction. At room temperature the compound belongs to monoclinic symmetry with NASICON structure. The samples were fired in the temperature range 1150-1300℃ with 5 hours sintering time. The electrical conductivity of the samples in the frequency range 0.1- 1 MHz was determined from Impedance spectroscopy measurements. The investigation of the electrical properties was carried out in air in the temperature range of 300- 700℃K. Results showed a significant influence of the processing conditions on the microstructure, affecting both grain and grain boundaries.

Keywords:

NASICON, electrical conductivity, solid electrolyte, sodium, sinter

Studying Mechanical Properties of $Ce_{0.9}Gd_{0.1}O_{1.95}$ and 8mol % YSZ Solid Solution as Oxygen ion Conductor Electrolytes

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Abstract:

Ceramic oxygen ion conductors based on zirconium oxide and recently cerium oxide has been widely used as solid electrolytes. In these categories, 8mol% yttrium stabilized zirconia and 10mol% gadolinium doped ceria (GDC) have been commonly used due to their higher ionic conductivity compared to other types of oxygen ion conductors. GDC is regarded as a promising candidate for intermediate service temperatures due to its high ionic conductivity at low temperatures, but cerium oxide would be reduced by decreasing oxygen partial pressure leading to electronic conductivity and also a volume change and weakening mechanical properties. In the present work, solid solution of 8mol% yttrium stabilized zirconia and 10mol% gadolinium doped ceria were prepared in the form of disk pellets with different contents of precursors corresponding to 20-80 weight percent by attrition milling, and then uniaxial pressing and finally by doing sintering process. The effect of chemical composition of the GDC- 8mol% YSZ solid solutions' on the mechanical properties of the specimens were investigated using ring on ring test, density of the samples were measured by Archimedes method and their microstructures were observed with SEM after carrying out an appropriate thermal etching process. The XRD method also used to ensure about creating a single phase solid solution. The results indicate the formation of a single-phase solid solution accompanied by complete dissolution in the range of mixing. Moreover, the formation of such a solid solution would slightly increase the fracture strengths of primary compounds.

Keywords:

GDC, YSZ, strength, electrolyte, fuel cell

Removal of Organic Dye from Contaminated Water Using $CoFe_2O_4$-Reduced Graphene Oxide Nanocomposite

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Abstract:

Up to now, a lot of materials have been used widely for removal dye from contaminated water, such as active carbon, iron, manganese, zirconium, and metal oxide among nanoparticles ferrites, $CoFe_2O_4$ is an interesting magnetic material due to its moderate saturation magnetization, excellent chemical stability and mechanical hardness. Graphene, a new class of 2D carbonaceous material with atom-thick layer features has attracted much attention recently due to its high specific surface area. Reduce graphene-oxide (rGO), as well as graphene, has attracted great attention because of its unique properties similar to graphene, such as its special surface, which makes it an ideal candidate for dye removal. By now, little work has been done on the preparation of $CoFe_2O_4$-rGO composite and their applications in contamination removal from water. In this report, $CoFe_2O_4$-Reduced graphene Oxide nanocomposite was fabricated using hydrothermal process. During the hydrothermal process reduction of graphene oxide and the growing of $CoFe_2O_4$ were simultaneously occurred on the carbon basal planes under the conditions generated in the hydrothermal system. The samples were characterized through X-ray diffraction (XRD), scanning electron microscopy (SEM), and Fourier-transform infrared spectroscopy (FT-IR). The removal performance of the $CoFe_2O_4$ nanostructures was evaluated using Congo red with UV-vis spectroscopy. The experimental results suggest that this material is suitable for treating Congo red contaminated water.

Keywords:

Dye, graphene, nanocomposite, removal

Influence of Temperature on the Photocatalytic Activity of Sol-Gel Titania

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Abstract:

The photocatalytic activity of TiO_2 powderss synthesized via the sol-gel process has been measured as a function of UV irradiation time and substrate temperature. FT-IR spectroscopy has been used to address the chemical changes in AR 15 on the photocatalytic surface. When the temperature of the photocatalytic substrate was raised above 50 °C, the removal of acid red from the surface was strongly affected by a process involving evaporation, whereas AR 15 revealed a superior stability. Our study shows that heat enhances the photocatalytic activity, suggesting the importance of an accurate temperature control in photocatalytic efficiency measurements.

Keywords:

Photocatalysis, titania, AR 15, FT-IR spectroscopy

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Effect of Rhodium Infiltration on the Microstructure and Performance of $Ni/Ce_{0.8}Gd_{0.2}O_{2-\delta}$ Cermet Anode for Low Temperature Solid Oxide Fuel Cell

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Abstract:

In order to further enhance the $Ni/Ce_{0.8}Gd_{0.2}O_{2-\delta}$ (Ni/GDC20) cermet anodic performance for low temperature solid oxide fuel cell (LT-SOFC), a study was performed on the nanostructuring of NiO/GDC composite by only once wet-infiltration of rhodium chloride precursor. By using electrochemical Impedance spectroscopy (EIS) analysis, the effect of once Rh-infiltrating on the anodic polarization resistance was examined using symmetric Ni–GDC20|GDC20|Pt electrolyte-supported cell at 400-600 °C. Nanostructural evolution before and after H2 reduction at 600 °C and also after anodic performance test was investigated by atomic force microscopy (AFM), field emission scanning electron microscopy (FE-SEM), and transmission electron microscopy (TEM) techniques in comparison to the bare anode. Despite the fine distribution of Rh-infiltrated nanoparticles having average particle size of 11.7 nm, the results showed the ineffectiveness and inability of the Rh-nanoparticles to succeed to the decrease of anodic polarization resistance for H2 oxidation reaction in LT-SOFC.

Keywords:

Anode, Ni/GDC cermet, infiltration, rhodium, LT-SOFC

Synthesis of WO_3: Ag Nanoparticles via Combustion Synthesis Routes for Photocatalytic Wastewater Treatment

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Abstract:

Synthesis of nanostructure tungsten trioxide by co-precipitation and combustion synthesis methods were investigated. The effect of different parameters, such as precursor type, surfactant addition, calcination process and dopant type on structure, microstructure, and photocatalytic activity of samples were studied. Structure and microstructure analyses of samples were performed using scanning electron microscopy, transmission electron microscopy and x-ray diffraction techniques. The photocatalytic activities of the samples were evaluated by degradation of methyl-orange solution as a model under UV light. Results showed that introducing dopants led to structure variation of tungsten trioxide from monoclinic structure to tetragonal one. Moreover, presence of Ethylene glycol in the synthesis process and calcination affected the mean particle size and morphology of powders, considerably. Also, photocatalytic activities of samples were significantly changed by variation of mentioned parameters.

Keywords:

WO_3, Co-precipitation, Combustion synthesis, Photocatalytic activity, Calcination Process

Influence of Temperature on the Photocatalytic Activity of Sol-Gel Titania

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Abstract:

The photocatalytic activity of TiO_2 powderss synthesized via the sol-gel process has been measured as a function of UV irradiation time and substrate temperature. FT-IR spectroscopy has been used to address the chemical changes in AR 15 on the photocatalytic surface. When the temperature of the photocatalytic substrate was raised above 50 °C, the removal of acid red from the surface was strongly affected by a process involving evaporation, whereas AR 15 revealed a superior stability. Our study shows that heat enhances the photocatalytic activity, suggesting the importance of an accurate temperature control in photocatalytic efficiency measurements.

Keywords:

Photocatalysis, titania, AR 15, FT-IR spectroscopy

General

Taguchi Analyses on the Densification of ZrB_2-Based Composites: Effects of Hot Pressing Conditions and SiC Content/Particle Size

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Abstract:

The influences of hot pressing parameters, SiC content and SiC particle size on the densification of ZrB_2-based ceramics and composites have been studied. A design of experiment approach, Taguchi methodology: L9 orthogonal arrays, was used to increase the relative density of the samples. The signal to noise ratios and analyses of variance were used to optimize the processing parameters. The hot pressing temperature was recognized as the most consequential factor affecting the relative density of monolithic ZrB_2. ANOVA verified the applied external pressure as the most critical factor on the relative density of ZrB_2-based composites with different SiC content, but both the applied pressure and temperature were identified as the consequential factors in ZrB_2-based composites with different SiC particle size. The confirmation tests, which were carried out under the optimal conditions, revealed that the experimental results were in harmony with the expected values by the Taguchi predictions.

Keywords:

Zirconium diboride, Silicon carbide, Hot pressing, Densification, Taguchi method

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Effect of Calcination Temprature on Mechanical Strength and Sintering Behaviour of β"-alumina Ceramic Synthesized by Sol-Gel Combustion Method in Presence of $MgNO_3$ as Stabilizer

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Abstract:

β”-alumina ceramic is one of the most functional ceramics in production of high temperature solid state electrolytes, because of their sodium ion conduction ability. In this paper, β”-alumina powder was synthesized by Sol-gel combustion method, a solution base method that has a few advantages in compare wih solid state methods. First, a homogenized solution prepared using Sodium nitrate, Aluminium nitrate, Magnesium nitrate, Citric acid and distilled water. Drying the solution in 100°C produced a yellow gel. Increasing the temperature to about 400°C led to ignition of the gel. The dried gel burned in a self-propagating combustion manner to form a amorphous loose powder. The as-burnt powders was calcinated at 1300,1400 and 1500°C and converted to β”-alumina powder. The phase identification of powders were performed by X-ray diffraction (XRD). After producing β”-alumina phase, powders were attrition milled, pressed and sintered at 1620°C for 15 minutes, respectively. Density of the samples were measured by Archimedes method. The solid electrolyte microstructure were examined by scanning electron microscopy (SEM). The fracture strength of the samples were measured by Ring on ring method. The experimental observation showed that the density and fracture strength of the β”-alumina ceramic increases with increasing the tepmrature to 1500°C and the sintering behavour improved.

Keywords:

Sol-gel combustion, sintering, β-alumina, calcination temprature

Rheological Properties of Silicon Nitride Slurry for Gelcasting

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Abstract:

Silicon nitride (Si_3N_4), an important structural material, possesses superior mechanical properties at both room temperature and elevated temperature, but it is difficult to be used further because of its poor reliability and high cost. One way to improve its reliability and decrease its cost is to prepare homogeneous near net shape green bodies through colloidal forming process, such as gelcasting. In this paper, porous silicon nitride ceramic green bodies were prepared by aqueous gelcasting. The monomers used in the research were acrylamide (AM) and N,N´-methylenebisacrylamide (MBAM). The effect of calcination operation on the rheological property of Si_3N_4 slurry was studied. The optimal values of temperature and time of calcination were 800 and 2 hours, respectively. In order to obtain the slurry with good stability and low viscosity, TMAH was selected as dispersant. Also the influence of dispersant content on the viscosity of Si_3N_4 slurry was investigated. The minimum viscosity was obtained when the amount of TMAH was 0.6 wt.% (on the solid loading base). The effect of the initiator concentration and the ratio of initiator to catalyst on idle times of gelation of ceramic suspensions as well as on green flexural strength of gel bodies were determined. An optimum initiator concentration and ratio were found, at which the highest green strength was measured. According to the investigation of the rheological property of the slurries with 30, 35 and 40 Vol.%, it was found as the solid loading increased, the thixotropy, viscosity and degree of shear thinning increased, too.

Keywords:

Gelcasting Si_3N_4, Suspensions, Rheological property, Flexural Strength

Interfacial Phenomena in TLP Bonding of Al_2O_3 Using a Bi_2O_3 Interlayer

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Abstract:

Bismuth oxide, due to its low melting point was selected as filler for joining alumina to alumina using Transient Liquid Phase (TLP) method. For this purpose a thin layer of bismuth oxide was placed as an interlayer between the ceramic bodies. The growth of interfacial compounds between Al_2O_3 and Bi_2O_3 during transient liquid phase bonding at 900 and 1000ºC for various times was investigated. The mechanical properties of the joined samples were measured using shear testing method. To investigate the microstructure of the joining area, the cross section of the joints were studied using scanning electron microscope (SEM) and X-ray diffraction method. The results showed that increasing the time and temperature resulted in bismuth oxide (Bi_2O_3) diffusion into alumina (Al_2O_3) and forming interfacial compounds. The highest joint strength of about 80 MPa was obtained for the samples joined at 900°C for 10hrs.

Keywords:

Alumina, Bismuth oxide, TLP, Interfacial Compounds

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Effect of Different Additives on Sintering Behavior of Fused Silica and Crystallization of Cristobalite

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Abstract:

Phase transformation in fused silica is a critical point and several parameters such as temperature, time and additives can be affect that. Sintering of fused silica bodies can be influenced by this transformation. In fused silica transformation some additives can be accelerator and some can be retarder. In this study we studied the effect of some retarders and accelerators on formation of cristobalite from fused silica and the effect of this transformation on sintering of fused silica. Yttria Stabilized Zirconia (YSZ), Magnesia, Yttria, Titania, Gallium Oxide and Sodium Carbonate in 1.5 and 5 weight percent were used as additives. Fused silica and the additives were mixed in wet media in jar mill. After pressing the samples were sintered at 1100 ºC for 4 hours. Porosity, shrinkage and phase analysis of samples were investigated. The results showed that the best retarders are gallium oxide, Yttria and yttria stabilized zirconia (YSZ) and addition of sodium carbonate caused significant acceleration in cristobalite crystallization. It is observed that crystallization of cristobalite is in contrast with sintering of fused silica and can control sinterability of the samples.

Keywords:

Fused silica, sintering, cristobalite crystalization

Investigation and Fabrication of Porous Alumina Bodies with Unidirectional Porosity by Freeze Casting Method

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Abstract:

Alumina Porous materials due to their exclusive properties were used in various applications such as filtration and catalyst supports. In this study, porous bodies were fabricated by freeze casting and conversion slip concentration. As a result for achieving optimum porosity percentage, 82% solid content was necessary. Samples were frozen unidirectionally due to formation of unidirectional porosity. XRD patterns of samples are shown that the dominated phases are corundum. SEM micrographs of samples microstructures indicate unidirectional morphology of porosity in the bodies. The porosity widths are in order of 5 microns.

Keywords:

Alumina, Alumina porous body, Unidirectional porosity, Freeze casting

The Effect of Opacifiers on Surface Roughness of Ceramic Glazes

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Abstract:

Surface smoothness of ceramic glazes is always an important characteristic of ceramic glazes as a point of surface engineering studies. Surface roughness affects chemical resistivity, glossiness and stainabiliy of glazes. In fact, less surface roughness improves cleanability of the surface by the least usage amount of detergents. In this investigation, surface topography of two common opaque glazes, zirconia and titania based, has been investigated. Crystallinity of the surface has been studied from SEM images, and comparison of EDS elemental results with phase analysis results of XRD. Surface roughness profile measured by Marsurf M300, shows that titania based glaze is almost 24% percentage more smooth than zirconia based glaze. Surface smoothness is in relation with crystallinity of glaze surface, crystal type and crystal distribution in amorphous matrix phase.

Keywords:

Opacifier, Surface smoothness, SEM, EDS, XRD