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EFFECT OF ANNEALING CONDITION ON THE PROPERTIES OF $Pb(Zr,Ti,Mg,Zn,Nb)O_3$ CERAMIC

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ABSTRACT
The effect of annealing condition on the properties of $Pb(Zr,Ti,Mg,Zn,Nb)O_3$ ceramic was studied. If the excess PbO in the samples had not completely volatilized out. The existence of excess PbO owing to its low dielectric constant as a second phase in the grain boundaries could be harmful to the poling effect. The behavior would result in lower piezoelectric and dielectric properties. A longer annealing time causes excessive PbO loss and a resultant variation in composition, which leads to an inhomogeneous microstructure and the emergence existence of a pyrochlore phase. The dielectric and piezoelectric properties are deteriorated in the two-phase PbO-deficient region, which can be understood by the increased concentration of second phase ZrO_2 and pyrochlore phase with low permittivity. As a annealing time (i.e. 1 h) are proper, they can depress the amounts of the second phase and increase the value of k_p, K^T_{33} and Q_m.

KEYWORDS
Pyrochlore phase, dielectric properties, piezoelectric properties, PZT, MPB.

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FABRICATION AND FRACTURE BEHAVIOUR OF SILICON CARBIDE COMPOSITES CONTAINING CHOPPED TYRANNO® Si-Al-C FIBRE

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ABSTRACT
Silicon carbide (SiC) composites reinforced with 0~50 mass% (0~47 vol%) of chopped Tyranno® Si-Al-C (SA) fibres (mean length: 394 □m) and 5 mol% of aluminium carbide (Al_4C_3) sintering aid were fabricated using the uniaxial hot pressing method (1800 °C/30 min/31 MPa). The maximum relative density of the specimens was 96.8% for the case of 40 mass% of SA fibre addition. The mean fracture toughness, K_{IC}, of the composite specimens was always higher compared to that of the monolithic SiC specimen (2.6 MPa·m$^{1/2}$) with a maximum K_{IC} value of 4.0 MPa·m$^{1/2}$ being achieved for the composite containing 30 mass% of chopped fibre. Furthermore, the use of 30 mass% of chopped SA fibre containing a carbon interface (interface thickness: ≈100 nm) increased the value of K_{IC} to 5.8 MPa·m$^{1/2}$.

KEYWORDS
SiC, Si-Al-C short fibre, carbon interface, hot pressing, fracture toughness.

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ENVIRONMENTALLY FRIENDLY TAPE CASTING FOR POROUS ALUMINA-ZIRCONIA SUBSTRATE

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ABSTRACT
A porous alumina substrate was prepared using a tape casting process involving an aqueous solvent. The as-received gibbsite powder, $Al(OH)_3$, a waste product of an aluminium anodizing process, was recycled as a starting raw material. A water-based slurry of the gibbsite was blended with various amounts of acrylic emulsion binder. Zirconia was added (1.0-20.0 wt.%) to strengthen and control the microstructure of the sintered tape. After casting the green tapes were then air dried and sintered for a fixed time at temperatures up to 1700°C, before furnace cooling. Both the green and sintered tapes have been characterized to identify particle size distribution and phase transformation using laser scattering and x-ray diffraction (XRD) respectively. Surface morphology of the tapes was observed using scanning electron microscopy (SEM). SEM examination showed that the localized distribution of the binder affects the pore morphology and pore distribution on the surface of the substrate. To measure the strength of the sintered tape, 4 point bending tests were carried out and indentation tests used to determine hardness. The relationship between mechanical properties of the porous alumina substrate and its microstructure development has been discussed.

KEYWORDS
Environmentally friendly tape casting, aqueous/water based system, porous alumina-zirconia substrate, a waste product of an aluminium anodizing process.

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CHARACTERISATION OF RF-SPUTTERED DOPED LANTHANUM GALLATE THIN FILMS FOR SOLID OXIDE FUEL CELL APPLICATIONS

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ABSTRACT
Scanning Electron Microscope (SEM) and Energy Dispersive Spectrometry (EDS) studies of doped Lanthanum Gallate (LSGM) thin films prepared by Radio Frequency (RF) magnetron sputtering reveal levels of oxygen vacancies which are higher than that expected from the target stoichiometry. Such films are thus possible candidates for intermediate temperature electrolytes for solid oxide fuel cells (SOFCs). These thin films also exhibit linearly ordered self-assembled microdots and holes. The formation and spontaneous alignment of these self-organised islands is similar to artificially and spontaneously ordered quantum dots formed by the Stranski-Krastanov mechanism. A model for the simultaneous formation of the microdots and holes is proposed. The patterns of microdots and holes could offer the possibility of self-assembled patterning of the electrolyte material of fuel cells.

KEYWORDS
Solid Oxide Fuel Cells, intermediate temperature electrolytes, doped lanthanum gallate thin films, self-assembled microdots, Stranski-Krastanov mechanism.

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PROPERTIES OF LIQUID PHASE PRESSURELESS SINTERED SiC-BASED MATERIALS OBTAINED WITHOUT POWDER BED

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ABSTRACT
High density liquid-phase pressureless sintered silicon carbide (LPSSC) bodies were obtained by means of a process which did not require powder bed to protect sample against weight loss. This process was successfully tested with yttria-alumina and yttria-aluminum nitride systems as sintering aids. In both cases, sintered samples showed a fine microstructure with $Y_4Al_2O_9$ and $Y_{10}Al_2Si_3O_{18}N_4$ as grain boundary phase, respectively. Sintering behaviour and mechanical properties were examined and compared to other LPSSC-based materials obtained with different sintering processes (hot pressing, gas pressure sintering, pressureless sintering with powder bed). Microstructural analysis confirmed that a glassy-phase scale protects these materials against oxidation up to 1500°C. In this manner we were able to demonstrate that silicon carbide could successfully be sintered by means of liquid phase mechanism also without powder bed. This fact opens liquid phase sintered silicon carbide to a wide range of industrial application.

KEYWORDS
Sintering, SiC, liquid phase, mechanical properties.

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NANOSTRUCTURED WORKING ELECTRODES IN DYE-SENSITISED SOLAR CELLS – AN OVERVIEW

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ABSTRACT
Nanostructured working electrodes are an integral component in the dye-sensitised solar cell (DSSC). This paper demonstrates the importance of its nanostructure, and consequent high surface area on the performance of this type of solar cell. The major types of nanostructured semiconductors used for the working electrodes are discussed, as well as the different processing methods. The role and importance of obtaining higher solar-to-electric conversion efficiencies by post-treatment of the working electrodes is also mentioned. In addition, the other components of the DSSC are examined to illustrate the interconnectivity of the various components of the solar cell.

KEYWORDS
Dye-sensitised solar cell, photoelectrochemical, nanostructured, working electrodes, solar cell.

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COMBUSTION SYNTHESIS OF AlN-SiC SOLID SOLUTIONS

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ABSTRACT
AlN-SiC solid solutions were successfully prepared by combustion synthesis from a mixture of Al, Si and C under high-pressure nitrogen. The reaction mechanism for combustion synthesis of AlN-SiC solid solutions is as follows: Al and Si melt at the front of combustion wave; Carbon black is mixed into the molten mixture; Al reacts with nitrogen to form AlN; Both liquid Si and silicon vapor (from evaporation of Si powder due to the high exothermic heat of the reactions, or from the decomposition of intermediate Si_3N_4) react with C to form SiC. Simultaneously, Si and C (or SiC) diffuse into the AlN crystal lattice directly to form an AlN-rich solid solution, and Al (or AlN) diffuses into the SiC crystal lattice directly to form a SiC-rich solid solution. The strengthening of the atomic bonding within the basal planes of the AlN-SiC solid solution, and a weakening of the bonds between the basal planes due to interdiffusion of AlN and SiC hinders the nucleation on the {0001} planes and promotes the growth of the {0001} planes, with the result that AlN-SiC solid solution tends to grow in the form of platelets. The combustion synthesized AlN-SiC solid solution spinodally decomposes into AlN-rich and SiC-rich domains during cooling. Both the AlN-rich and the SiC-rich domains share the same <0002> zone axis and their reciprocal planes perpendicular to the <0002> zone axis are rotated 30° clockwise around it.

KEY WORDS
Combustion synthesis, aluminum nitride, silicon carbide, solid solution, platelet, reaction mechanism, spinodal decomposition, interdiffusion.

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MECHANICAL PROPERTY DEVELOPMENT IN ISOTHERMALLY SINTERED MECHANICAL BLENDS OF HYDROXYAPATITE AND FLUORAPATITE

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ABSTRACT
Hydroxyapatite and fluorapatite have been known to co-exist in the skeletal system making the resultant apatitic assembly as a potential biomaterial for bone regeneration and growth. Development of the mechanical properties of mechanical assemblies of hydroxyapatite and fluorapatite sintered at 1200°C and 1250°C for different sintering times were investigated. The study was focussed on two main compositions of the mechanical assemblies of hydroxyapatite blended with 60 and 80 wt% fluorapatite. The microstructural characteristics such as density and grain size were determined prior to investigation of hardness, elastic modulus, fracture toughness and brittleness from indentations. Increase in sintering time and temperature is associated with an exponential increase in density, hardness, elastic modulus and brittleness. The increase in mobility of the fluoride and hydroxyl ions into the adjacent crystallites results in an increase in the densification and an associated increase in the hardness, elastic modulus and brittleness of the sintered blend. Fracture toughness increases with the porosity and fluorapatite content of the sintered mechanical blend.

KEYWORDS
Fluorapatite, isothermal sintering, mechanical properties, biomedical application, hardness.

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BIO-INSPIRED CERAMIC STRUCTURES: FROM INVERTEBRATE MARINE SKELETONS TO BIOMIMETIC CRYSTAL ENGINEERING

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ABSTRACT
Nature is a source of inspiration in all facets of human endeavour from art, poetry to science and technology. Conventional techniques for the fabrication of ceramic structures with intricate architectures fall below the specifications natural structures. More technologies such as biomedicine demand the production of complex inorganic structures. The idea of biomimesis is to abstract good design principles and optimizations from nature and incorporate them in the construction of synthetic materials and structures. Direct appropriation of natural inorganic skeletons is also biomimetic since their properties can inform us on ways to generate functional, optimized scaffolds. This paper reviews promising biomimetic approaches toward bioceramic design-with-construction taking inspiration from nature.

KEYWORDS
Biomimesis, bioceramic, bio-inspired, tissue engineering, natural biomaterial, biomineralisation, invertebrate skeletons.

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HIGH-RESOLUTION TRANSMISSION ELECTRON MICROSCOPY INVESTIGATION OF THE NANOSTRUCTURE OF NANOCRYSTALLINE PULSED LASER DEPOSITION SnO_2 THIN FILMS

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ABSTRACT
Pulsed laser deposition (PLD) was used to grow nanocrystalline SnO_2 thin films into glass substrates. The nanocrystallines and microstructure performances of SnO_2 thin films grown by PLD techniques have been shown to be highly sensitive to the deposition conditions. The reactive PLD process was carried out at room temperature under the working pressure of about $2x10^{-6}$ mbar. Experimental results indicate the PLD deposition under vacuum is found to produce thin films that are composed of both a polycrystalline SnO_2 phase and an amorphous SnO phase. In particular, the presence of such an amorphous SnO phase in the thin films greatly limits their practical use as gas-sensing devices. High-resolution transmission electron microscopy (HRTEM) observations revealed that the SnO_2 nanocrystallines with tetragonal rutile structure embed in an amorphous SnO matrix, and tend to be in quasi-spherical shape. This quasi-spherical SnO_2 nanocrystalline contains a high density of defects, such as twin boundaries and edge dislocations. The microstructure of the thin films is highly sensitive to their PLD conditions.

KEYWORDS
Pulsed laser deposition, thin film, nanocrystalline.

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IN-SITU REINFORCED LI-SIALON CERAMICS BY A NEW PROCESSING STRATEGY

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ABSTRACT
Spark Plasma Sintering® (SPS) was applied to produce fully dense lithium-stabilized sialon ceramics with or without the present of an extra liquid phase. The liquid phase, thermodynamically compatible with α-sialon, was introduced by raising the oxygen content of an already oxygen-rich α-sialon composition, i.e. by increasing the O/N ratio in $Li_mSi_{12-(m+n)}Al_{m+n}O_nN_{16-n}$ and keeping the RE, Si and Al proportions constant. The introduced liquid phase not only influences the phase compositions but also their forming rate. With the increase of liquid phase, the crystalline phase shifts from mono-phase Li-doped α-sialon to duplex α/β composite. The SPS-process allows the application of very fast heating rates thus shortens down the total processing duration to 1/10 of that required by traditional sintering process, providing a unique possibility to monitor and manipulate the sintering kinetics. Sialon ceramics with *in-situ* reinforced microstructure were produced by SPS at 1650°C with a dwell time of 10 min.

KEYWORDS
Sialons, sintering, phase transformation, *in-situ* reinforcement, and SPS.