4th International Conference and Expo on

Ceramics and Composite Materials

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Posters

Dmitry I. Vershinin et al., Res. Rev. J Mat. Sci. 2018, Volume 6
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Li_2O-ZnO-TiO_2 ceramics with eutectic additives for LTCC technology

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Statement of the Problem: Currently, due to intensive development of Wi-Fi and mobile communications, the number of widely used microwave devices, such as filters, resonators and a number of other electronic components, has significantly increased. Since modern electronic devices tend to be portable, it is necessary that electronic components are also miniaturized and highly sophisticated. Technology of low-temperature co-firing of ceramics (LTCC) allows to miniaturize multilayer components, using silver as a high-conductivity metal electrode. In addition to the need to provide microwave dielectric properties, ceramics obtained by the LTCC technology must have a sintering temperature that does not exceed the silver melting temperature of 961°C. Methodology & Theoretical Orientation: Despite the fact that there are a number of materials with high microwave dielectric properties, they cannot be obtained with LTCC technology, since they have a sintering temperature much higher than 961°C. The Li_2O-ZnO-TiO_2 system has developed a material with a sintering temperature of 950°C for LTCC, which can be used for the production of electronic applications, such as resonators, filters and other. Findings: As a sintering additive, a eutectic composition in the Li_2O-ZnO-B_2O_3 (LZB) system was used. The addition of 5.0 wt. % of LZB allows reach a relative density of 98% at 950°C. The effects of the additive on sintering behavior, phase composition, microstructure and microwave dielectric properties were studied. Conclusion & Significance The material is characterized by dielectric permittivity ε17.7 and quality factor Qxf of 407 MHz.

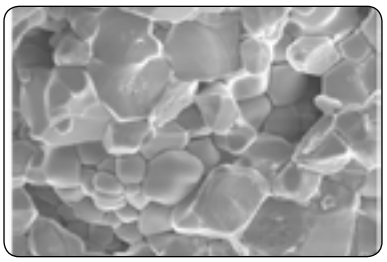

Figure 1. Microstructure of LZT ceramics doped with 5 % wt. of LZB additive

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Biography

Dmitry Vershinin is a young specialist in the field of chemistry and technology of inorganic materials, physicochemical regularities in the technology of ceramic materials based on refractory oxide compounds. The main scientific activity is devoted to the creation of new types of ceramic materials and the study of their properties.

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Dimitar Shandurkov et al., Res. Rev. J Mat. Sci. 2018, Volume 6
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Aerogels – functional materials with promising optical applications

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Sol-gel technology is an advanced physico-chemical method for production of oxide ceramics, glasses, thin film coatings or aerogels. The starting chemicals /liquid precursors as tetraethoxysilane – TEOS/ allow homogenization at molecular level, production of rare chemical compositions and modification of their surface properties [1 - 5].

Aerogels are advanced solid sol-gel materials with extremely low thermal conductivity down to 0.01 W/m K; low density (bellow 0.1 g / cm^3) and porosity at about 95%. There are two general strategies for preparation of aerogel particles depending on drying conditions, supercritical and subcritical drying [1, 2]. In the Department of Physical Chemistry, University of Sofia, a novel subcritical preparation scheme based on controlled drying at 0.2-0.5 atm and 40-70 °C was developed. The sol-gel scheme allows preparation both of aerogel microgranules and nanopowders. Recently, we also developed a new technique for incorporation of strongly red emitting complexes / Eu(III) phenanthroline nitrate / into silica aerogels leading to multicolour emiting powders [1, 2]. The technique was also applied to incorporate $[Tb(phen)_2](NO_3)_3$ and Eu(III) – DMF complexes into aerogel powders. Physicochemical properties of the powders obtained are shown bellow, SBET and Dav are surface area and mean pore diameter, respectively. Cabot Lumira™ aerogel granules (sample 5) are given for comparison.

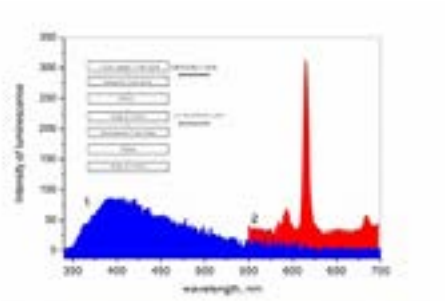

Figure 1. Luminescence spectra of functionalized aerogel powders: 1- blue emitting silica doped with 1,10 – phenanthroline, SiO2:0.18phen; 2 – red emitting composites, SiO2:0.007[Eu(phen)2](NO3)3

Recent Publications:

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Notes:

Biography

Dimitar Shandurkov studies Physical and theoretical chemistry at the Faculty of Chemistry and Pharmacy, Sofia University "St. Kliment Ohridski". He possess experience in the sol-get chemistry, hybrid optical materials, obtained at the Department of Physical Chemistry. In addition, he has a strong background in computational chemistry and applied mathematics.

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S. Balaji et al., Res. Rev. J Mat. Sci. 2018, Volume 6
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Hybrid carbaneous nanomaterials composites to enhance the performance of grinding/Cutting fluids

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The rapid developments in nanotechnology has led to the emergence of a relatively new class of fluids called nano-fluids, which could offer enhanced thermal conductivity and reducing the surface tension of the base fluid. Neat oil is traditionally and commonly used in many fields such as cutting, grinding and machining applications. Different nanoparticles exhibit various physicochemical properties (e.g., structure and shape), which can influence their lubricating properties. In this work, we have engineered colloidal suspensions of nano composite with an average size of 30 to 50 nm of functionalized graphene was covalently bonded to boron nitride by a microwave process, the nanocomposite was dispersed with base fluid concentration ranging from 0.1 to 0.01% , by ultrasonication method. To obtain a uniform distribution of the nanocomposite in the fluid matrix, with the purpose of filling the research gap in the literatures, this paper presents experimental data of thermal conductivity and viscosity properties of hybrid graphene based nanocomposite in the nano fluids for effective grinding applications. The FTIR spectroscopy further confirmed the presence of pyrophosphate and metal-oxygen bonding with O-H stretching and existence of nitride bonds in the composites which reveal the existence of boron group and carbon particles in the composite nano-fluid. Machining parameters are measured during grinding applications using nano composite fluid. It is observed that properties such as surface roughness, temperature stability, cylindrical and chips morphology, and cutting efficiency drastically improved with increased tool life exhibiting better machining performance compared to base fluid. The grinding chips morphology observed in the scanning electron microscope revealed less shearing with improved martial cutting. The results showed that the type of nano-composite and its concentration in base fluid play a significant role in reducing friction.

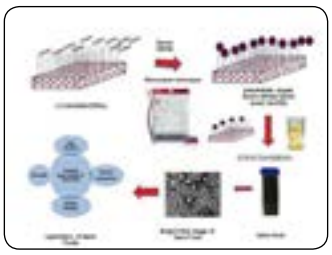

Figure 1: Schematic representation of preparation and application of nano-fluids

Recent Publications:

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Biography

Dr. S. Balaji obtained his doctoral degree in the field of Material and Biomaterial science. His additional expertise is in the synthesis of nanoparticles and composite fabrications. His current research is focused towards the development of nano-biomaterials and metal matrix composite and improving their performance in applications such as Automobile & Health Care. He also holds five Indian patents & 16 International publications.

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Natarajan N et al., Res. Rev. J Mat. Sci. 2018, Volume 6
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1D Carbonaceous hybrid noble nanometal core-shell composite for battery grids to enhance the performance of lead acid batteries

Natarajan N, Yumna Khan, Balaji S, Aman Shaikh, Sharanya Prakash, Dhanashri Dhuri, Bipin Patil, Amit Kalyani and Sujatha Pushpakanth
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The present study is to investigate the formation of 1D carbon coated with noble metal core shell's nanoparticles and the novel composites helps in the fabricating a Hybrid lead-acid battery to improve the electrochemical performance for high end application-hybrid batteries. The core shell (Ag@Au) was synthesized using natural reducing agents favoring the "go green methods" by first reducing the silver salts using Cymbopogon citratus (lemon grass) extract followed by the addition of gold solution (Chlorauric acid) on the surface of silver nanoparticles where in Nano silver acts as a self-reducing agent to form Nano gold shell as shown in the schematic diagram (A). The core shell of Au@Ag Nano particles was synthesized by using lemon grass as reducing agent for the Nano core gold (chlorauric acid) followed by the addition of silver salt solution kept in Hydrazine atmosphere to obtain the core shell Au@Ag, (Schematic diagram B)which leads to the formation of bimetallic Au core–Ag shell & Ag Core- Au shell nanoparticles. The well stabilized core shell was further added to functionalize MWCNT-COOH & MWCNT-NH_2 to make the Nano-composites of MWCNT- Noble metal core shell, investigated through XRD & TEM. The Nano composite is coated on the lead acid battery grid and the same was confirmed by SEM & EDAX. The capacity of the battery performance was improved to 10 % from C1 & C10 test.

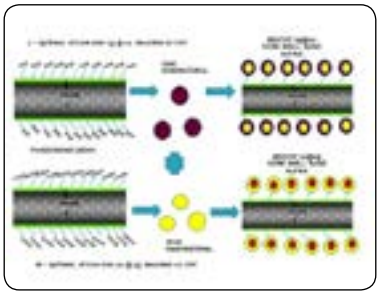

Fig:1. Schematic representation of 1D carbonaceous core shell Nobel metal nano composites for hybrid batteries.

Recent Publications:

1. M. Saravanan,‡ M. Ganesan and S. Ambalavanan* Enhanced electrochemical performance of a lead–acid battery by a surface modified negative grid with multiwall carbon nanotube coating. Journal @The Royal Society of Chemistry 2015 RSC Adv., 2015, 5, 26081–26091 | 26081
2. Dipali Nagaonkar, Mahendra Rai*, sequentially reduced biogenic silver-gold nanoparticles with enhanced antimicrobial potential over silver and gold monometallic nanoparticles, Journal of Adv. Mater. Lett. 2015, 6(4), 334-341.

Biography

Mr. Natarajan .N has expertise in nanomaterial synthesis and characterization, mainly focusing on the nanomaterials and biomaterial towards various applications like medical devices, Metal Injection Moulding and energy storage system. He has 5 India patents application filed and 2 International Journal Publications.

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José G. Miranda-Hernández et al., Res. Rev. J Mat. Sci. 2018, Volume 6
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Ceramic composite calcium aluminate reinforcement with Ag particles synthesized by solid-stated reaction

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[1,2,3]Universidad Autónoma del Estado de México, México
[4]Universidad Politécnica de Victoria, México

The composites cermets are a combination of ceramic and metallic materials and these new materials have different properties that their precursors materials. In this work, the fabrication route of the composite $CaO^*Al_2O_3$ / Ag-10 wt.% is discussed. The chemical composition in powder form is submitted to high energy milling for 4 hours at 200 rpm in dry. The powder was compacted into cylindrical samples at 200 MPa by a uniaxial load. Then the samples obtained are sintered at 1500°C in air atmosphere for one hour into an electrical furnace. The manufactured materials were characterized by optic microscopy (OM), scanning electron microscopy (SEM-EDS), X-ray diffraction (XRD) and X-ray computed tomography (XR-CT). The density was obtained by Archimedes principle; the hardness and fracture toughness were determinate by indentation method. XRD results indicate the formation of different phases of calcium aluminates during the sintering process and also the Ag phase. These materials also present changes in bulk density, hardness, and fracture toughness compared with the reference sample.

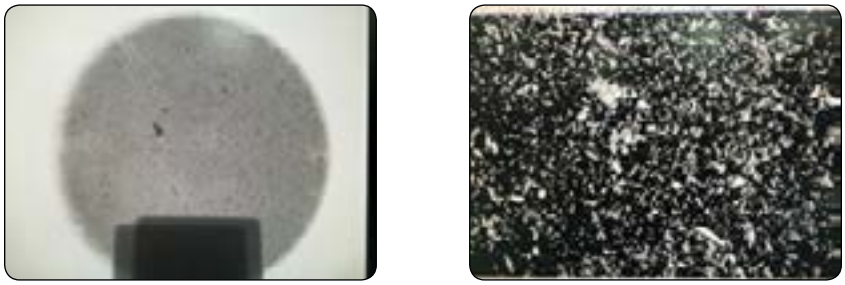

Figure 1. XR-CT of calcium aluminate composite with Ag synthesized by solid- state reaction during the sintering process.

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3. José G. Miranda Hernández, Miriam Vázquez Bustamante, Héctor Herrera Hernández, Carlos O. González Morán, Enrique Rocha Rangel, Elizabeth Refugio García, "Tenacidad a la fractura de compuestos cermets $3Al_2O_3$*2SiO2/Ag manufacturados por molienda de alta energía," Revista Matéria, Vol. 21, No.1, pp. 243-251, 2016.
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Biography

José G. Miranda has her expertise in development and manufacture of advanced materials in structural applications. Also, in the management, development, and evaluation of research projects, human resources training, participation in national and international conferences, and publication of articles in the national and international journals in the field of the synthesis and characterization of nanomaterials, metal composites and functional materials through powder metallurgy technique.

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B Gebhardt et al., Res. Rev. J Mat. Sci. 2018, Volume 6
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Novel Ge- and Sn-based initiators for light induced radical polymerization of dental resins

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Ivoclar Vivadent AG

Polymerization of light-curing dental materials is initiated using camphorquinone (CQ) (λmax = 468 nm) with tertiary arylamines (Norrish-II type) at wavelengths of 400-500 nm. Alternatively, acylphosphine oxides (APO; λmax = 385 nm) and bisacylphosphine oxides (BAPO, λmax = 397 nm) are used to avoid discoloration by arylamines. The low solubility of BAPO and limited VIS-absorption of APO limit their potential for many applications.[1, 2] The strong absorption and scattering of wavelengths between 390-420 nm in methacrylate-based restorative materials limit the depth of photocure (DOC) achievable in acceptable periods of time. To achieve the 4 mm DOC demanded from so-called „Bulk-Filling" restorative composites, the bisacyl-germane based (BAGe) initiator Ivocerin® (λmax = 408 nm) was developed.[3, 4, 5] For further improvement of DOC, bathochromically shifted Initiators are investigated. Novel Ge- and Sn-based initiators, such as tetraacyl-germane (TAGe) and -stannane (TASn) initiators are herein discussed in comparison to Ivocerin®.[6, 7, 8] While λmax of TAGe and TASn show no bathochromic shift relative to Ivocerin, the absorption at 440-480 nm overlaps significantly better with the emission spectrum of dental light-curing unit (LCU). TAGe's and TASn's rapid photolysis results in complete and irreversible bleaching within 10 s irradiation using a LCU (390-510 nm). Dental composites comprising equimolar concentrations of initiators (0.2 wt.% BAGe, 0.4 wt.% TAGe and TASn) were compared regarding DOC at different wavelengths (400-517 nm). Here, TASn gave an increased DOC at higher wavelength in comparison to BAGe. The presented systems are highly interesting alternatives to commercially available photo initiators. Their highly effective radical generation, excellent photobleaching, excitation at biocompatible wavelengths and low toxicity of photolysis products offer great potential for a variety of different medical and industrial applications.

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Biography

Dr. Benjamin Gebhardt joined Ivoclar Vivadent AG in 2012 after his PhD at ZPM in Fürth (Friedrich-Alexander University Erlangen-Nuremberg). He started his career in the development of adhesives and self-adhesive dental materials. In 2014 he changed his focus to the development of resin based dental restorative materials. One of his major fields is the development of light and dual-cured bulk-fill composites. Since 2018 he is head of the composite department at Ivoclar Vivadent AG.

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Notes:

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Accepted Abstracts

Ceramics 2018

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Study and measurement of the thermal and structural properties of silicate materials (SiO_2)

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[2]Lille Université, France

The compounds based on SiO_2, are of interest in several fields: as strengthening additives in the potter's clay materials, insulator in electronic compounds and in glass industry, concrete, Polymers… Reactivity of SiO_2 depends on the chemical process that occurs between amorphous or poorly crystallized SiO_2 and the matrix, in turn depends on the surface state of SiO_2 particles. The silanol groups (SiOH) are the main surface reactive sites and their properties (nature, concentration, distribution, accessibility, etc.) will determine the chemical activity of the silica. The aim of this work is to study the dependence between structure properties and reactivity of silica for different SiO_2 compounds. The results show the effect of reaction time and concentration of basic solution (KOH) on creation of the silanol groups on silica surface. A methodology is proposed to quantify different silanol groups on silica surface.

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Novel diesel particulate filters containing fine ceramic fibres

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Ongoing concerns about adverse health effects of carbon particulate in Diesel engine exhausts continue to drive the quest for improvement performance from Diesel Particulate Filter (DPF) systems for their removal. Two of the main areas in which improvements are being sought are enhanced removal of very fine particles (<~50nm), particularly during the period immediately after regeneration (removal of accumulated particulate via combustion), and improved thermo-mechanical stability - especially in terms of resistance to thermal shock (during regeneration). The latter is focused partly on raising the fracture toughness of the materials concerned. One approach to achieving these aims is to create novel composite materials via the introduction of (ceramic) fibres. This has the potential both to enhance the fracture toughness, mainly by promoting fibre pull-out, and to improve the filtration efficiency by creating "hybrid" (multi-scale) structures, with some gas flowing through very fine channels, while the presence of other (relatively coarse) pathways ensures that the overall permeability remains acceptably high. For DPFs, the latter requirement corresponds to the specific permeability being no lower than about ~10-12 m^2. This presentation covers the creation of novel DPF structures containing fine ceramic fibres and measurement of their porosity, permeability and fracture toughness. Work is also presented on tomographic capture of DPF structures (using a Simpleware package) and simulation of the flow through them of hot gas containing fine carbon particulate (using COMSOL packages. It is concluded that there is scope for significant improvement in overall DPF performance via the incorporation of fine fibres.

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Synthesis of Al_2O_3-SiC porous ceramics from coal ash

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[2]Technische Universität Darmstadt, Germany

Coal ash is an industrial waster during the combustion of coal for energy production, which is identified as an environmental pollutant. It is necessary to find a new route which can effectively and comprehensively utilize coal ash. We reported using coal ash and activated carbon as raw materials to synthesize Al_2O_3-SiC porous ceramics by carbon reduction reaction method. Effects of silicon carbide content on phase compositions, microstructures, mechanical properties, apparent porosity, distribution of pore size, thermal diffusivity, and compressive strength of final products were investigated. Experimental results showed that Al_2O_3-SiC porous ceramics can be synthesized with the mass ratio of coal ash to activated carbon is 100:58, an addition amount of silicon carbide10wt%, and 5wt% phenolic resin as a binder at 1600 °C for 5 h. The as-synthesized Al_2O_3-SiC porous ceramics have the apparent porosity of 48.35%, the high temperature and room temperature compressive strength of 21.65MPa and17.57MPa, water absorption of 33.21%, the thermal shock resistance more than 8 times (1400°C, 6 times in air and 2 times in water), diameter shrinkage of 15.48%, bulk density of 1.05g/cm^3, thermal diffusivity of 0.0194cm2/s, and median size is about 4.24μm. The formation process of Al_2O_3-SiC porous ceramics was also discussed.

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Silicon nitride nanowires toughened boron nitride ceramic composite

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Wave-transparent antenna window for hypersonic aircrafts requires the material to possess sufficient mechanical strength and structural integrity to withstand the aerodynamic force as well as rain and particle erosion, and should exhibit excellent dielectric properties, i.e. low and thermally stable dielectric constant and loss tangent, to transmit microwave signals at high temperatures. As the amost promising candidate of the high temperature wave-transparent materials, nitride ceramics, including boron nitride and silicon nitride, possess excellent high-temperature mechanical properties, superior heat proof ability and fair enough shock resistance. However, as ceramic material, the inherent brittleness acts as an obstacle for its further application in the extreme environment. Therefore, an excellent reinforcement for the wave-transparent composite is required. Silica fiber is the commonest wave-transparent reinforcement and widely used in the last decades, however, its long-time use temperature is blow 1000 °C. Silicon nitride nanowire with high modulus, high strength, low dielectric parameters, and stability at high temperatures, is supposed to be a potential reinforcement to meet the hypersonic flying environment. In this study, silicon nitride nanowires were synthesized by a Vapor-Solid reaction method, and the growth mechanism, the surface element composition of silicon nitride nanowires were investigated. The as-received silicon nitride nanowires at 1500°C exhibit a diameter about 200nm, a length about several millimeters and a relative high yield. The low dielectric boron nitride ceramic matrix composites toughened by silicon nitride nanowires were then fabricated. The composites exhibit good mechanical properties and excellent dielectric properties, with the flexural strength of 120 MPa, the fracture toughness of about 5.5 MPa•m1/2, the dielectric constant of 3.1 and the loss tangent of 0.002. The toughening mechanism includes crack deflection, nanowires pull-out, nanowires bridged and nanowires breakage in the composites.

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Microstructure and properties of grain oriented $KSr_2Nb_5O_{15}$ electro-ceramics

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Lead-free ferroelectric materials especially niobate crystals and ceramics with tungsten bronze structure (TB) have attracted much more attention in recent years. $KSr_2Nb_5O_{15}$ (KSN), with a full of TB structure, taking a higher Curie temperature (Tc) than Sr1-xBaxNb$_2$O$_6$, has shown a room-temperature electro-optic effect approximately seven times than that of $LiNbO_3$. Thus KSN can be widely used in thermal sensitive element, electro-optic modulator and surface acoustic filters, etc. However, the piezoelectric and ferroelectric properties of KSN ceramics are not desirable, which has restricted the applications of material. In this work, well-developed 1-Dimentional rod-like KSN particles are fabricated by Molten Salt Synthesis, and textured KSN ceramics with highly grain orientation have been successfully produced by RTGG using the rod-like KSN particles as templates. The microstructure of KSN textured ceramics are analyzed by using XRD, SEM, Neutron Diffraction, Raman Spectra, and Piezo Response Force Microscopy (PFM). The formation mechanism of the oriented grain growth is discussed and the existence of domain structure with different polarization direction is certified by PFM analysis.

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Influence of Al_2O_3 nano particles addition on the mechanical properties of medium density fiberboards (MDF)

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The importance of the application of composites in high-tech industries especially in aerospace and automobile industries have been improved nowadays due to their good properties such as high strength with respect to weight. Among different types of composites, wooden composites have a special importance in various industries due to their energy absorption as lightweight structures with modified ballistic capabilities. In this paper, the effects of alumina (Al_2O_3) nanoparticles on the mechanical properties of medium density fiberboards (MDF) have been reported. The thickness of boards and the percentage amount of Nano-alumina were considered as variables. In this research, the combination of forest and garden fibers, due to their excellent abrasion resistance, as well as their affordability and suitable price were used as a composite field, with Nano-Al_2O_3 powder (APS: 20nm) as a hardening phase for making the desired Nano composite specimens. The strength including internal bonding (lB), bending strength (modulus of elasticity in bending and modulus of rupture) (MOE, MOR), density, water absorption and swelling in thickness tests were performed on the specimens. The experimental findings show that the resultant properties of the new Nano wooden composites are higher compared to witness samples. The results indicated that increasing the content of Nano-particles had significant effect on the internal bonding as well as bending strength and modulus of rupture of panels. Increasing the thickness of the panels from 5 to 14 mm improved modulus of bending (47%), internal bonding (34%) modulus of rupture (27%). The greatest increase in modulus of bending was observed when 1% by weight Nano Al_2O_3 was added to the samples (10% increase in modulus of bending was observed). The addition of Nano Al_2O_3 particles resulted in an enhancement in MOR compared to witness samples. The maximum MOR had occurred for samples containing 1% Nano Al_2O_3.

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First principles study electronic properties of (110) surface GaAs/GaN nanowires

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GaAs one of III-V compound semiconductor nanowires that exhibit direct band gap has attracted much attention of researchers due its potential application in the field of optoelectronic and microelectronic devices like photovoltaic cells, photo detectors, modulators, filters, integrated circuits and light emitting diodes, it has been widely studied both experimentally and theoretically, a fundamental understanding of its physical properties is still in demand of this novel material. During the manufacture of its nanowires, their surfaces present anomalies which bound to Ga-free broken bonds which are easily interacted with the environment and they oxidize for remedy this problem. We passivated these surfaces by the nitrogen for saturating their surfaces. Motivated by the available literature on GaAs according to the crystalline plane (110), we carried out calculations for structural and electronic properties of GaAs in its stable zinc-blende phase using full potential linearized augmented plane wave method (FP-LPAW) designed within DFT. After that, we will passivate these nanowires by the nitrogen; we study the nutrient effect on their physical properties (GaAs / GaN) by keeping the same theoretical model used previously from a similar study that has been carried out on plane surfaces of GaAs showed that nitridation phenomena leads to the deposition of a thin layer of GaN and confers passivated to the solid.

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Microstructure and electrical properties of b($Zr_{0.5}Ti_{0.5}$)O_3-Pb($Zn_{1/3}Nb_{2/3}$)O_3-Pb($Ni_{1/3}Nb_{2/3}$)O_3+x$S_3Ti_2O_7$ ceramics

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Pb($Zr_{0.5}Ti_{0.5}$)O_3-Pb($Zn_{1/3}Nb_{2/3}$)O_3-Pb($Ni_{1/3}Nb_{2/3}$)O_3 (PZNNT) ceramics with different content of plate-like $Sr_3Ti_2O_7$ compound was prepared through conventional solid state methods. The effect of $Sr_3Ti_2O_7$ amount and the sintering temperature on the microstructures and piezoelectric properties of PZNNT ceramics were investigated. Analyses of phase and microstructure indicated that both of grain size and the content of tetragonal phase at the MPB decreased significantly by increasing $Sr_3Ti_2O_7$ while dilute the Pb-O covalency with more lower ferroelectric properties. When the $Sr_3Ti_2O_7$ was 5wt%, the specimen had relative optimum properties due to the close content of tetragonal and rhombohedral phase at the MPB. Additionally, with further increase of sintering temperature for mature grain, the content of tetragonal phase and electric properties of PZNNT-5wt% $Sr_3Ti_2O_7$ ceramics gradually increased. The optimal piezoelectric and dielectric properties of PZNNT-5wt% $Sr_3Ti_2O_7$ ceramics sintered at 1040°C for 2h was $d33$=572pC/N, $d33 \times g33$=17630×10^{-15} m^2/N and k_p=0.57 due to the content of tetragonal and rhombohedral phase coexisted and relative larger grain size ceramics, which is potential candidate materials used for the application in energy harvesting.

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Densifying TaC ceramics with various additives and the relevant mechanisms

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Tantalum carbide (TaC) has the highest melting point, at up to 3997°C, among the carbides of the transient metals. Recently it has attracted extensive research interest as a member of the Ultra High-Temperature Ceramic (UHTC) family. However, pure TaC ceramics are extremely hard to densify. The entrapment of residual pores has hindered further densification. Herein we report our research results on densifying TaC ceramics by adding various additives, including (i) ceramic particles (SiC, Si_3N_4 and SiO_2), (ii) B4C as a reductive agent, (iii) metallic sintering aids (Al, Cu, Ag and Au), (iv) Si as a transient liquid sintering aid, and (v) ZrC. The relevant densification mechanisms were discussed. It was observed that full densities could be reached for most of the compositions after spark plasma sintering at 1600-1900°C under a mechanical pressure of 20-30 MPa. Although it was common that the secondary particles would increase densification of UHTCs by physically pinning the grain boundaries, a small among of glassy phase in the multi-grain conjunctions suggested liquid phase sintering in case of addition of SiC and Si_3N_4 to TaC. Elongation growth of the SiC and Si_3N_4 grains in the microstructures indicated dissolve-reprecipitation, also in consistency with existence of some liquids. The metallic sintering aids (Al, Cu, Ag and Au) could inhibit cross-boundary diffusion to avoid entrapment of residual pores and refine the TaC grains. Combining ZrC and trace metallic agents resulted in dense (Ta,Zr)C ceramics with fine microstructures and good mechanical properties. When Si was used as the sintering aid, transient liquid sintering was realized. Oxygen introduced by adding the SiO_2 substance did not hinder densification of TaC.

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Microstructure and thermoelectric properties of $Sr_{0.9}La_{0.1}TiO_3$ ceramics with nano-sized metal particles as additive

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$Sr_{0.9}La_{0.1}TiO_3$ thermoelectric ceramics with nano-sized Ag ($Sr_{0.9}La_{0.1}TiO_3$/xAg, x=0.05, 0.10, 0.15, 0.20) and Ti ($Sr_{0.9}La_{0.1}TiO_3$/yTi, y=0.05, 0.10, 0.15, 0.20, 0.30, 0.40) metal particles as additives were prepared by conventional solid state reaction method, and the influences of metal particles adding content on the microstructure and thermoelectric properties were investigated. XRD characterization confirmed that the main phase was perovskite $Sr_{0.9}La_{0.1}TiO_3$, along with a small amount of metal phase. SEM images showed that all of the samples were dense, and the metal particles accumulated at the grain boundaries, to form a complex network, contributing to increasing the electrical conductivity. Raman spectra of samples before and after annealing in Ar+C atmosphere showed a great difference, resulting from the creation of oxygen vacancies and changes in the Ti-O bond vibration and rotation modes. Adding nano-sized metal particles can increase the electrical conductivity and improve thermoelectric properties effectively. The maximum *ZT* value of 0.37 was obtained for $Sr_{0.9}La_{0.1}TiO_3$/0.30Ti samples at 1073 K, accompanying with the relative high Seebeck coefficient of -336 μV/K and low thermal conductivity of 2.14 W/m/K. This work suggested a route for using nano-sized metal particles to enhance the thermoelectric properties of oxide thermoelectric ceramics.

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Repairing imperfections of air bubble, stain and piece which are arising from the first firing by way of laser sintering method without need of second firing in sanitary ware

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The various parameters such as capacity increase, product development and design played an important role to improve the productivity in the sanitaryware industry. High costs of energy and labour made process of product development /improvement important with technological infrastructure and possibilities. This study involve that regional repair at the finished products have defects glaze which affect directly the product quality using low-temperature frit with Laser (Light Amplification by Stimulated Emission of Radiation) that product of applied physics and material science. One of the most important characteristics of Lasers based on the timulated emission theory of radiation is that photons can move in one direction in the form of coherent beam. This means that the photon energy ($E=h\gamma$) can easily focus on a region. The porous structure of the glaze, released gases from the component of the glazes cause air bubbles, piece and stain in the melting phase. The glaze defects is observed at the finished products take part in the first region must be needed to the second firing. Thereby its possible to get products have a deformation such as shock. The laser sintering method brings on technological infrastructure in contrast with conventional/traditional methods. Additional to targeted decrease in costs of energy and labour which have an important share in the total cost is among the most remarkable project results.

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Centrifugally spun alumina zirconia fibers

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Statement of the Problem: Ceramic fibers (micron or nano meter dia.) are being used in place of conventional refractory bricks due to their exceptional thermal insulation properties like low thermal mass, low thermal conductivity etc. There are high and low temperature methods to synthesize fibers. But the low temperature methods conserve lot of energy. Hence, sol-gel with centrifugal spinning was chosen to synthesize fibers. The purpose of this study is to synthesize alumina zirconia (stabilized and unstabilized) fibers and to understand the grain growth controlling mechanisms. Methodology & Theoretical Orientation: In the present work, alumina zirconia (5-20 wt. % zirconia) fibers were synthesized by sol-gel with centrifugal spinning. Monolithic alumina fibers had an average grain size of ~4 μm which is huge and it will degrade mechanical properties. Hence zirconia was added to control the grain growth. Findings: The diameter of the fibers was between 5-15μm. Fiber index after sieving at 90 μm sieve was around 96 %. SEM images confirmed that the fibers were devoid of any abnormal grains (Fig. 1 (a-d)). Average alumina grain size was ~ 4 μm. Alumina fibers with zirconia showed homogeneous distribution of zirconia throughout the fibers (Fig. 1 (b-d)). It was also confirmed that zirconia controlled the growth by triple junction pinning effect which is in good agreement with the mechanisms reported. With the increase of zirconia content from 5 wt. % to 20 wt. % more number of grain boundary junctions are pinned which controls the grain boundary mobility effectively. Conclusion & Significance: Alumina zirconia fibers of 5-15 μm dia. were synthesized using sol-gel with centrifugal spinning. Average alumina grain size was ~ 4 μm. This got reduced to 2.8 μm and 1.1 μm respectively for 5 and 20 wt. % and it varied in between for 10 and 15 wt. % zirconia Zirconia controlled the growth by secondary phase pinning which is in good agreement with the mechanisms reported.

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Impedance spectroscopy theory and applications

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Impedance spectroscopy (IS) is the measurement of electrical impedance, admittance, or some other closely related quantity as a function of frequency. It is used to resolve processes of electrical polarization according to their relaxation frequencies or time constants. The technique can be used to characterize ionic or electronic conductors as well as dielectric materials. It is commonly applied to electro ceramics, solid electrolytes, dielectrics, including polymers and glasses, and to integrated energy conversion devices such as batteries and fuel cells. Material Impedance spectroscopy is a powerful technique used for the characterization of electrical proprieties of materials (ceramics, polymers,..) and for investigation of Kinetics of reactions in materials. These properties are temperature dependent. Impedance spectroscopy provides the contribution of different micro structural features of a material in the row impedance of materials (grains, grain Boundaries,..). This technique has the inherent potential of non-destructive testing. The principle of the impedance spectroscopy experiment is to apply a sinusoidal electrical stimulus (either voltage or current) to a sample and observe the response (respectively current or voltage). The data resulting from such a measurement (usually a list of f, Z_{re}, Z_{im}) are analyzed using a complex nonlinear least squares (CNLS) fitting code, to determine the parameters of a circuit equivalent. Through the system in terms of amplitude and phase shift compared to voltage-time function. The complex value of impedance can thus be described in terms of its real and imaginary values at different frequencies. The results of an impedance measurement can be graphically demonstrated using bode and Nyquist or Cole-Cole plot for all applied frequencies. In this presentation, I will present our research on impedance techniques:

- Electrical conductivity and dielectric analysis of the perovskite $La_{0.7}Ca_{0.3}xK_xM_nO_3$ (x = 0.00, 0.05 and 0.10).
- Studies of (90-x) P_2O_5-xB_2O_3-10Fe_2O_3 glasses by impedance spectroscopy methods (x = 0 mol.%, 10 mol.%, 20 mol.%, 30 mol.%,40 mol.%)
- $10B_2O_3$–(90 – x) P_2O_5– xNa_2O) with x=0, 5, 10, 15, 20 mol%.

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Influence of impregnation parameters on structure and properties of plasma sprayed alumina coating impregnated by aluminium phosphate

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This paper deals with the physical properties and the structure of electrical insulation barriers based on a thermal sprayed alumina coating. The objective of this coating is to protect stainless steel components submitted to electrical potential differences in an induction furnace. The process constraints (corrosive atmosphere, radiated energies, thermal stress, and mechanical constraints) forbid to use organic compounds. Only ceramics meet the needs of the process. Moreover, there are implementation constraints because the stainless steel areas to be protected are complex shaped and large size. To protect electrically stainless steel substrates over a wide area, the most commonly used technique is the thermal spraying of an alumina coating. These coatings are known to form an electrical insulation barrier that protects efficiently the stainless steel structures subjected to high differences of voltage. However, for specific applications, electrical conductor liquids inlet or corrosive gases inlet requires to seal the open and/or interconnected porosity of the alumina coating with aluminium phosphate. The sealing procedure has been realized by impregnation of thermal sprayed alumina coating with a mono aluminium phosphate solution (MAlP) and applying heat treatment to the system. This procedure is characterized by parameters related to the impregnation technique (vacuum, brush and spray), the heat treatment, and the impregnating solution. We show in this paper how these different parameters impact the coating physical properties (thermal and electrical tests). A diffusion barrier at the liquid inlet and presenting a good electrical insulation in aggressive conditions is finally obtained.

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In-situ visualization and analysis of single atom dynamics in nanoparticle catalysts on ceramic supports using novel environmental (scanning) transmission electron microscopy

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Many heterogeneous catalytic processes employ metal nanoparticles on ceramic oxide supports to produce environmentally sustainable energy, healthcare products and to control emissions. These catalytic chemical reactions take place at the atomic level. Understanding and controlling complex catalytic reactions at the atom level are therefore crucial for the development of improved processes and materials. To visualize and analyse gas-ceramic supported catalyst reactions, we have designed and constructed the first atomic resolution environmental transmission electron microscope (ETEM) (1), which has been exploited for commercial production and used globally. We have now developed it further to support full ES(scanning) TEM functionality with aberration correction (AC), (AC ESTEM). Single atom resolved high angle annular dark field (HAADF) imaging (image) and full analytical functionalities, including electron diffraction and EDX, are enabled for the first time under controlled chemical reaction conditions of high temperatures in a continuously flowing gas atmosphere around supported nanoparticle catalysts while retaining single atom sensitivity for atom-by-atom analysis of critical catalytic processes [3-5). The AC ESTEM instrument in our laboratory has been used to obtain new insights into processes of metal nanoparticle catalyst activation and deactivation on ceramic supports which has both economic and societal importance. Gas pressures used are fully adequate to flood the surface with gas molecules and to drive the chemistry which also aim to avoid electron beam effects. The AC ESTEM supports quantitative atom-by-atom analysis of the underlying mechanisms of sintering and metal-ceramic support interacttons in nanoparticle systems supported on several ceramic supports (ceria, alumina and silica) have been been studied with new levels of single atom precision using the novel capabilities in our laboratory and leading to a better informed understanding of their effect on the catalyst function and enabling developments needed going forward

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Investigation of anisotropic mechanical properties of textured $KSr_2Nb_5O_{15}$ ceramics by ab-initio calculation and nanoindentation

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By applying first-principles calculation based on density functional theory (DFT), elastic properties of $KSr_2Nb_5O_{15}$ (KSN) crystals were derived, involving elastic constants, Young's modulus, Poisson's ratio, bulk modulus and shear modulus, hardness, and universal anisotropy index. Calculated results show that in the KSN lattice, Nb-O forms relative strong covalent effect and Nb-O octahedral distortion causes spontaneous polarization in the KSN crystal. To verify the simulated results experimentally, textured KSN ceramics with highly oriented grains with tetragonal symmetry were fabricated by RTGG (Reactive Template Grain Growth) method. Nanoindentation was carried out on textured samples in parallel and perpendicular to the elongated-shape grains oriented to [001] direction. Measured indentation modulus values are in accordance with the predictions which show an anisotropic ratio of ~10% between the two tested orientations. Predictions of Young's modulus revealed a more pronounced anisotropy with a ratio of ~40% between the [100] direction and at a tilt angle of about 45° from the [001] direction towards the [100].

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Joining and machining of (ZrB_2-SiC) and (Cf-SiC) based composites

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ZrB_2-SiC and Cf-SiC based ultra high temperature ceramics (UHTC) are most promising materials for the application in thermal protection systems and high temperature components of future hypersonic aircraft or reentry vehicles. The difficulty in fabricating large size or complex shapes limits the application of these composites. Machining and joining are inevitable requirement for flexible use of advanced ceramics. Diamond machining is an expensive and time consuming process. Low cost near net shape processing of ceramic parts with complex geometries is possible with pressure less sintering (PS). (ZrB_2-SiC-B_4C-YAG) composites have been developed by PS of (ZrB_2-SiC-B_4C) with (Y_2O_3-Al_2O_3) sintering additives at relatively low temperature of 1550-1680°C. Filler materials of (ZrB_2-SiC-B_4C-YAG) composite were developed for tungsten inert gas (TIG) welding of the ZrB_2-SiC and Cf-SiC based composites to themselves and to each other. By incorporation of Cf-SiC short fibre reinforcement the (ZrB_2-SiC-B_4C-YAG) composites were machinable with tungsten carbide tool bit. The joint and machined composite exhibited resistance to oxidation and thermal shock upon exposure to oxy-propane flame at 2300°C for 300 seconds. The combination of (ZrB_2-SiC-B_4C-YAG) and Cf-SiC based composites can be used for making low cost parts like thermal protection system or nozzles for rocket motors.

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Development and characterization of Hydroxyapatite-Alumina- Zrirconia biocomposites for orthopedic implants

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The development of new biomaterials with enhanced mechanical and physical properties and biocompatibility has become a major challenge in biomaterials community. In this case, biomaterials play a very important role as source for needed materials to satisfy human requirements. Among different categories of biomaterials, hydroxyapatite HAP is responsible for bio-mineralization, osteoinduction, and osteo-integration and has good biocompatibility and bioactivity. Because pure HAP shows poor mechanical properties, low strength (<120MPa) and low fracture toughness, different inorganic additives such as zirconia and alumina are introduced in order to improve the properties of hydroxyapatite. In this study, various HAP-ZrO_2 and HAP-Al_2O_3 biocomposite powders have been synthesized using a modified precipitation method under ultrasonic irradiation and haracterized by numerous techniques. The in situ growth of ZrO_2 and Al_2O_3 followed by thermal treatment allowed for the formation of nanocomposites homogeneously dispersed in the hydroxyapatite phase. The benefit of this association favors the dispersion of oxide phase in the apatite structure and therefore enhances their intrinsic mechanical properties. High oxide loadings within the HAp structure can even lead to superior mechanical efficient compared to the HAP alone. Considering these results, we have prepared here HAP-ZrO_2 and HAP-Al_2O_3 nanocomposites and evaluated their mechanical properties towards the addition of oxide phase.

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Use of halide solution to improve the RDI and RI of sinter : An experience at JSPL

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The reduction-degradation index (RDI) of sinter is an important parameter to estimate the quality of sinter in low temperature zone (450-550°C) of blast furnace. Hence, it is of great importance to reduce the RDI of sinter which improve the permeability of blast furnace burden column for a stable and smooth performance resulting high yield and low consumption. In the last few years, many researchers have studied and reported the method for improving sinter quality by adding halide solution on to surface of the manufactured sintered ore. Some sinter producers also established from practices that spraying $CaCl_2$ solution on to the sinter surface will reduce the RDI (reduction-Degradation Index) of sinter. A study on the RDI and RI (reducibility index) of sinter, which was sprinkled with different concentrations of $CaCl_2$ solution was carried out at Jindal Steel & Power Ltd., Raigarh. The laboratory results showed that up to a certain percentage the RDI and RI of sinter decrease with the increase of Cl- concentration. With comprehensive consideration of the RDI and RI of sinter, when the concentration of Cl- reaches an optimum level (say X%), the RDI of sinter will be significantly reduced and at the same time RI will not be affected. On the basis of the laboratory results, the same has been implemented successfully for the existing sinter plant. The experience thus gained has been explained in this paper.

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Structural adjusting and luminescence property refinement of $NaSr_2Nb_5O_{15}$:0.03Eu^{3+} phosphors

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Tetragonal tungsten bronze type $NaSr_2Nb_5O_{15}$ offers two kinds of sites with different symmetries for Eu^{3+} occupying. Based on the selected rules of Eu^{3+} ionic radiative transition, the luminescence properties of $NaSr_2Nb_5O_{15}$: 0.03Eu^{3+} phosphors could be refined by adjusting the symmetries of crystal structure. In this work, $NaSr_2(1-x)Nb_5O_{15}$: 0.03Eu^{3+} (x=0, 0.02, 0.04, 0.06, 0.08) phosphors were prepared via traditional solid state reaction method. The effects of absent Sr^{2+} on the crystal structure and luminescence properties was investigated. The phase structures, morphologies, elements, and luminescence properties were characterized by the X-ray diffractometer (XRD), Scanning electron microscopy (SEM), Energy dispersive spectroscopy (EDS) and Photoluminescence spectroscopy (PL). The results confirmed that the distortion of [NbO6] octahedrons increased with the absence of Sr^{2+}, whereas the symmetries of the sites occupied by Eu^{3+} decreased. Following the adjustment of structure, the relative intensity of magnetic-dipole transition ($^5D_0 \rightarrow {}^7F_1$) could be reduced (~6%), and more excited electrons release energy through electric-dipole transition ($^5D_0 \rightarrow {}^7F_2$). This work suggested a route for using lattice structural adjustment to refine luminescence properties of tungsten bronze type phosphors.

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Effects of polymer derived SiC on the microstructure and properties of C/ZrC composites prepared by reactive melt infiltration

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Polymer derived SiC matrix was introduced into C/ZrC composites, which were prepared via reactive melt infiltration (RMI) of zirconium into C/C preform, to improve its mechanical properties and erosion resistance at high temperatures. After polymer infiltration and pyrolysis (PIP) process, the density of the composites increased from 3.06 g/cm^3 to 3.17 g/cm^3 and the porosity decreased from 9.20% to 3.80%. SiC matrix mainly distributed at the surface of composites, but defects decrease and increasing interface strength of the composites during PIP process resulted in the remarkable increase of rigidity and strength. The flexural strength and modulus increased substantially from 182 MPa and 12.8 GPa to 289 MPa and 38.2 GPa, respectively, and the fracture toughness also increased from 5.4 MPa-m$^{1/2}$ to11.4 MPa-m$^{1/2}$. The oxidation resistance of C/ZrC composites at 1600°C was enhanced with PIP-SiC, but the linear recession rate rose from 0.004 mm/s to 0.009 mm/s after introduction of PIP-SiC.

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Structure-property correlations in perovskite oxide materials for potential applications

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Perovskite oxide materials have become the basis of modern scientific and technological inventions. The research on Perovskite materials has accelerated and shown great attention from the past years because of their excellent functional properties for technological applications. These properties can easily be tuned with structure-property correlations. These materials were prepared by using a different method (solid state method, Semi-wet Method and Highly energy ball milling) followed by powder consolidation convectional and Spark plasma sintering under the optimized conditions. Structural, microstructure, and electrical (dielectric, ferroelectric, piezoelectric and thermoelectric) properties were studied systematically.X-ray diffraction (XRD), Raman spectroscopy, Fourier-transform infrared spectroscopy (FTIR) and Field emission scanning electron microscopy (FE-SEM) were used to study the crystal structure, functional groups, and surface morphology respectively. The synthesized oxide materials (Lead-free ceramics/ Nanocomposites) are novel in terms of a commercially viable innovative and indigenously developed by chemical synthesis route adopted and have significant potential for the different applications.

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4th International Conference and Expo on

Ceramics and Composite Materials

May 14-15, 2018 | Rome, Italy

Experimental analysis of low density poly ethylene effect on the mechanical properties of poly ethylene vinyl acetate for prosthetic and orthotic application

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In this comparative study, the effect of low density poly ethylene and ethylene vinyl acetate loading ratio by melt blending with additives and without additives on mechanical properties for prosthetic and orthotic application was analyzed. To carry out this thermoplastic materials such as low density poly ethylene (LDPE), Ethylene vinyl acetate (EVA), color pigment, calcium carbonate, titanium dioxide and black carbon have been used as raw material to produce the sample in sheet form and to achieve comfortable prosthetic and orthotic application. The method used were blending, molding, testing of produced materials. Increasing the content of EVA and decreasing content of LDPE had effect on compatibility, tensile strength and elongation at break vice versa. The blended composite with additives have no significant effect on molding and without additive have significant effect on molding due to molecular mobility which leads shrinkage. The maximum tensile strength reached to 10.5Mpa and minimum tensile strength reached 2.8Mpa and the maximum elongation at break reached 469.8% and minimum elongation at break 40.2%.The other result are in between of these ranges, which have better than existing one has maximum tensile strength of 2.3Mpa and elongation at break have 265%.The mean value of maximum tear load is 74.4N/mm and minimum tear load have 38.9N/mm which have better result than existing one has 10.5N/mm. Scanning electron microscope(SEM) test result showed that specimen with more filler and less content of EVA become poor in its morphology and compatibility.

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Novel approach to the fabrication of alumina self-lubricating composites

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Alumina matrix composites are promising wear-resistance components because of their superior strength, hardness, corrosion resistance, and anti-wear. However, the industrial applications of these materials is limited by their poor lubricating property, as indicated by their high friction coefficient under dry sliding conditions. The incorporation of solid lubricant in ceramic matrixes remains challenging because high temperature during ceramic sintering cause solid lubricant melt or even decompose. In the present study, we designed a novel approach to introduce the lubricant into a sintered alumina ceramic matrix. A series of alumina matrix self-lubricated composites was fabricated. The influence of macro/micro structures on the properties of materials was investigated by SEM, EDS, 3D profile, universaltesting machine and friction and wear tester. The results show that the developed composites have much higher reliability, and also have good self-lubricating ability.

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