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## Posters

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# 3D additive manufacturing of bioceramic applied to the bone reconstruction using reverse thermo-responsive hydrogel technique

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The key advantages of a 3D printed biodegradable scaffolds are custom control of shape, porosity, pore connectivity, material composition, site-specific drug/growth factor delivery, and orientation. Another limitation in 3D printed parts is that the mechanical properties of printed objects do not always resemble the repaired tissue in terms of modulus, and strength. Improvement in mechanical strength often resulted in compromise in biodegradability or biocompatibility. Clinical reported that porous biphasic bioceramics of hydroxyapatite/β-tricalcium phosphate (Hap/β-TCP) can promote osteoconduction during new bone formation in in vivo experiments. However, the brittle nature of porous bioceramic substitutes cannot match the toughness of bone, which limits the use of these materials for clinical load-bearing applications. Fortunately, our novel methods to enhance mechanical properties are mainly based on the admixture of a combustible reverse negative thermo-responsive hydrogel (poly(N-isopropylacrylamide base) that burns away during sintering in the resulting object. This method can be regarded as functioning in a manner similar to the cold isostatic press (CIP) step before the powder sintering densification process. In other words, sintering densification is expected via free volume contraction, which will increase the mechanical properties after the formation of the porous bioceramics. We will develop the curved shape bioceramic block with interpenetrating channels for bone reconstruction. The study aimed to investigate the processing chain, the dimensional accuracy and the mechanical and physical characteristics of the implants.

## Biography

Chih-Kuang Wang has completed his PhD from National Cheng Kung University and Post-doctoral studies from Industrial Technology Research Institute (ITRI) in Taiwan. He is a staff member of the Department of Medicinal and Applied Chemistry and also the Investigator working in the Orthopaedic Research Center (ORC) at Kaohsiung Medical University (KMU). He has published more than 40 papers in reputed journals, 5 kinds of patent have been acquired, and 3 kinds of patent application are in process.

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**Notes:**

Vasily Tarnopolskiy et al., J Material Sci Eng 2016, 5:4(Suppl)
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# All-solid state Li-ion batteries with ceramic electrolyte

**Vasily Tarnopolskiy and Samer Kurdi**
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Today battery safety is one of the main problems blocking the market of electric vehicles. Toxic and flammable liquid electrolytes are responsible for most of the safety incidents including electrolyte leakage, ignition and cell explosion. It is critical to address such safety concerns when scaling up the battery size for use in electric transport and stationary applications. Solid lithium-ion conductors have granted much attention as candidates to replace liquid electrolytes in Li-ion batteries due to the following possible advantages: non-flammability, non-reactivity, higher thermal stability, absence of leakage, large electrochemical window, ease of miniaturization and excellent storage stability. However, solid-state Li-ion batteries have their issues: low ionic conductivity, difficult implementation and volume changes are some of the reported limitations. CEA LITEN has a broad experience in development of conventional Li-ion cells with liquid electrolyte. The studies of solid electrolyte implementation have been initiated to meet the demands of car-makers. Nowadays, a number of techniques have been reported in literature to incorporate solid electrolyte into the Li cell but still there is no commercial product. The main problems are the interfacial resistance due to poor contact between particles, chemical and electrochemical interactions between components of the cell. Our lab develops ceramic and glassy solid electrolytes to improve the battery safety and employ advanced electrode active materials. One of the amitious targets is to adapt the approaches from the world of ceramics to create a «one stone» dense Li-ion cell. In this study, two aspects of solid electrolyte implementation will be discussed: one relates to conductive membrane stabilization; another deals with composite electrodes. Ceramic $Li_7La_3Zr_2O_{12}$ having a garnet structure and softer $Li_{10}SnP_2S_{12}$ are used as a solid electrolytes. These electrolytes have different physical properties which allows using different implementation methods.

## Biography

Vasily Tarnopolskiy has completed his PhD in 2003 from Russian Academy of Sciences and Post-doctoral studies from Samsung SDI (S. Korea), Muenster University (Germany) and CEA (France). His interests include lithium-ion batteries, high-voltage cathodes, solid electrolytes, all-solid Li cells.

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# The absorption and radiation transitions of $Mn^{2+}$ ions in the polyvinyl pyrrolidone capped ZnS: Mn nanoparticles

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Polyvinyl pyrrolidone (PVP) is a conductive polymer having strong polarized carbonyl (–C=O) group, in which oxygen atom is able to coordinated bond with $Zn^{2+}$ and $Mn^{2+}$ ions on the surface of ZnS:Mn nanoparticles. Under the effect of ultraviolet radiation, electrons of PVP chains can be absorption, radiation transitions HOMO LUMO and then energy transfer to ZnS:Mn nanopartiles. This paper present the preparation process of PVP capped ZnS:Mn nanoparticles, in which ZnS:Mn nanoparticles were synthesized by co-precipitation method, after that they were dispersed in PVP matrix. Microstructure, morphology and average crystalline size of PVP capped ZnS:Mn (ZnS:Mn/PVP) nanoparticles were determined by X-ray diffraction pattern (XRD) transmission electron spectroscopy (TEM), thermal gravimetric analysis (TGA) and differential gravimetric analysis thermographs (DTG). Fourier transfer infrared absorption spectra (FT-IR). The results show that the capping of ZnS:Mn nanoparticles by PVP almost do not change crystalline structure with average particle size about of 3.6 – 4 nm. The optical properties of PVP capped ZnS:Mn nanoparticles were investigated by UV-Vis absorption spectra, photoluminescence (PL) and photoluminescence excitation (PLE) spectra. The capping of ZnS:Mn nanoparticles by PVP mass almost not change the peak position of bands characterized to absorption and radiation transitions of Mn2+ ions in PLE and PL spectra. But their intensities were changed according to PVP mass and the PL intensity increase stronger with appropriate PVA mass. From achieved experimental results, the absorption and radiation transitions of Mn2+ ions in PVP capped ZnS:Mn nanoparticles were studied and explained

## Biography

Tran Minh Thi has got his academic degree as an Doctor from the Institution, Faculty of Physics, Hanoi National University of Education, Hanoi city, Vietnam.

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# Evaluation of mechanical properties and cell response of glass infiltrated zirconia after sandblasting

**Sang-Won Park**
Chonnam National University, Korea

Zirconia surface modification technique, especially, glass infiltrated zirconia method is one of the most effective method on producing a composite with more desirable properties than the individual components. The aim of this in vitro study was to evaluate the mechanical properties and initial cell response of glass infiltrated zirconia ceramic before and after sandblasting. 100 zirconia specimens were divided into the following 4 groups, according to the surface treatments: untreated zirconia (control), sandblasted zirconia (S), glass infiltrated zirconia (G), and sandblasted glass infiltrated zirconia (GS). Surface roughness (Ra) was determined using a nanosurface 3D optical profiler. Biaxial flexural strength was measured by universal testing machine, according to ISO 6872. Vicker's indentation test was performed to estimate the material hardness (Hv). MC3T3 osteoblast-like cells proliferation and attachment were examined for 1 day and 3 days. Glass infiltration depth, surface morphology, and indentation patterns were characterized under a high-resolution field emission scanning electron microscopy (FE-SEM). One-way analysis of variance (ANOVA) and Tukey's HSD pairwise multiple comparisons were performed on all the test. GS group showed a slight decrease in hardness, but revealed the improvement of flexural strength (686.2 MPa). After sandblasting, GS group had the highest surface roughness (Ra=1.24 μm) compared to the other groups, and supported an enhanced osteoblast cells response than the untreated zirconia. FE-SEM images of the glass infiltrated zirconia surface microstructure showed a smooth surface before sandblasting. After sandblasting, the new surface exhibited roughness with the formation of shallow irregularities. The results of this study indicated the beneficial influence of graded structures in the design of zirconia implant, possibly also all-ceramic crowns and ridges restoration. The glass infiltrating process could be used as a promising method to enhance the mechanical properties with better surface roughness of zirconia implant for osteoblast cells response. Limitation of this study related to the experiment conditions which may different from the actual clinical situation.

## Biography

Sang-Won Park received his DDS degree (1985) and PhD (1995) from Chonnam National University, South Korea. Since 2000, he has been a Professor of Prosthodontics, Chonnam National University. He served as Visiting Professor at University of Texas Health Science Center at San Antonio from 2002 to 2003. He is a Prosthodontist, but has the experience of implant surgery and prosthesis over 20 years and his research interests has been focused on implant surfaces and zirconia prosthesis. He has published articles in international peer-reviewed journals and is co-author of several books and serves on the editorial board of Journal of Advanced Prosthodontics. He was the Chairman of Dept. of Prosthodontics and a Director of Chonnam National University Dental Hospital.

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# Mechanical alloying, sintering and characterization of Al-10 wt% $Al_2O_3$ nanocomposite

**Mahmoud Nasr El-Din Mohammed**
National Research Centre, Egypt

Al-10 wt% $Al_2O_3$ metal matrix composite (MMC) was synthesized by mechanical alloying technique. The effect of milling time and consequently the distribution of $Al_2O_3$ through the Al matrix, on the properties of the obtained powder composites were studied. X-ray diffraction (XRD) and transmission electron microscopy (TEM) were used to investigate their phase composition and morphology. The powders were cold pressed under 10 MPa and sintered in argon atmosphere at different temperatures (300, 370 and 470°C) for 1 h. The relative density and apparent porosity of the sintered samples were determined by Archimedes method, their microstructure was investigated by using scanning electron microscopy (SEM) attached with energy dispersive spectrometer unit (EDS) and their microhardness was measured. The results showed that no notification of phase changes during milling, and as the milling time was gradually increased the crystallite and particle sizes were decreased, while the internal micro-strain increased. It was also found that the relative density increased with increasing milling time and sintering temperature, while the apparent porosity decreased. The micro-hardness of the sintered composites increased with increasing milling time.

## Biography

Mahmoud Nasr El-Din Mohammed has completed his PhD from Al-Azhar University. He has published 5 papers in journals and conferences (some other papers are submitted to international journals). He is a PI and member in two NRC internal projects. He has suprvised MSc thesis. In addition, he participated in some conferences and workshops.

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## Synthesis of miserite or wollastonite glass-ceramics for dental applications

**Jae Chul Bang**
Soonchunhyang University, Korea

Glass-ceramics with special properties are suitable for application in dental implants. In this study, we synthesized glass-ceramics based on miserite or wollastonite system. The composition and heat treatment were studied for their effect on the formation of the crystalline phases and on the resulting mechanical properties, such as hardness, fracture toughness, and bending strength. Various colors in Vita shades were achieved by the addition of various metal oxides such as $Er_2O_3$, $Fe_2O_3$, and $Mn_2O_3$.

### Biography

Jae Chul Bang has completed his PhD from Virginia Tech. He is the Professor of Soonchunhyang University in Korea and has been studying on ceramics for various applications.

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# Peculiarities of vibration assisted surface finishing methods for brittle material surfaces

**Vytautas Ostaševicius and Gytautas Balevičius**
Kaunas University of Technology, Lithuania

Employment of new materials, into existing production processes, commonly challenges the suitability of existing machining methods by imposing new conditions in order to maintain machinability, or preserve the integrity of the material in question. This case is most prominent when finishing surfaces of hard-brittle materials, like glass, ceramics, alloys, metals etc. Main limits imposed on conventional machining processes, concern the scale of machining, as it must be low enough to maintain ductile regime deformation. The main challenges in this case are, the necessity of real time, seamless monitoring and analysis of performance metrics of the process and the need for increasing ductile regime machining limit or brittle-ductile transition. Presented in the poster are findings of recent glass, and PZT ceramic vibration assisted drilling and binderless tungsten carbide vibration assisted side grinding experiments, performed by the Kaunas University of Technology Institute of Mechatronics and in cooperation with Fraunhofer Institute of Production Technology. Effect of vibration on brittle-ductile transition is discussed and current modelling efforts are presented. Wireless, self-charging sensors, developed by Institute of Mechatronics are proposed as a monitoring solution for the real time, seamless monitoring and analysis of performance metrics problem. Potential application benefits of wireless, self-charging sensors and their integration into cloud manufacturing systems, for machining of hard-brittle materials, are introduced.

## Biography

Gytautas Balevičius is a Mechanical Engineering PhD student at Kaunas University of Technology, Institute of Mechatronics. The main focus of his doctoral thesis is - brittle-ductile transition of brittle materials during vibration assisted machining.

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# Surface treatment of yttria-stabilized tetragonal zirconia polycrystals with argon plasma-jet: A pilot study

**Emre Seker[1], Basak Kusakci Seker[2] and Suat Pat[3]**
Eskisehir Osmangazi University, Turkey

This study aimed to evaluate the surface roughness and wetting properties of Zirconium as a prosthetic material after different durations of argon plasma-jet surface treatment. Six yttria-stabilized tetragonal zirconia polycrystals (Y-TZP) discs were machined and smoothed with silicon polishing discs. The surface roughness was evaluated in a control group and in groups with different plasma-jet exposure application times [15-30-60-90-120 seconds (s.)]. The average surface roughness (Ra) and contact angle (CA) measurements were recorded via an atomic force microscope (AFM) and tensiometer, respectively. Data were analyzed with one-way analysis of variance (ANOVA) and the Tukey HSD test ($\alpha$ =.05). According to the results, the argon plasma-jet surface treatment significantly affected the wettability properties ($P < 0.05$), but there is no significant between application time and surface roughness changes ($P > 0.05$). With an increase in the application time, a remarkable reduction in CA was observed. With the limitation of this study it can be concluded that the argon plasma-jet could enhance the wetting performance of Y-TZP but the effect on roughenning not been clearly established.

## Biography

Emre Seker has completed his Under-graduate education and PhD from Ankara University and Near East University respectively. He served as a Lecturer and Clinical Specialist and currently working as an Assistant Professor at Eskisehir Osmangazi University Faculty of Dentistry Department of Prosthodontics. He has published more than 30 papers and presentations, and continues to study on surface treatment techniques of dental materials, CADCAM dentistry and plasma technology.

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# Evaluation of surface raughness and adhesion capability of titanium after argon plasma-jet surface treatment: A pilot study

**Basak Kusakci Seker, Emre Seker and Suat Pat**
Eskisehir Osmangazi University, Turkey

Six titanium (Ti Grade 5) discs were machined and smoothed with silicon polishing discs. The surface roughness was evaluated in a control group and in groups with different plasma-jet exposure application times [15-30-60-90-120 seconds (s.)]. The average surface roughness (Ra) and contact angle (CA) measurements were recorded via an atomic force microscope (AFM) and tensiometer, respectively. Data were analyzed with one-way analysis of variance (ANOVA) and the Tukey HSD test ($\alpha$=0.05). According to the results, the argon plasma-jet surface treatment significantly affected the roughness and wettability properties ($P<0.05$). With an increase in the application time, an apparent increment was observed for Ra and a remarkable reduction in CA was observed in all groups. It concluded that the argon plasma-jet technology could enhance the roughening and wetting performance of Grade 5 Titanium.

## Biography

Basak Kusakci Seker has completed her undergraduate education and PhD from Hacettepe University and Near East University respectively. She served as a Lecturer and Clinical Specialist and is currently working as an Assistant Professor at Eskisehir Osmangazi University Faculty of Dentistry Department of Periodontology. She has published more than 20 papers and presentations and continues to study on dental implant surgery, dental laser applications, plasma disenfection and wound healing and bone regeneration techniques.

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# Effect of sintering temperature on the microstructure and electrical properties of porous BS-0.64PT piezoceramics

**Jinting Tan and Zhenrong Li**
Xi'an Jiaotong University, China

Porous BiScO3-0.64PbTiO3 (BS-0.64PT) ceramics were fabricated by using burnable plastic sphere technique (BURPS). The volume fraction of poly methyl methacrylate microsphere (PMMA) was changed from 10 vol% to 50 vol% for higher porosity. As sintering temperature increased from 1000°C to 1150°C, average grain size of porous BS-0.64PT ceramics with different volume fraction of PMMA increased evidently from 1.02 μm to 9.0 μm, while pore shape was nearly sphere with no obvious difference in pore size. Relative permittivity (Ɛr) increased slightly with increasing sintering temperature. Piezoelectric coefficient ($d_{33}$) of porous ceramics with 10~30 vol%PMMA sintered at 1100°C was about 430 pC/N, which was higher than that of sintered at 1000°C, 1050°C, 1150°C. When the PMMA content was 40~50 vol%, $d_{33}$ decreased gradually with increasing sintering temperature. Electromechanical coupling coefficients ($\kappa_p$, $\kappa_t$), mechanical quality factor ($Q_m$), piezoelectric coefficient ($d_{31}$), hydrostatic voltage coefficient ($g_h$), hydrostatic figure of merit (HFOM) were derived from impedance spectrum. The result demonstrated that the value of $g_h$ and HFOM for porous BS-0.64PT ceramics sintered at 1000°C and 1100°C were higher than that sintered at 1050°C and 1150°C. The highest gh and HFOM were 0.025 V/m•Pa and $5867\times10^{-15}$/Pa respectively, with 30 vol% PMMA and porosity of 21.6% sintered at 1100 °C.

## Biography

Jinting Tan is currently pursuing her Doctoral degree at Xi'an Jiaotong University. She has published more than 12 papers in reputed journals, such as Ceramics International and Journal of Materails Science.

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# Simultaneous DTA-TGA i8nvestigation of thermal behaviour of photovoltaic solar crucible silicon nitride ($Si_3N_4$) coating material at high temperatures

**Chettat Yassine**
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Background: Silicon Nitride ($Si_3N_4$) is widely used in numerous applications due to their unique fascinating properties such as high refractoriness, good thermal shock resistance, thermal stability, chemical inertness, resistance to corrosion, and its good oxidation resistance at high temperature. Among them photovoltaic industry where silicon ingot for solar cells manufacturing is crystallized in fused solar silica crucibles lined with thick film of $Si_3N_4$ protective coating. The raw $Si_3N_4$ coating layer is heated very slowly at atmospheric air until 1100°C, after that it is sintered at this temperature point during three hours to improve its scratch resistance prior to loading the solar grade silicon feedstock in the silica crucible for crystallization. However, such thermal treatment could cause significant oxidation of the $Si_3N_4$ coating leading to an increase in oxygen contamination of the silicon ingot. Simultaneous TGA-DTA thermal analyzer type NETZSCH STA 409 PC/PG was used to investigate the intensity of thermal oxidation in air (stability) of higher purity raw $Si_3N_4$ powder for solar silica crucible coating preparation at 20°C-1450°C range. The measured TGA/DTA and DTA derivative (DDTA) heat signals of debinded 95% α-$Si_3N_4$ green body versus temperature showed an exothermal step between 494.3°C and 544.6°C. At 814.0°C another exothermal effect starts. They showed also that $Si_3N_4$ starts oxidizing at 800°C. However, its intense oxidation starts around 950°C where an important increase in the mass of the sample is observed. These results clearly demonstrate how much impurities can influence the thermal behaviour of the $Si_3N_4$ material, and that it is unstable above 950°C which could explain the silicon ingot intense contamination by oxygen.

## Biography

Chettat Yassine is a Researcher in the field of Photovoltaic Energy in CRTSE, Algeria. He is responsible for the Rheology team. He completed his studies in Crystallography with Master's degree from Ceramics Laboratory of Constantine University. Currently, he is a PhD student at Mhamed Bougara University, Boumerdes. He is working on a project of R&D on ultra-pur $Si_3N_4$ coating systems for solar silica crucible for directional solidification of multicrystalline silicon for photovoltaic applications. He has presented 11 presentations in reputed international conferences among which five are Europeans Photovoltaics Solar Energy Conferences and Exhibition. Three papers are under preparation for publication in reputed international scientific journals and one patent is under development for industrial application.

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# Investigation of structural and optical properties of nickel doped ZnO deposited by MW-CBD method

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Transparent conducting oxides having a wide band- gap (>3.0eV) are being used extensively for photovoltaic and optoelectronic devices. The physical characteristics of ZnO can be successfully optimized by doping as well as optimizing the various processing conditions. Among them, doping of ZnO with Ni is interesting as these tend to improve its optical, electrical, morphological and structural properties. In this work, we present the study on the variation on the Nickel content on the crystalline quality and optical properties of ZnO obtained by microwave chemical bath deposition (MW-CBD) on to n-Si substrate. The p-Si substrates were cleaned using the suitable procedure. 0.1 M zinc nitrate hexahydrate ($Zn(NO_3)_2.6H_2O$;ZnNt), nickel nitrate hexahydrate ($Ni(NO_3)_2.6H_2O$;NiNt) and an equal molar concentration of hexamethylenetetramine ($C_6H_{12}N_4$;HMTA) were dissolved in DI water. Doping precursor various amount of NiNt added separetly into the aqueous ZnNt+HMTA solutions. The solution was stirred 2 h at 90°C. After, solution was irradiated using a temperature-controlled microwave synthesis system at 600 and irradiation times 10 min. The films were washed with DI water to remove the remaining salt. Finally, the films were dried at 60oC for 1 h. Structural characterization of the layers was carried out using X-ray diffraction (XRD). Field emission scanning electron microscope (FESEM) was used to analyze the surface morphology of the ZnO films. The diffuse reflectance spectra of the Ni doped ZnO films were measured and the optical band gap values were determined using Kubelka–Munk theory.

## Biography

Yasemin Caglar has completed his PhD from Anadolu University and is a Full Professor of Solid State Physics at Anadolu University. She is currently interested in the areas of semiconductors devices, nanoelectronics, organic electronics, metal oxide materials. She has published more than 76 papers in reputed journals, has presented 142 presentations in national/international conference and has been serving as the Editorial Board Member of repute.

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# Fabrication and characterization of p-Si/n-MgZnO heterojunction diode

**Mujdat Caglar**[1], **Kamuran Gorgun**[2], **Saliha Ilican**[1], **Yasemin Caglar**[1] and **Fahrettin Yakuphanoglu**[3]
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[3]Firat University, Turkey

Semiconductor nanorods represent a novel class of materials structure with a number of interesting properties that give them potential applications in optoelectronic devices, including light-emitting diodes (LEDs), photoelectrochemical systems, andϕ solar cells. A chemical bath deposition (CBD) is attracting attention as low-cost film formation processes. In these processes, nucleation and crystal growth on substrate in solution result in the formation of metal–oxide films. We present a fundamental experimental study of a microwave assisted chemical bath deposition (MW-CBD) method for Mg doped ZnO films. The MW-CBD method was used to prepare nanorod Mg doped ZnO (1% and 10%) films onto p-Si substrates. Zinc nitrate hexahydrate and magnesium nitrate were the precursor materials and doping source materials. Scanning electron microscopy (SEM) and X-ray diffraction (XRD) spectroscopy had been used to analyze the morphological properties and structures of this films products, respectively. The current density–voltage characteristics (*I–V*) of the diodes were measured at room temperature. The important junction parameters such as series resistance ($R_s$), the ideality factor (*n*) and the barrier height ($\phi_b$) were determined by performing different plots from the forward bias *I–V* characteristics. Norde function was compared with the Cheung functions and it is seen that there is a good agreement with both method for the series resisance values.

## Biography

Mujdat Caglar is a member of the Physics Department of the University of Anadolu. He studied Condensed Matter Physics at University of Anadolu, starting in 1997. His academic and research interests are in the areas of nanomaterials, nanoelectronics, organic electronics, metal oxide materials. He has published more than 79 papers in international scientific journals and has been serving as the Editorial Board Member of repute.

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# Electrochemical alternative energy microstructure fractal perspectives

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It is well known that the microstructure processes influence is very important for electrochemical energy generation. Wordls interest race to develop the new batteries systems, especially based on lithium-ion technologies, are in the research and development focus. Simultaneously, in electric cars technologies development the battery systems getting the increasing role from the point of view how meny times in electrochemical reactions we can perform recharging. Also, beside the electrochemical processes and recharcgable speed the storage capacity has special significance. Based on our previous research in the field of ceramics, generally materials science, enriched by the fractal nature analysis, in this paper we contribute in some fundamental electrochemical laws through fractal corrections in relevant formulas. In that sense, we based this on experiments with BaTiO3-ceramics and different additives (CaZr2O3, Er2O3, Ho2O3, MnCO3, Nb2O5 and Yb2O3) consolidated under the pressing pressure up to 150 MPa and processed in the temperatures from 1190oC to 1380oC. The SEM and EDS analysis are performed. Fractal nature microstructure analysis directly from experiments confirmed new frontiers in direction of electrochemical fractal microelectronics.

## Biography

Vojislav Mitic in 1995 has completed his PhD from University of Nis (Serbia). He is a Full Professor at University of Belgrade and Nis. In1995-2006, he was the Director of Electronic Industry Corporation, Serbia – Ei. He has published more than 200 papers in reputed journals and has been serving as an Editorial Board Member of repute. He is a Scientific Adviser at the Institute of Technical Sciences of the Serbian Academy of Sciences and Arts. He is a member of European Academy of Sciences and Arts, member of World Academy of Ceramics and President of Serbian Ceramics Society.

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# Wind energy exploration fractal perspectives

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The wind energy conversion heavily depends on wind speed fluctuation demanding new and more durable materials. The great deal of resistance to wind depends on wind speed series that are known to have fractal character and are characterized by (Hausdofff) fractal dimension. The accurate prediction of wind speed is essential in order to improve performances of wind energy systems. In order to improve the prediction performance of the wind speed series, the fractal characteristics of the wind speed series were analyzed. An improved fractal interpolation prediction method is proposed to predict the wind speed series. According to the non-linear self-similarity characteristic and the scale invariance, the extrapolation prediction can be performed by extending the fractal characteristic to external interval. In this work, the optimal input combination for wind speed prediction at certain height is given. The reliability of the computational models was analyzed based on simulation results and using three statistical tests including Pearson correlation coefficient, coefficient of determination and root-mean-square error.

## Biography

Vojislav Mitic in 1995 has completed his PhD from University of Nis (Serbia). He is a Full Professor at University of Belgrade and Nis. In 1995-2006, he was the Director of Electronic Industry Corporation, Serbia – Ei. He has published more than 200 papers in reputed journals and has been serving as an Editorial Board Member of repute. He is a Scientific Adviser at the Institute of Technical Sciences of the Serbian Academy of Sciences and Arts. He is a member of European Academy of Sciences and Arts, member of World Academy of Ceramics and President of Serbian Ceramics Society.

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# Electrodeposited boron doped ZnO films: Preparation and characterization

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As a wide-direct-band gap semiconductor with large exciton binding energy (about 60 meV), ZnO is one of the most promising semiconductor materials for the next generation of optoelectronic devices applications in nanodevices. Many useful methods have been used to prepare high quality ZnO thin films, such as, magnetron sputtering, metal-organic chemical vapor deposition, pulsed-laser deposition, molecular beam epitaxy and electrodeposition. Among these methods, the electrodeposition method has some advantages to prepare large area ZnO thin films at low cost and easy technology. Electrodeposition is well known for depositing metals and metallic alloys at the industrial level, with a wide range of applications from large area surface treatments (i.e. zinc electroplating) to most advanced electronic industries. In this study, undoped and boron (B) doped ZnO films were grown by electrochemical deposition onto p-Si substrates from an aqueous route. Aqueous solution of $Zn(NO_3)_2 6H_2O$ and hexamethylenetetramine (HMT) was prepared using triple distilled water. The different atomic ratios of $H_3BO_3$ were used as a dopant element. Electrodepositions were carried out in a conventional three electrode cell for the working electrode (p-Si), reference electrode (Ag/AgCl, sat.) and counter electrode (platin wire). The effects of B doping level on the structural, morphological and optical properties of B doped ZnO films were investigated by means of XRD, FESEM and UV spectrophotemeter, respectively. The optical band gap of the B doped ZnO film deposited on silicon substrate was determined using the reflectance spectra by means of Kubelka-Munk formula.

## Biography

Saliha Ilican received her PhD degree from Anadolu University and is currently working in the same university. Her current research includes in the preparation and characteriaztion of nano-semiconductors and fabrication of their devices. She has published more than 73 papers in reputed journals.

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# Applications of microfluidic chips in functional polymers

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Microfluidics is a multidisciplinary science integrating engineering, physics, chemistry, and biotechnology. The application of droplet-based microfluidic technology in polymer science is an emerging research field. We summarize currently developed droplet-based microfluidic technologies of our lab for functional polymers. For example, synthesis of core-shell structure microcapsules with dual pH-responsive drug release function; microfluidic assisted synthesis of silver nanoparticle–chitosan composite microparticles for antibacterial applications; synthesis of uniform core–shell gelatin–alginate microparticles as intestine-released oral delivery drug carrier; synthesis of uniform poly (d, l-lactide) and poly (d, l-lactide-co-glycolide) microspheres using a microfluidic chip for comparison; and microfluidic one-step synthesis of $Fe_3O_4$-chitosan composite particles and their applications, and the others.

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# Study on sliding wear behaviour of Cu/$SiC_p$ metal matrix composites

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In the present work, pure Cu and Cu/$SiC_p$ metal matrix composites were prepared by sintering and sinter–forging processes. The tribological behaviour of copper and Cu/$SiC_p$ composites was studied using a pin–on–disk tester. The influence of SiC particles and fabrication type on the tribological behaviour of pure Cu and Cu/$SiC_p$ metal matrix composites were studied. Dry sliding wear tests represented that the composites with 60 vol. % SiC exhibits a lower wear loss compared to other compacts. This was due to the reinforcing SiC particulates being effective to reduce the extent of wear deformation in subsurface region during sliding. Moreover, the results indicated that applying external compressive force during the sintering process of Cu and Cu/$SiC_p$ compacts has an important effect on reducing and eliminating porosities and reach to a high final density. Therefore, wear loss of the samples produced through sinter–forging process was improved significantly compared to conventionally sintered samples.

## Biography

M Shabani is a PhD candidate of Materials Science & Engineering at University of Aveiro in Portugal. He has studied about metal matrix composite materials processing and characterizing for structural applications during his MSc at Shiraz University in Iran. After his MSc, he worked in oil and gas industry as Welding and Corrosion Engineer for the pipelines. Prior to starting his PhD, he worked on nanocrystalline ceramic coatings on Ti–based alloys for biomedical applications. His current research interests focus on development of nanocrystalline superhard coatings on ceramic materials for heavy duty machining of hard materials.

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# Corundum plasma ceramic products with gradient channel porosity: Advantages and application

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Thanks to its excellent chemical, radiation and heat resistance properties and high mechanical strength, corundum ceramics is versatile for use in a large variety of applications. Emphasis is placed on products with gradient porosity. Plasma spraying proved to be one of the most promising methods for the production of products with gradient porosity. It was established experimentally that the change of some traditional spray coating parameters can result not only in the required integral porosity value, but also in the formation of a pore space, which appears as a system of well-organized channels with a porosity gradient, i.e., the channel size increases to the periphery of a product. Corundum plasma ceramic materials are applied as membranes to the separated anode and cathode spaces and in the creation of electrolysis cells used with aqueous electrolytes and melted media. In particular, we actively participated in the development, production and commercial testing of electrolysis cells used for cerium oxida-tion in nitrate solutions and for electrochemical refining of nonferrous metals in salt melts, where we applied corundum membranes with channel porosity instead of ion-exchange membranes. This enabled us to (1) achieve current efficiency of up to 90% and substance ef-ficiency of up to 97 – 98 % at optimal energy consumption, and (2) reduce energy intensity of the process and save on electrolyte. New three-chamber electrodialysis cells are currently be-ing developed. Their anode and cathode spaces will be separated from the receiving chamber by porous ceramic membranes. Products made from plasma ceramics with gradient porosity are promising as hot gas/aggressive liquid/molten salt filters. They can be used in the design of catalytic reactors, where corundum ceramics will be an ideal chemically inert media capable of intense regeneration.

## Biography

A V Ermakov graduated from UrFU (former Ural State Technical University named after S.M. Kirov), Metal Industry department, in 1979. In 1989, he defended a PhD thesis in Engi-neering Science on the topic: “Development of technology for production of semi-finished products from iridium single crystals of a given crystallographic direction”. Since 2007, he has held a position as a General Director of JSC Ural Innovative Technologies. He is the author of over 100 scientific papers and the holder of 67 invention certificates and patents.

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# Porous graphene aerogel composite supercapacitors

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Graphene sheets derived from electrochemical exfoliation have shown more pristine qualities such as better electrical properties than those derived from reduced graphene oxide (rGO). In this work, we developed porous 3D structures using graphene obtained via electrochemical exfoliation and explored their application as supercapacitor electrodes. By adjusting the content of the electrolyte in the exfoliation process, the aspect ratio of graphene sheets and the porosity of the graphene network can be optimized. Furthermore, the freezing temperature in the freeze drying step was also found to play a critical role in the resulting pore size distributions of the porous networks. The optimized conditions lead to meso- and macro-porous graphene aerogels with high surface area, extremely low densities and superior electrical properties. As a result, we have found that the graphene aerogel supercapacitors exhibit a specific capacitance of 325 F/g at 1 A/g and an energy density of 45 Wh/kg in 0.5 M $H_2SO_4$ aqueous electrolyte with high electrochemical stability required for the practical usage. This research provides a practical method for lightweight, high-performance and low-cost materials in the effective use of energy storage systems.

## Biography

Hyun Young Jung is now an Assistant Professor in the Department of Energy Engineering at the Gyeongnam National University of Science and Technology in Korea. His ongoing researches focus on energy conversion and storage devices of engineered nanomaterials and composites, aerogel for energy and environment, and optoelectronics. He has published more than 33 papers in reputed journals.

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## Preparation of $MgAl_2O_4$ nanopowders via hydrolysis of double magnesium-aluminum isopropoxide

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Magnesium aluminate spinel ceramics is promising optical material for industrial and military applications due to its high hardness, melting point, thermal conductivity and high optical transmission in the ultraviolet, visible, and infrared spectral ranges. The properties of such ceramics are significantly determined by the characteristics of the starting powder: its stoichiometry, morphology and crystallite size. This work is devoted to the development of $MgAl_2O_4$ nanopowders fabrication technique via alkoxotechnology using double magnesium aluminum isopropoxide ($MgAl_2(OPr^i)8$) as the precursor. $MgAl_2(OPr^i)8$ was synthesized by interaction of activated magnesium-aluminum alloy with isopropyl alcohol. Since the precursor is a volatile compound, vacuum distillation method was successfully used for its purification and the possibility of high pure powders synthesis from starting technical pure grade materials were demonstrated. According to ICP-AES analysis the main impurities in synthesized $MgAl_2(OPr^i)_8$ are Si (9 ppm), Fe (0.39 ppm), Na (0.35 ppm), Zn (0.36 ppm). The content of the rest elements is below the detection limit. The hydrolysis of $MgAl_2(OPr^i)_8$ was performed by azeotropic mixture isopropyl alcohol – water (ratio 88:12 vol. %) with equimolar ratio 1:8. Magnesium aluminate spinel powders were obtained by calcining the hydrolysis products at 900°C. The powder particles are spherical with the average size of 30-50 nm and aggregated into soft agglomerates up to 50 μm in size. The resulting powders were used to sinter $MgAl_2O_4$ ceramic by hot pressing at a temperature of 1600°C and pressure of 50 MPa in graphite dies. Optical transmission of obtained transparent samples is more than 80%.

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## Separation of monounsaturated and saturated fatty acids from oil seeds of *Jatropha curcas*

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Urea complex fractionation is a common method used to separate a mixture of FAs based on the saturation properties FAs. Optimum conditions of the experiment to obtain maximum percentage of MUFA (OA) (56.01%) was observed for sample treated with a urea-to-FAs ratio (w/w) of 3:1 at 10°C for 16 h. The lowest percentage PUFA (LA) (8.13%) was incorporated into the UCF with a urea-to-FAs ratio (w/w) of 1:1 at 10°C for 8 h. All of the above mentioned factors have to be controlled to yield a reasonable yield% of product with a desirable purity of FAs.

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## Processing of metal-ceramic composites using microwave heating

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Microwave technology is an emerging field in materials processing for synthesis, sintering, melting, joining, surface-modifications, recycling of waste products, quality improvements, etc. Microwave processing of materials is highly attractive and recognized for its many advantages namely energy-efficiency, substantial reduction in process cycle time, providing fine microstructures leading to improved mechanical properties and eco-friendliness. This presentation describes microwave application to fabricate metal-ceramic composites by molten metal infiltration and reaction bonding in-situ process. Metal Ceramic Composites (MCC) offers tailorable physical, thermal and mechanical properties for a variety of applications. Conventional fabrication of the composites using molten metal infiltration mechanism involves use of the resistance heated furnaces and takes very long processing cycle time. This work relates the ability of microwave to enhance the infiltration and reaction processes to fabricate composites. Identical composite compositions were also fabricated using conventional heating for comparison. Properties of the composites made by microwave heating were comparable or better than the properties of the composites made by the conventional methods. Substantial process time reductions were achieved for all the infiltration processes using microwave. Several prototype components for real applications were fabricated to demonstrate process scale up.

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## Energy-efficient sintering of ceramics

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Electric current assisted sintering (ECAS) techniques, such as electrical discharge sintering (EDS) or resistive sintering (RS), have been intensively investigated for longer than 50 years. In this work, a novel system including an electrically isolated graphite die for Spark Plasma Sintering (SPS) is described, which allows the sintering of any refractory ceramic material in less than 1 minute starting from room temperature with heating rates higher than 2000°C/min and an energy consumption up to 100 times lower than with SPS. The system alternates or combines direct resistive sintering (DRS) and indirect resistive sintering (IRS). Electrical isolation of the die has been achieved through the insertion of a film made of alumina fibers between the graphite die and the graphite punches, which are protected from the alumina fibers film by a graphite foil. This system localized the electric current directly through the sample (conductive materials) as in DRS and EDS, or through the thin graphite foil (non-conductive materials) as in IRS or RS and is the first system capable of being used under EDS or RS conditions independently, combining current concentration/localization phenomena. In addition, geometry elements of the graphite mold used for SPS, such as graphite mold wall thickness or graphite punch diameter, play an important role in the electric field magnitude during sintering. Furthermore, electric field for this novel geometry will be analyzed as well as tailorability of electric field in order to intensify the value of the electric field towards induced flash sintering in a SPS furnace.

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## $TiO_2$ nano composite thin films texture and properties in self-cleaning process

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Titanium Dioxide ($TiO_2$) has been considered as an ideal photocatalyst due to its chemical properties. This paper is discusses about how $TiO_2$ nanoparticle in a thin film work as a photocatalyst for self-cleaning purpose and in future we prove how doping increase photocatalytic activation in visible light range. In this work, nanostructured $TiO_2$ thin films were grown by spray pyrolysis technique on glass substrates at 400°C. $TiO_2$ thin films were then annealed at 600-1000°C in the air for a period of 3 hours. The samples were characterized at several views; thickness of the films was measured by Focused Ion Beam (FIB) and field ion beam. The effect of annealing on the structure, morphology and optical properties was studied. The X-ray diffraction (XRD) and Atomic Force Microscopy (AFM) measurements confirmed that the films grown by this technique have good crystalline structure and homogeneous surface. The study also reveals that the RMS value of thin film roughness increased with increasing annealing temperature. The optical properties of the films were studied by UV-Vis spectrophotometer. The optical transmission results showed that the transmission over ~65%, which decrease with the increasing of annealing temperatures.

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## Synthesis of dense and porous nanofibers by electrospinning

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The main goals of this research were morphology and structural control of electrospun ceramic nanofibers. We studied the interplay between the tip to collector distance (TCD), applied potential, precursor viscosity and the fiber diameter distribution. Adjustment of the precursor viscosity by dilution was found to be the useful way to control the fiber diameter in the 100-800 nm range. In a high viscosity sol a transition from a single to a bimodal distribution was observed at an electric field of 0.8 kV cm-1. In a low viscosity sol, a sharp step-like transition from a large to a small fibers diameter regime at the same electric field was occurred. We demonstrate how to control the branching effect to yield either single or bimodal fiber distribution in wide diameter range. The thermal behavior of "green" PZT nanofibers was studied by TGA/DTA/DTG analysis coupled with MS. A pre-firing stage at 350oC was found to be necessary to maintain the fiber structure. Sintering of pre-fired fibers was executed in two ways: a long procedure at 650oC for 2 hr and by rapid thermal processing (RTP) at 500-800oC for 30 sec. RTP at 800°C provides formation of perovskite phase similar to long sintering with minimal lead loss via evaporation. Finally, the sensing ability of the prepared PZT nanofiber mats was tested under cyclic mechanical loading. In conclusion, the combination of morphology control, pre-firing and RTP might be used as an efficient procedure for dense PZT ceramic nanofibers preparation.

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## The complexing in copper(II) salt (flame retardant) – polyamine (hardener) system as an effective way to the combustibility decrease of epoxy-amine polymeric materials

**Helen Lavrenyuk and Borys Mykhalichko**
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Among great number of polyamines, the diethylenetriamine *(deta)* is widely used as a curing agent in the production of epoxy resins. The polymeric materials on the basis of epoxy resins, *viz*. thermoset polymers, are one of the most important polymer systems used today in the industry, ranging from simple two-part adhesives to high-tech applications On the other hand, *deta* is a potentially tridentate ligand which can form chelate bonds with transition metal atoms, in particular, with copper(II). This feature of deta behavior has allowed us to solve a problem related to the elaboration of new polymeric materials with the decreased combustibility using the following approach: crystaline copper vitriol (flame retardant) was added to epoxy-amine resin. In this process the chemical interaction of deta (a curing agent of epoxy resins) with noncombustible copper vitriol (copper(II) sulfate pentahydrate) in many respects predetermines the properties of $[Cu(deta)H_2O]SO_4.H_2O$ as flame retardant-hardener. The total energy of three Cu–N bonds which belong to the square-pyramidal coordination core equals 237.39 $kJ \cdot mol^{-1}$. These strong coordination bonds that arise between metal atoms of incombustible $CuSO_4$ and N atoms of the amine hardener – *deta* as well as formation of stable chelate complex in solid state are responsible for the flammability suppression of the modified epoxy-amine composite material. Appositely, works directed towards the use of chelate complexes with participation of other transition metal salts in the production of self-extinguishing epoxy-amine composites are under way

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## Characteristics of in-fight powder particles and thermal barrier gradient coatings by plasma spray

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In the present work, three kinds of coatings, i.e.NiCoCrAl-$Y_2O_3$ coating, NiCoCrAl-$Y_2O_3$/AZ50 thermal barrier coating and NiCoCrAl-$Y_2O_3$/AZ50 thermal barrier gradient coating, were sprayed on the surface of K417 nickel-based high temperature alloy by plasma spraying. The physical characteristics of in-flight particles and related influences of spraying process parameters were investigated by Spray Watch on-line measuring system. The surface roughness and microstructure characteristics of the coatings were studied by Confocal Laser Scanning Microscopy (CLSM) Scanning Electron Microscopy (SEM), Energy Dispersive Spectroscopy (EDS) and X-ray Diffraction (XRD). The bonding strength, hardness distribution, and thermal shock properties of the coatings were evaluated by tensile, microhardness, and thermal shock tests. The water bath thermostatic method and Oxyacetylene flame heating method were used to investigate the thermal barrier effects of the coatings with different structures. The results show that the bonding strengths and thermal shock resistances of the two kinds of thermal barrier coating are higher than that of the standard HB7269-1996, which are 15MPa and 6 times respectively

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## Migration of new bio-based additives from rigid and plasticized PVC stabilized with epoxidized sunflower oil in the soil

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Plasticizers, primarily phthalates, are added to the originally rigid PVC polymer in order to make flexible products. Stabilizers are indispensable to provide the necessary stability of the PVC polymer against heat, light and weathering. Applicable stabilizers are heavy metals and organotin compounds as well as organic co-stabilizers, depending on the desired product properties. The significant increase of the use of PVC induces an increase in the use of plasticizers (phthalates) and thus generates the pollution of air, soil and water. In a previous work, commercial sunflower oil was epoxidized and the effects of ESO on the thermal degradation and stabilization of PVC in the presence of metal carboxylates were investigated. Vegetable oils are renewable raw materials. Their conversion to useful intermediates for polymeric materials is significant because of their low cost, ready availability, and possible biodegradability. The use of environmentally benign additives is another way to avoid the health and environmental issues. For that purpose, alternative plasticizer (DINA) and heat stabilizers (ESO) are used. The artificial aging of the PVC samples was investigated under uncontrolled temperature in the laboratory for 4 months. The modifications of the structure of the polymer were followed by Fourier transform infrared spectroscopy (FTIR). The morphological changes were followed by scanning electron microscopy (SEM). Furthermore, the evolution of the bacterial growth, variation of pH and variation of mass were considered.

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## Some nanograined ferrites and perovskites for catalytic combustion of acetone at low temperature

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Two types of nanograined oxide compounds, $CuFe_2O_4$, $MgFe_2O_4$, $Ni0._5Co0._5Fe_2O_4$, with spinel-type structure, and $SrMnO_3$, $FeMnO_3$, $La_{0.6}Pb_{0.2}Ca_{0.2}MnO_3$ with perovskite-type structure, were prepared by sol-gel self-combustion method and tested for the catalytic combustion of dilute acetone in air. Their structure and surface properties were investigated by X-ray diffraction (XRD), scanning electron microscopy (SEM), BET surface area measurements and energy-dispersive X-ray spectroscopy (EDX). We chose acetone as a VOC model because, among all VOCs, it is a common organic solvent extensively used in the manufacture of plastics, fibers, drugs and other chemicals. The catalytic activity studies revealed that between these two types of catalysts, the perovskite catalysts exhibited the best activity in the catalytic combustion of acetone. The acetone conversion degree over perovskite catalysts can exceed 95% at 300°C, while over ferrospinel catalysts it is of about 70%. Our experimental results indicate that the $SrMnO_3$ and $La_{0.6}Pb_{0.2}Ca_{0.2}MnO_3$ perovskites are the preferred catalysts in the catalytic combustion of acetone at low temperatures. The time stability of $La_{0.6}Pb_{0.2}Ca_{0.2}MnO_3$ catalyst for acetone combustion was also investigated and no deactivation was observed for 36 h at 250°C.

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## Experimental investigation of thermal conductivity and tensile strength of iron ore tailings filled polypropylene composite

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Iron ore tailings (IOT) filled polypropylene (PP) composites were produced by reinforcing polypropylene with iron ore tailings which is a waste product. Particle sizes 53 μm, 75 μm and 100 μm were considered for different volume fractions of 0% to 40% at intervals of 5%. The thermal conductivity of the IOT filled PP composites was determined using the transient techniques employed in the KD2 pro thermal analyzer. 30% volume of iron ore tailings gives increase in thermal conductivity of the composite. Tensile test was conducted and the experimental results were compared with theoretical results obtained from suitable mathematical models. It was discovered that the smaller the particle sizes of the iron ore tailings, the higher the thermal conductivity and tensile strength. The thermal conductivity increases as the volume fraction increase for either particle size. However, the thermal conductivity and tensile strength start to fall from 35% to 40% because the polymer starts to loss its stability at these volume fractions.

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## Machinable hydroxyapatite: Yttrium phosphate bio-ceramic composite drilling quantification and bioactivity

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The use of Hydroxy-apatite bio-ceramics as restorative implants is widely known. These materials can be manufactured by pressing and sintering route to a particular shape. However machining processes are still a basic requirement to give a near net shape to those implants for ensuring dimensional and geometrical accuracy. In this context, optimizing the machining parameters is an important factor to understand the machinability of the materials and to reduce the production cost. In the present study a method has been optimized to produce true particulate drilled composite of Hydroxyapatite Yttrium Phosphate. The phosphates are used in varying ratio for a comparative study on the effect of flexural strength, hardness, machining (drilling) parameters and bioactivity. The maximum flexural strength and hardness of the composite that could be attained are 46.07 MPa and 1.02 GPa respectively. Drilling is done with a conventional radial drilling machine aided with dynamometer with high speed steel (HSS) and solid carbide (SC) drills. The effect of variation in drilling parameters (cutting speed and feed), cutting tool, batch composition on torque, thrust force and tool wear are studied. It is observed that the thrust force and torque varies greatly with the increase in the speed, feed and yttrium phosphate content in the composite. Significant differences in the thrust and torque are noticed due to the change of the drills as well. Bioactivity study is done in simulated body fluid (SBF) up-to 28 days. The growth of the bone like apatite has become denser with the increase in the number of days for all the composition of the composites and it is comparable to that of the pure hydroxy-apatite.

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## Immobilization of simulated high level nuclear waste with magnesium-zinc-phosphate glasses

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The disposal of radioactive waste generated by the nuclear fuel cycle is among the most pressing and potentially costly environmental problems. The high level nuclear wastes (HLW) are immobilized in a stable solid state and completely isolated from the biosphere. Nuclear waste glasses are typically borosilicate glasses, and these glass compositions can experience phase separation at elevated concentrations of $P_2O_5$. For some waste streams, this can require considerable dilution and a substantial increase in the volume of the waste glass produced. Magnesium and Zinc phosphate glasses are classified as 'anomalous phosphate glasses', which exhibit anomalies in the relationship between physical properties, such as density and refractive index, and $MO/P_2O_5$ (M/P) (M=Mg, Zn) molar ratio around the metaphosphate composition (M/P=1). Most of the phosphate glasses form high polyphosphate consisting of chains of phosphate ions, while the structures of M-P glasses and Z-P glasses are of 2 types, one includes 4 membered rings of PO4 tetrahedra at M/P<1 (type T) and the other contains dimers of PO4 tetrahedra at M/P>1 (type P). In this study, M-P, Z-P, M-Z-P glasses are chosen as the base glass. Simulated HLW was incorporated into the base glass to study its effects on the leaching behavior of M-P, Z-P, M-Z-P glasses for nuclear waste immobilization. The gross leach rates and the leach rates of each constituent element of the sample in water at 90°C were determined from the total weight loss of the specimen and chemical analysis of leachate solution.

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## Characterization and mechanical properties of hot-pressed tantalum carbide without sintering additives

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The increasing interest and need for materials used in extremely high temperature applications such as rocket nozzles has inspired research into the behavior of ultra-high temperature ceramics (UHTCs). Tantalum carbide (TaC) is one of these materials which has the operating temperatures excess of 3000°C. Unfortunately, monolithic TaC is difficulty densified due to its highly covalent bonding character, low self-diffusion coefficient, and high activation energy for viscous flow. In this study, ultrafine starting powder (0.1-0.5 μm) and high pressure (40 MPa) were used to improve TaC sintering. Densification was performed by hot pressing at temperatures of 1700°C to 1900°C under vacuum with a hold time of 45 min. A lattice parameter of 4.4460 Å was determined for the starting powder by XRD analysis, which corresponds to $TaC_{0.93}$ calculated based on the relationship between lattice parameter and composition. The relative density increased from 96% at 1700°C to 97.7% at 1900°C. The average grain size of the TaC grains increased significantly with sintering temperature. As the temperature enhanced, SEM micrographs of TaC ceramics microstructures revealed extensive transgranular fracture. Moreover, mechanical properties including Young's modulus, Vickers' hardness, and fracture toughness were studied.

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## Cutting and extruding processing technology for ceramics based on edge-chipping effect

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Edge-chipping referred to the fact that the edges of hard, brittle materials are easily broken during processing. This problem has brought many difficulties to their quality control. In fact, it was that the machining process itself destroyed materials, even though it could be controlled. Based on this principle, a new machining technology based on crack propagation driven by edge-chipping effect was proposed here. Multiple flanges caused by the cutting could increase the number of edges. Additionally, the fracture defects were prefabricated on the surface of flanges. When the turning tool made of cemented carbide came into contact with the surface of the ceramics, under the intermittent impact. The fractures were generated on the sides of flanges contacted with the tool and the prefabricated micro cracks were expanded rapidly under this three-dimensional stress field applied externally by the tool. In addition, due to the stress release toward the free surface, the cracks would expand to the surfaces of newly generated edges and the chips would be broken off continuously, resulting in irregular edge-chipping and removal of material pieces. Furthermore, based on the spatial distribution of grayscale images, the surface quality after rough processing under the different conditions was reasonably reflected with the grayscale co-occurrence matrix (GLCM). With the new processing technology, these cracks became advantageous under specific conditions. Therefore, the high external energy and ultra-hard tools required for the traditional processing technologies could be significantly reduced and the ceramics could be removed with less energy consumption and the tools with the hardness of lower than its own one. Therefore, it not only could reduce the processing costs, but also could promote the extensive applications of engineering ceramic materials.

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## Liquid precursor synthesis of lanthanum zirconate ceramics

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Liquid precursor for Lanthanum Zirconate ($La_2Zr_2O_7$) was synthesized by controlled cohydrolysis of $Zr(n\text{-}OC_3H_7)_4$ and acetylacetone–coordinated-yttrium compound. The liquid precursor featured adjustable viscosity and long shell life. FT-IR was measured to characterize the molecular structure of LZO to verify the coordination of acetylacetone to Zr or La atoms. TGA/DTG and XRD were utilized to investigate the thermal behavior of the precursor. The results showed the organic-to-inorganic transformation mainly happened at 450 to 800°C. When the ceramization completed at 900°C, $La_2Zr_2O_7$ powders were obtained with an average crystal size of less than 20nm. The microstructure of the prepared ceramic powders characterized by SEM-EDS showed the agglomerated particulates with a mean size of less than 20μm and a homogeneous elements distribution of Zr and La.

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## Microstructure and mechanical properties of zirconia ceramics consolidated by a novel oscillatory pressure sintering

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Zirconia ceramics with high density and fine, uniform grains were consolidated by a novel oscillatory pressure sintering (OPS) approach. Compared with the zirconia ceramics by hot pressing (HP) at the same sintering temperature, grain sizes of the OPS specimen were distributed in a narrower range with average size of 278 nm; besides, the anisotropic grain growth was inhibited by oscillatory pressure, resulting in a smaller difference between the long radius and the short radius than the HP specimen. Due to microstructure evolution, the flexural strength of the OPS specimen reached approximately 1549 MPa and the load-displacement behaviors were also improved. Such evolutions in microstructure and mechanical performances were ascribed to the new densification mechanisms induced by oscillatory pressure.

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## Formulation of calcium dialuminate ($CaO•2Al_2O_3$) refractory cement from local bauxite

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Three types of bauxites containing aluminum hydroxide of 58.1% gibbsite and 19.3% boehmite for BX3, 95.5% of gibbsite for BX55 and 84.5% of gibbsite for BX8 were used with lime at 95% of CaO through solid state sintering in one stage to prepare a refractory clinker at 1550°C. The powder obtained after grinding the clinker showed in the XRD curves the presence of $CaO•2Al_2O_3$ and $CaO•TiO_2$ phases in the cement samples. The density of cement powder varied between 2.95 and 3.17 g/cm3 and the specific area of powder obtained after grinding was between 0.72 and 0.85 m2/g. The properties of hydrated cement, W/C = 0.33, after stabilization of cement components for 48 h at 105°C were showed by XRD, DTA, DTG and SEM (C3AH6, AH3, CA2 and $CaO•TiO_2$). The Young's modulus of the cement made varied between 35.5 and 39.4 GPa, and these Young's moduli were compared to conventional CA14M cement.

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## Synthesis and characterization of $MgCr_xFe_{2-x}O_4$ spinel ferrites produced by the ceramic technique

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Magnesium–Chromium spinel ferrites with the general formula $MgCr_xFe_{2-x}O_4$ ($0 \leq x \leq 1$) were synthesized by the ceramic technique and characterized using X-ray diffraction, FT-Infra Red and Raman spectroscopy. From XRD diffraction patterns, the lattice parameters, bond length, crystallite size, density and porosity have been calculated and compared with those predicted theoretically. From FT-Infra Red band frequencies, the force constants $K_t$ and $K_o$ for tetrahedral (A) and octahedral (B) sites respectively, have been calculated and compared with the trend of bond lengths. For all compositions, Raman spectra show the five active modes $A_{1g} + E_{1g} + 3\ T_{2g}$ of the motion of $O^{2-}$ ions and both the A-site and B-site ions. The trend of Infra Red and Raman frequencies with chromium content shows a blue shift for all modes consistent with the replacement of $Fe^{3+}$ by lower mass $Cr^{3+}$.

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## Potentiality of a frit waste from ceramic sector as raw material to glass-ceramic material production

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This work consists of studying the devitrification capacity of a residue from sodium-calcium frit, using the vitreous powder sintering method, which follows the traditional ceramic processing route, including a specific heat treatment to generate the appearance of crystals from the original glass phase. Initially the frit residue has been characterized by instrumental techniques such as XRF, XRD and DTA/TG. Furthermore, the chemical analysis (XRF) has allowed the prediction of devitrification potentiality of this residue by theoretical approaches represented by Gingsberg, Raschin-Tschetverikov and Lebedeva ternary diagrams. Then, this residue was subjected to traditional ceramic method, by changing the grinding time, the pressing pressure and prepared samples were obtained at different temperatures. In this part, the techniques for measuring particle size by laser diffraction and XRD and SEM to evaluate the generated crystalline phases, were applied. Finally, it has been found that this frit residue works as glass-ceramic precursor, devitrifying in wollastonite crystals as majority phase and without being subjected to the melting step of the glass-ceramic typical method.

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## Glass-ceramics fabricated with coal gangue as main raw material

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High strength glass-ceramics were fabricated with coal gangue and clay as main raw materials. The effects of the ratio of the coal gangue with clay, mineralization agents, forming process and sintering process on the properties of the glass-ceramics were studied. The ratio of coal gungue and clay for optimum property are 3/1. The glass-ceramics showed a main phase of mullite and spindle. The appropriate amounts of codoping of $TiO_2$, ZnO, and $MnO_2$/dolomite as mineralization agents obviously improved the properties of the glass-ceramics, leading to optimal strength of ~187.67 MPa, water absorption of ~0 % and density of 1.83 g/cm$^3$. Process optimizations further determined reasonable and optimal process parameters of forming and sintering.

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## Preparation of catalyst-loaded viscose rayon fibers with sustainable antimicrobial functionality

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Viscose rayon cellulose fiber was first selectively oxidized on its surface without significant loss of its pristine fiber structure so that carboxylate functional group was introduced on the fiber. Separately, uniformly dispersed silver nanoparticles (AgNPs) having sizes of 2-5 nm were prepared by using amine-terminated fourth generation poly (amido amine) dendrimer as a capping agent. Then, the AgNPs were immobilized on viscose rayon fibers through chemical reaction to form amide bond between terminal amine groups of dendrimer protector with the carboxylic acids on oxidized fibers. The loaded nanoparticles did not release away from the fiber even after 60 times washings. The AgNPs-loaded fibers (0.3 wt%) has exhibited excellent biocidal activity against *E. coli*. Therefore, this procedure can be effective for the prolonged sustainment of similar bioactive agents on fibers and maximize the efficiency of the cellulose product for anticipated purposes.

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## Mechanical alloying, sintering and characterization of $Al_2O_3$-5 wt% Cu nanocomposite

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$Al_2O_3$ 5 wt.%-Cu nanocomposite powder was synthesized by mechanical alloying method using a planetary ball mill up to 20 h. The properties of the milled powders were studied by X-ray diffraction (XRD) technique and transmission electron microscopy (TEM). Then, the milled powders were cold pressed and sintered at different temperatures for 1 h in argon atmosphere. The relative density and the apparent porosity of the sintered samples were measured. Scanning electron microscopy (SEM) coupled with energy dispersive spectroscopy (EDS) was employed to investigate the microstructure of the sintered samples. Microhardness and fracture toughness of the sintered composites were also measured. The effect of milling time on the properties of the prepared powders and sintered samples were studied. The results revealed that the Cu particles were uniformly distributed in the $Al_2O_3$ matrix and covered the $Al_2O_3$ matrix after 10 h of milling. The crystal and the particle sizes were decreased with increased milling time while lattice strain increased. The relative density of the sintered samples exhibited a remarkable increase with the increase of milling time and sintering temperatures. Results also pointed out that the microhardness increased while the fracture toughness slightly decreased with the increasing of milling time.

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## Potentiality of clay raw materials from gram area (Northern Tunisia) in the ceramic industry

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The geological study of Miocene clays from Gram area, North West of Tunisia shows an important series of clay materials to use them in the faience ceramic. Selected samples were studied with the objective of analyzing their chemical and mineralogical composition, morphology, particle size, plasticity, thermal analysis and their ceramic aptitude to be used in the faience ceramic. Raw materials are mainly composed of illite and kaolinite are the dominant clay minerals with minor quartz and dolomite. The plasticity indexes are lower than 15.40%, suggesting that these clays are not plastic. Technical characterization was carried out on one representative mixture of Miocene clay samples. The firing characteristics (shrinkage and water absorption) were measured. The optimum firing temperature of clay mixture (M) has been established. These clays could be used in the manufacture of ceramic pieces.

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