LUCIDEON
insight creating advantage

WORLD CERAMICS ABSTRACTS

February 2019 Pt.1

World Ceramics Abstracts provides comprehensive coverage of the world's literature on ceramic materials, processing and applications.

Coverage includes advanced materials, engineering ceramics and electroceramics, refractories, traditional ceramics (tableware, tiles and sanitaryware), bricks and roofing tiles, glass and vitreous enamels.

COMMERCIAL AND ECONOMIC

203527

TABLEWARE BOOST AS CONFIDENCE GROWS

Asian Ceram. AC 18-10,2018,p.12

Multinational companies are increasingly customising goods specifically for the Indian market, which is now the largest consumer market after the US and China. The tableware market is huge, and increased purchasing power and evolving lifestyle has moved the market away from the purely functional. Technological advances have also played a major role.

Company Activities

See also Abstract(s): 203540 203555 203687

Production organisation and planning

See also Abstract(s): 203592 203674

Statistics and economic information

See also Abstract(s): 203551 203552 203615

203528

CONSTRUCTION WILL CONTINUE TO GROW IN EUROPE IN THE NEXT FEW YEARS

Ceram.Forum Int./Ber.DKG. 95,No.11/12,2018,p.E47-E48

According to the Euroconstruct forecast in June 2018, European construction will grow 2.7% in 2018, a lower growth rate than in 2017, and continue to grow in 2019 and 2020, but again at a lower rate. It is predicted that the focus of growth will shift from new housing construction to civil engineering construction. Hungary will see the fastest construction growth in the next two years, followed by Poland, Ireland and Portugal. Total construction output for the 19 member countries is tabulated for 2014-2017, with forecasts to 2020.

203529

CICA: INSIDE ASEAN TRADE. BATTENING DOWN THE HATCHES

Ahmed J

Asian Ceram. AC 18-10,2018,p.32-34,36,38,40

A report is given of the 25th annual meeting of the Ceramic Industry Club of Asean (CICA) held in Malaysia in November 2018. The current state of the ceramics industries (predominantly tiles, tableware and sanitaryware) in Indonesia, Malaysia, Philippines, Thailand and Vietnam is reviewed with information on production, imports, exports and markets. The recently launched Asean free market, which requires product standardisation, is discussed and CICA aims are outlined. An Asean Harmonised Product Standard for ceramic tiles has been proposed.

203530

CHINESE SANITARYWARE DEVELOPMENT

Asian Ceram. AC 18-10,2018,p.42-43

The number of ceramic sanitaryware manufacturers in China and their capacity has increased significantly over the past 20 years, but there has been a slowdown recently due to changes in regulation policies in the real estate industry. The regions where sanitaryware production is concentrated are discussed. The fast expansion of the industry has resulted in overcapacity. Export volumes rose 11.3% in 2017 and values by 38.6%, and import volumes rose 59.1% and values by 65.6%. Export destinations are listed, the USA being the top destination with over 16% of the market share.

203531

PRESENT AND CORRECT... ASEAN GIFTWARE RUSHES TO THE FRONT

Malik Y

Asian Ceram. AC 18-10,2018,p.44-46,48-49

The ceramic giftware industry in Asean countries is discussed, focusing on Indonesia and Thailand, the two largest producers in the region. The tourist industry is a major factor in the growth in giftware and many tableware producers are involved in the market. Some business has shifted from Chinese producers to Asean producers due to increased Chinese production costs. Leading ceramic giftware producers in Indonesia and Thailand are listed, and the Thai regions of Lampang and Chiang Mai are profiled, with emphasis on celadon ceramic wares.

203532

PRESSURE IN THE GULF. CHINESE TILE EXPORTS UNDER SCRUTINY

Asian Ceram. AC 18-10,2018,p.50-52

Chinese tile makers are finding that the tile markets in the Middle East are becoming harder to service. Saudi Arabia is a major market for the export of Chinese ceramic tiles, but in recent years the export value has fallen significantly (by 38.21% for unglazed and 26.25% for glazed compared to the previous year). The import and consumption of tiles in Saudi Arabia, Qatar and the UAE is discussed. Reasons for the decline in exports include the economic situation in the Middle East, due to decreasing oil prices, the demand for higher quality products, and competition from India.

203533

SHRINKING VIOLETS? CHINA'S PIGMENTS UNDER PRESSURE

Asian Ceram. AC 18-10,2018,p.54-57

The pigment market in China is suffering due to the increase in the ink jet printing of tiles and the reduction of production lines for polished tiles, and

also stricter environmental policies. Ways in which pigment manufacturers are responding to these pressures are outlined, including the use of dry mixing pigments and the emphasis on higher quality products.

203534

INSIGHT ARGENTINA

Asian Ceram. AC 18-10,2018,p.62,64

Statistics are given for the tile and sanitaryware industry in Argentina for 2017, covering leading glazed and unglazed tile export destinations (m2), total glazed and unglazed tile exports (m2, 2014-2017), leading glazed and unglazed tile import sources (m2), total glazed and unglazed tile imports (m2, 2014-2017), and sanitaryware imports and exports (no. pieces, 2014-2017).

203535

CONTAINER GLASS PRODUCTION COSTS. PT.2. MODERNISATION THE KEY TO A BRIGHTER FUTURE

Malik Y

Asian Glass. AG 18-5,2018,p.68-70,73

Container glass production costs in India, Pakistan, Bangladesh and Sri Lanka are discussed. The Indian sub-continent has about 45 container glass producers of all sizes, most of which are in India. Production costs have increased recently due to rising fuel and raw material prices, and due to investments in the latest technology to improve quality and optimise production costs in the medium term. Cost factors are analysed for each country. Based on fuel, raw material and labour costs, India is the least cost producing country of the four. Leading container glass producers in Pakistan and India are listed and figures for container glass production and consumption in Pakistan for 2012-2017 are provided.

203536

RUSSIA RISING. FIGHTING AGAINST THE IMPORT TIDE

Asian Glass. AG 18-5,2018,p.74-76,78,80,82,84,87

The flat glass industry in Russia is reviewed. Several global leaders are now active in the country and imports are gradually being replaced by domestic products. Potential export markets for future growth are also being explored. Foreign trade in flat glass is now almost balanced with imports and exports in 2017 both having a value of about $310 million. The demand for building glass is increasing with new high-rise buildings in urban areas and there is demand for domestic automotive glass. Details are given of major flat glass producers in Russia and export destinations of float glass and safety glass are tabulated for 2013-2017.

203537

WINDOW ON INDIA

Asian Glass. AG 18-5,2018,p.94,96

Statistics are provided for the glass industry in India in 2017, looking at total float glass imports and exports (m2, 2013-2017), total sheet glass imports (m2, 2013-2017), total insulating glass unit imports (t, 2013-2017), total container glass imports and exports (t, 2013-2017), principal float glass import sources and export destinations (m2) and principal container glass and safety glass export destinations (m2).

203538

CHINA'S REFRACTORY MATERIALS OUTPUT UP 5% IN H1 2018

Shi C

Ind.Miner. No.605,2018,p.11

Data from the China Association of Refractories indicate that China's total output of refractories in H1 2018 was 9.45 million tonnes, up by 4.8% year on year. The output rose due to increasing demand from downstream consumers. Prices for most refractory raw materials, such as magnesia and graphite, remained firm. Output of unshaped refractory materials in August was also up by 10.16%. This was also due to stronger demand, especially for alumina-silicon and magnesia-based products from the steel and construction sectors.

203539

SOLID FUNDAMENTALS FOR INDIAN REFRACTORIES

Singh S

Ind.Miner. No.604,2018,p.18-19

The Indian Refractory Manufacturers' Association reported a growth of about 3.5% in refractory production in India in 2017-2018. The industry is heavily dependent on the domestic steel industry which has been growing and should continue to do so. Imports of refractory products from China are a key issue facing Indian refractory producers. However, the industry depends on Chinese raw material imports, the supply of which has been affected by the stricter Chinese environmental regulations, and there are calls for the Indian government to intervene. The lack of raw materials in India is forcing new strategies to be implemented. Details on the joint venture between Indian company Dalmia and Slovenian Seven Refractories and the new Dalmia Seven plant in India are discussed. Data are given on refractory products by type for 2012-2017.

203540

OUT OF THE MELTING POT: A YEAR OF CHANGE IN REFRACTORIES

McCormick M

Ind.Miner. No.604,2018,p.28-31

The global refractory industry in 2018 is analysed, looking at some of the major companies operating in the sector. The activities of the giant RHI-Magnesita, formed in October 2017, and the expansion plans of Imerys are discussed. The refractories industry is looking quite healthy, mainly due to an upturn in construction activity, which increases the need for glass, cement and steel. However, supply of raw materials is unable to meet demand and prices are rising fast. The possible effects of US import tariffs on the steel industry are being monitored. The Indian refractory market is expected to expand significantly, driven by growth in steel production.

203541

DISSECTING ALUMINA SUPPLY

Dickson T

Ind.Miner. No.604,2018,p.32-36,38-39

Non-metallurgical applications for alumina comprise those that use hydrates as the raw material and those that use calcined alumina, and, although the sector is small compared to the overall consumption of alumina, it is diverse and complex. Alumina hydrates are mainly used for water treatment chemicals, but other applications include aluminium fluoride production, flame retardants and zeolites. The largest consuming sector for calcined aluminas is the refractory industry, with direct use estimated at 800000 t. Tabular alumina production is estimated at about 700000 tpy and white-fused alumina for refractory applications is 270000 tpy. Refractories markets were strong in 2017 and this has continued into 2018. The ceramics sector, which covers applications such as grinding balls and high-tech ceramics and represents about 17% of the calcined alumina market, is also growing, with growth up 4-5% in 2018 compared to 2017. Supply and pricing issues for alumina hydrates and calcined alumina are discussed.

203542

DEMANDING SUPPLY

Flook R; Wilson I - *Mosman Resources*

Ind.Miner. No.604,2018,p.47-51

The global magnesia market is reviewed. Ways in which disruptions in magnesia supplies from China are affecting the industry are outlined. Supply has been developing in other areas and the situations in Russia, Turkey, Brazil, Serbia and Pakistan are discussed, looking at deposits, resources and companies involved in mining and mineral processing. The refractory market accounts for about 75% of the global demand for magnesia. Information is also given on prices.

LEGISLATION AND STANDARDS

See also Abstract(s): 203547 203585

203543

BS EN 772-22:2018. METHODS OF TEST FOR MASONRY UNITS. PT.22. DETERMINATION OF FREEZE/THAW RESISTANCE OF CLAY MASONRY UNITS

British Standards Inst.

London,2018,pp.22

A method is specified for determining the freeze/thaw resistance of clay masonry units in one of two categories (F1 or F2), determined by the number of freeze/thaw cycles to failure. Normative references, terms and definitions, principle and apparatus, materials, specimen preparation (sampling, water absorption and conditioning), construction and conditioning of the test panel, freezing and thawing procedure, and evaluation of results are detailed. The British Standard is the UK implementation of EN 772-22:2018. It supersedes DD CEN/TS 772-22:2006, which is withdrawn.

203544

BS EN 997:2018. WC PANS AND WC SUITES WITH INTEGRAL TRAP

British Standards Inst.

London,2018,pp.68

This European Standard specifies constructional and performance characteristics together with test methods for close-coupled suites, one-piece and independent WC pans with integral trap used for personal hygiene, manufactured from glazed ceramics or stainless steel. It does not apply to squatting toilets, WC pans without integral trap or flushing cisterns as separate appliances. In the case of close-coupled suites and one-piece WCs, it also specifies design, performance characteristics and test methods for designated flushing cisterns with flushing mechanisms, inlet valves and overflows. Before installation of WCs, EN 12056-2 and national requirements need to be taken into consideration. The standard is the UK implementation of EN 997:2018 and supersedes BS EN 997:2012+A1:2015, which is withdrawn.

203545

BS EN ISO 10545-2:2018. CERAMIC TILES. PT.2. DETERMINATION OF DIMENSIONS AND SURFACE QUALITY (ISO 10545-2:2018)

British Standards Inst.

London,2018,pp.20

Methods are specified for determining the dimensional characteristics (length, width, thickness, straightness of sides, rectangularity, and surface flatness (curvature and warpage)) and the surface quality of ceramic tiles. Tiles with areas < 4 cm2 are excluded from measurements of length, width, straightness of sides, rectangularity and surface flatness. Spacer lugs, glaze blobs and other irregularities of the sides are to be ignored in the measurements. The test apparatus and specimens, test procedure, expression of results, and test report are described for each characteristic. The standard is the UK implementation of EN ISO 10545-2:2018. It supersedes BS EN ISO 10545-2:1997, which is withdrawn.

ENVIRONMENT AND POLLUTION

See also Abstract(s): 203561 203562 203584 203592 203686 203698 203723

203546

BUILDING A SUSTAINABILITY BENCHMARKING FRAMEWORK OF CERAMIC TILES BASED ON LIFE CYCLE SUSTAINABILITY ASSESSMENT (LCSA)

Ferrari A M; Volpi L; Pini M; Siligardi C; Garcia-Muina F E; Settembre-Blundo D - *Modena & Reggio Emilia,University; Madrid,Universidad Rey Juan Carlos; Gruppo Ceramiche Gresmalt*

MDPI Resour. 8,No.1,2019,pp30

The indices of environmental, economic and social sustainability related to the Italian production of ceramic tiles in porcelain stoneware were determined, in order to contribute to the construction of a reference benchmarking useful to decision makers, designers and end users of ceramic

tiles. The Life Cycle Sustainability Assessment (LCSA) framework was used, which incorporates the three dimensions of sustainability with cradle-to-grave Life Cycle Assessment (LCA), Life Cycle Costing (LCC) and Social Life Cycle Assessment (S-LCA) tools. It was found that in the production of porcelain stoneware, one of the major environmental problems is the distribution system of the product to end users and, to a lesser extent but always significant, the process of supplying raw materials. It was also highlighted that the joint use of the three impact assessment tools (LCA, LCC, S-LCA) requires further methodological work to avoid the risk of double counting of sustainability performance. This research adopted a detailed methodological approach, both in the collection and in the processing of data, keeping the main phases of the production process separate. In this way, it has been possible to highlight that the major environmental criticalities are just beyond the "gate" of the ceramic factories, along the logistics chain. The study also proposes not only indicators of environmental but also economic and social sustainability in relation to the Italian ceramic sector. 62 refs.

203547

RESULTS AND PROSPECTS OF APPLYING AN ISO 50001 BASED REPORTING SYSTEM ON A CEMENT PLANT

Pelser W A; Vosloo J C; Mathews M J - *Pretoria,North-West University*

J.Clean.Prod. 198,2018,p.642-653

Since energy costs make up 30% of production costs in the cement industry, reducing energy consumption increases profitability. Existing energy management methods often demand large capital investments. An electrical energy management system to improve cement plant productivity at minimal cost is reported. The system consists of an automated energy performance report which encompasses the Plan Do Check Act approach of ISO 50001. The system collects data from various sources to provide valuable information and graphs on these reports. Large electricity-consuming systems can then be isolated, monitored, and compared with continuously updating benchmarks to identify missed saving opportunities. The system was implemented at a South African plant where the electrical energy cost of cement reduced by 25%. Qualitative consultations confirmed that the system promotes the implementation of ISO 50001 management practices. The system makes it possible to monitor the energy performance of equipment and continuously improve operations. It is thus shown that cement plant profitability can be improved with minimum capital investment by using an energy management system. 47 refs.

INDUSTRIAL HEALTH AND SAFETY

See also Abstract(s): 203585 203586

RAW MATERIALS

See also Abstract(s): 203535 203582 203584 203645 203653 203682 203685

Minerals

See also Abstract(s): 203541 203542 203551 203552 203583 203687

203548

SPECIFICATION AND CHARACTERISATION OF SINTERING PARAMETERS PERTAINING TO CRUSHED BRICK-BEARING TERRACOTTA CERAMIC CLAY

Uz V; Isik I; Issi A; Coskun N D; Celik F; Isik C E - *Kutahya,Dumlupinar University; Ordu,University*

Seramik Turk. No.54,2019,p.120-127

In English; Turkish - Additions are made to clays used for artistic ceramics to create different aesthetic appearances and to prevent deformation after firing. The use of crushed brick-bearing grog (chamotte) clay, which turns into a red colour after firing, was analysed. The addition of coarse-grained grogs creates a difference in the product, as well as the patterns and colours applied on the surface. The selection of particle size and the additive content can prevent post-firing deformation. The plasticity value of the clay was found to be 23.18%, and thermal analysis indicated that the optimum firing temperature was in the range 950-1000 C, with 960 C giving the highest shrinkage rate. An example of a plate made by ceramicist Ozlem Ozdemir is illustrated. 10 refs.

Processed raw materials, synthesised powders

See also Abstract(s): 203541 203561 203597 203613 203627 203646 203651 203654 203656 203664 203666

203549

SYNTHESIS OF COLLOIDAL NANOSILICA FROM WASTE GLASS POWDER AS A LOW COST PRECURSOR

Asadi Z; Norouzbeigi R - *Iran,University of Science & Technology*

Ceram.Int. 44,No.18,2018,p.22692-22697

Glass powder is a chemically neutral and abundant low cost source of silica. Reuse of waste glass has advantages such as saving energy and materials, reduction of production costs, and decrease of landfill space demands. Waste glass powder was used for the first time as a low cost precursor for the production of colloidal nanosilica. The process included the production of wet silica gel and thermal peptisation of the wet gel. Purification of the glass powder and wet gel production were initiated by acid washing. The obtained powder was reacted with sodium hydroxide to produce the wet silica gel. The type of acid used (sulphuric, hydrochloric and nitric) was examined one factor at a time. The temperature of the alkaline step and concentrations of the applied acid and base were investigated using Taguchi design of experiments. After determining the best combination of the investigated factor levels in the production of the wet gel, the time of stabilisation in thermal peptisation was studied. The wet gel and colloidal silica were characterised by XRF, dynamic light scattering, FESEM, TEM, FTIR and N2 sorption evaluation. Pure and stable colloidal nanosilica (98.50%) with an average particle size of 21.9 nm was successfully produced from the glass powder. The specific surface area of the dried porous optimum sample was 83.63 m2/g. 32 refs.

203550

FEASIBILITY OF IN SITU DE-AGGLOMERATION DURING POWDER CONSOLIDATION

Giuntini D; Bordia R K; Olevsky E A - *Hamburg,University of Technology; Clemson,University; San Diego,State University*

J.Am.Ceram.Soc. 102,No.2,2019,p.628-643

The consolidation of nanosized powders is a growing area in the manufacturing of advanced materials due to the reduced processing times, enhanced mechanical properties and high potential for the introduction of multi-functionality enabled by such reduced particle sizes. However, nanopowders are particularly prone to the agglomeration phenomena, and to the formation of hierarchical porous structures. The presence of pores differing up to several orders of magnitude in size leads to undesired differential shrinkage and localized grain growth. In order to avoid these issues, strategies for in-situ de-agglomeration are proposed. The strategies are based on the development of an analytical model for shrinkage kinetics and mechanical properties of a hierarchical porous structure, containing both small size intra-agglomerate pores and large size inter-agglomerate pores. The modelling approach is an expansion of the continuum theory of sintering to the case of biporous materials presenting nonlinear viscous rheology, as expected for nanosized crystalline powders. Considering the nonlinear viscous constitutive behaviour of the solid phase also allows the assessment of the influence of the temperature on the microstructural evolution during processing, due to the dependence of creep and strain-rate sensitivity on the thermal history. Material structure optimisation strategies, aimed at de-agglomeration or at the design of tailored porous structures, then become possible and are explored. 74 refs.

203551

COLOURFUL FUTURE - THE REBOUND IN IRON OXIDE PIGMENTS

McCormick M

Ind.Miner. No.605,2018,p.22-25

The construction industry is the largest consumer of iron oxide pigments (54% of the market in the USA) and so the global growth in construction is fuelling a growth in demand for such pigments. The two biggest players in the production of synthetic materials, Lanxess and Cathay, both increased prices substantially in 2017. The majority of iron oxide pigments used are synthetic (1 million tpy synthetic compared to 0.3 million tpy natural mined product). Differences in synthetic and natural pigments are discussed. Natural products tend to be used in pavers, cement and concrete where strength is important. Demand in the coming years should continue from the construction industry, but new opportunities exist, including use in 3D printing.

203552

TITANIUM DIOXIDE MARKET SETTLES IN FOR WINTER ON A HIGH PLATEAU

Clarke W

Ind.Miner. No.605,2018,p.30-33

Titanium dioxide markets began a long-term upward trend in early 2017 and a period of stability is predicted. The production and processing of titanium dioxide is described, and factors affecting the market are discussed. Demand for paint, one of the principal applications, is increasing due to increased building activity.

203553

SINTERING OF ALUMINUM-OXYNITRIDE POWDER PREPARED BY SELF-PROPAGATING HIGH-TEMPERATURE SYNTHESIS

Galakhov A V; Zelenskii V A - *Baikov A.A.,Institute of Metallurgy & Materials Science*

Refract.Ind.Ceram. 59,No.1,2018,p.25-26

Aluminium-oxynitride powders were prepared by self-propagating high-temperature synthesis in a nitrogen-containing gel, followed by sintering. Due to the low specific surface areas of the powders, extensive mechanical grinding was needed. Equipment fitted with grinding containers lined with high-density plates and grinding balls made of the same material, 9Al2O3.5AlN, was used to increase the specific surface area. 9 refs.

CERAMICS FOR BUILDING

203554

EXPERIMENTAL INVESTIGATION OF MORTAR MECHANICAL PROPERTIES FOR GLASS BRICK MASONRY

Fila J; Eliasova M; Sokol Z - *Czech Technical University*

Glass Struct.Eng. 4,No.1,2019,p.127-141

The main advantage of solid bricks over hollow blocks is substantially higher compressive strength. However, solid bricks have much higher thermal conductivity, which can lead to major heat loss when used for exterior walls. Masonry pillars and walls are usually loaded in compression and/or bending resulting from the eccentricity of the vertical load or wind load. In the case of solid glass bricks, compressive strength is about ten times higher than tension strength, and therefore the limiting factor of the glass masonry is tensile stress resulting from the bending. Whether compared to ceramic or concrete brick masonry, the glass bricks have a smooth and non-absorbent surface and the adhesion of the mortar to the glass surface is the critical parameter. An investigation of mortar applicable for glass brick masonry was carried out with regard to use for load bearing brick walls or columns. Shear, compression and tension tests were performed, and the shear and tension resistance and failure modes of the brick bed joint were determined during a series of tests using various mortar composition, two types of surface treatment and the different thickness of the mortar joint. The joint thickness significantly affected the resistance. The compression tests were performed on two small pillars to determine the compression resistance and failure mode of glass brick walls and pillars. In parallel to these tests, several small-scale tests were performed to determine the flexural and compressive strength of the hardened mortar. 11 refs.

Building materials: clay-based

See also Abstract(s): 203543 203618 203619 203718

203555

ULTRA-MODERN FACING BRICK PLANT FOR IBSTOCK

Keller HCW GmbH

ZI Int. 71,No.6,2018,p.44-49

In English; German - Bricks have been produced at Ibstock since the 1830s. A new brick plant has been built at the Ibstock headquarters near Leicester for the production of soft-mud bricks in a wide range of colours and shapes. Plant and machinery has been supplied by Keller HCW. There was a focus on energy saving, and the tunnel dryer, tunnel kiln, cogeneration system and automatic setting and unloading systems are described. The production capacity will be 100 million bricks per year.

Building materials: calcium silicates, cements etc

See also Abstract(s): 203547 203551

203556

EFFECT OF THE SODIUM SULPHATE SOLUTION EXPOSURE ON PROPERTIES AND MECHANICAL RESISTANCE OF DIFFERENT KINDS OF RENDERS

Pavlikova M; Pokorny J; Jankovsky O; Zaleska M; Vavro M; Soucek K; Pavlik Z - *Czech Technical University; Prague,University of Chemistry & Technology; Ostrava,Institute of Geonics*

Ceramics-Silikaty. 62,No.4,2018,p.311-324

The effect of 5% water solution of sodium sulphate, with distilled water used as a reference, on changes in the mechanical resistance of commercial dry render mixes for construction ceramics was studied. Prism-shaped specimens cured for 28 days in humid and stable conditions were immersed in water or sodium sulphate water solution. At the chosen time, specimens were collected, dried to constant mass, and tested. The maximum time of specimen exposure to moisture or salt action was 168 days. Length changes, mass gain, mechanical and basic properties were measured to determine the effect of sulphate corrosion on the studied materials. Pore size distribution measurement and X-ray CT analysis were carried out for the most damaged renders, in order to characterise the disruptive impact of the sulphate solution on the porous microstructure of the lime-metakaolin-based render. The data revealed the high capacity of the porous space of the renders tested for salt storage. For shorter times of exposure to salt action, the mechanical resistance of most of the studied renders improved. However, after the full filling of the porous space, the crystallisation pressures led to a decrease in mechanical resistance and material damage. One type of render originally designed for restoration of salt laden masonry maintained its excellent mechanical properties, even after 168 days of sulphate exposure. 45 refs.

203557

SURFACE TREATMENT OF CONCRETE WITH TETRAETHYL ORTHOSILICATE, Na2SiO3 AND SILANE: COMPARISON OF THEIR EFFECTS ON DURABILITY

Guo Z; Hou P; Huang S; Xie N; Cheng X; Singh L P; Strokova V; Nelyubova V - *Jinan,University; Roorkee,Central Building Research Institute; Belgorod,State Technological University*

Ceramics-Silikaty. 62,No.4,2018,p.332-341

The surface treatment of existing concrete structures with silica-based organic and inorganic agents is often used to improve the durability of the structures, but their effects vary. Tetraethyl orthosilicate (TEOS), an organic precursor for manufacturing silica sol, together with two other normally used silica-based agents, Na2SiO3 and silane, were used for the surface treatment of concrete. Their effects on the durability were studied and compared by investigating the compressive strength, water absorption rate, carbonation, chloride penetration and sulphate attack of cement concrete samples. The results showed that TEOS decreased the transport properties of concrete significantly: reductions of 49.0% of the water absorption rate, 28.5% of the chloride ion penetration depth, and 20% of the carbonisation degree to that of the control sample were found, while corresponding values of 42%/80%, 39%/71%, and 23%/10% of Na2SiO3/silane-treated samples were shown. The compressive strength results and visual observation showed that the samples treated by TEOS exhibited the best performance for long term exposure in the 5 wt% sodium sulphate solution compared with silane-treated and Na2SiO3-treated samples. The variation of the in-situ Ca(OH)2 consuming capability of the agents, as well as their effects on the hydration and hardening properties of the cement-based material, could be ascribed to their differences in improving the durability. 56 refs.

203558

SOME DURABILITY PROPERTIES OF ALKALI ACTIVATED MATERIALS (AAM) PRODUCED WITH CERAMIC POWDER AND MICRO CALCITE

Memis S; Kaplan G; Yaprak H; Yilmazoglu M U; Mutevvelli Ozkan I G - *Kastamonu,University*

Ceramics-Silikaty. 62,No.4,2018,p.342-354

Alkali-activated materials (AAM) were produced under different curing conditions using a ceramic powder (CP) instead of a blast furnace slag (BFS) and a micro calcite (McK) instead of a calcareous aggregate. The water/binder (W/B) ratios of the AAMs ranged from 0.30 to 0.42 and the sodium silicate (SS) ratios ranged from 15% to 60%. They were cured in 80 C water and in an oven, in air, and with a chemical curing method. An increase in the ratios of SS and W/B was found and the use of 25% McK with a spherical structure increased the workability. An increase in the CP and McK usage ratios reduced the 28-day compressive strengths. Using the CP while designing the AAMs, which were exposed to sodium sulphate and sulphuric acid, reduced the losses in strength. An increase in the CP ratio had a positive effect on the AAM as it increased the high-temperature endurance of the mortars. For conventional concrete, permeability in freeze-thaw resistance is an important factor for AAMs, and so using McK in AAMs increases the freeze-thaw resistance. It was also found that using a CP up to 40% influenced the AAM positively. 31 refs.

203559

PROPERTIES AND HYDRATION OF PORTLAND CEMENT CONTAINING CALCIUM SULPHOALUMINATE CEMENT

Li W; Yu J; Ma S; Hu Y; Ge D; Shen X - *Nanjing,Tech University; Nanjing,Laboratory of Materials-Oriented Chemical Engineering*

Ceramics-Silikaty. 62,No.4,2018,p.364-373

Calcium sulphoaluminate (CSA) cement has attractive properties, such as rapid setting, high early strength, and micro-expansion, and has commonly been used to improve the properties of Portland cement (PC). It was shown that the setting times were considerably reduced as the CSA cement content was increased. The compressive strength was slightly lower for PC-CSA blends containing < 10% CSA cement, but noticeably lower for the PC-CSA blend containing 20% CSA cement compared to PC. High amounts of CSA cement significantly delayed the hydration of alite, thereby increasing the porosity. The addition of CSA cement also changed the ettringite morphology. 35 refs.

203560

EFFECT OF NANO-TiO2 ON THE DURABILITY OF ULTRA-HIGH PERFORMANCE CONCRETE WITH AND WITHOUT A FLEXURAL LOAD

Gu C; Wang Q; Liu J; Sun W - *Zhejiang,University of Technology; Jiangsu,Key Lab.Construction Materials*

Ceramics-Silikaty. 62,No.4,2018,p.374-381

Addition of nano-TiO2 particles to ultra-high performance concrete (UHPC) gives the material self-cleaning and photocatalytic properties, making UHPC even more sustainable. The durability of nano-TiO2 modified UHPC with and without a flexural load was experimentally studied. The mechanical properties of UHPC with various nano-TiO2 contents were tested, and it was shown that UHPC with 1 wt% nano-TiO2 had the best properties. 1 wt% nano-TiO2 was added into UHPC to evaluate its effects on the dry shrinkage, chloride ingress resistance, freeze-thaw resistance and carbonation resistance of UHPC. The effect of the flexural load on the durability was also studied. The dry shrinkage of nano-TiO2 modified UHPC was reduced compared with the control UHPC. The flexural load accelerated the chloride penetration process in the tensile region of the UHPC specimens, and the addition of nano-TiO2 mitigated the negative influence of the flexural load on the chloride ingress resistance of UHPC. The addition of nano-TiO2 particles also improved the freeze-thaw resistance of the flexural loaded UHPC by reducing the mass loss under 800 freeze-thaw cycles. Carbonation was not detected in all UHPC specimens after being exposed to 60% CO2 for 180 days. Mercury intrusion porosimetry results indicated that the addition of nano-TiO2 refined the pore structure of the UHPC, improving the mechanical properties and durability of the UHPC. 34 refs.

203561

COMPREHENSIVE REVIEW ON MECHANICAL AND DURABILITY PROPERTIES OF CEMENT-BASED MATERIALS CONTAINING WASTE RECYCLED GLASS

Paul S C; Savija B; Babafemi A J - *Malaysia,Monash University; Delft,University of Technology; Obafemi Awolowo University*

J.Clean.Prod. 198,2018,p.891-906

Disposal of consumer waste is a major challenge in urban areas. Many types of wastes can be used instead of raw materials in the field of building materials. Production of binders such as Portland cement is also a CO2 intensive process. However, the properties of building materials containing waste materials must be satisfactory for construction applications. For concrete, fresh, hardened and durability properties are the most important. Waste recycled glass is a promising waste material for sustainable concrete composites. Literature on the use of waste recycled glass as partial replacement of either cement or aggregate in concrete is systematically reviewed. The focus is the influence of recycled waste glass on the engineering properties of concrete. Main advantages and drawbacks of using recycled waste glass are discussed. The aim is to identify major research needs to enable worldwide practical use. As concrete is the most used man-made material in the world, such development would significantly reduce the need for landfilling of waste recycled glass that is unsuitable for reuse in glass production. 103 refs.

203562

SUSTAINABLE CONCRETE: BUILDING A GREENER FUTURE

Assi L; Carter K; Deaver E; Anay R; Ziehl P - *South Carolina,University; Holcim (US) Inc.*

J.Clean.Prod. 198,2018,p.1641-1651

An attempt was made to develop a cost-competitive, environmentally friendly geopolymer concrete mixture that offers structural benefits relative to OPC, uses fly ash, a toxic waste byproduct as a raw material, and reduces the amount of CO2 emitted during its production. The production of OPC, the current standard in concrete, uses a large amount of energy and accounts for 7% of CO2 emissions worldwide. It is expected that OPC production will increase four-fold over the next 30 years, posing a significant environmental risk. Although there have been many studies on the use of geopolymer concrete as a more sustainable construction material, concerns about the cost and environmental impact have prevented widespread production and market adoption. New mix designs are proposed which result in up to a 50% decrease in the cost of geopolymer concrete, making this sustainable alternative a viable option relative to traditional concrete. The activating solution is a combination of silica fume, sodium hydroxide and water. The production of the proposed mixtures also requires < 50% of the fuel usage (thermal energy) required for OPC, decreasing CO2 emissions. The proposed mixtures not only reduce environmental impact, but also offer improved performance. While the proposed alternative to Portland cement is suitable for most applications, it is thought that firms interested in pursuing sustainable construction may be most inclined to adopt the proposed mixture in order to meet sustainability goals. 41 refs.

GLASS

Glass

See also Abstract(s): 203535 203536 203537 203549 203554 203561 203585 203607 203615 203620 203625 203629

203563

OPTICAL PROPERTIES OF Er3+/Yb3+ CO-DOPED PHOSPHATE GLASS SYSTEM FOR NIR LASERS AND FIBRE AMPLIFIERS

Zhang Y; Li M; Li J; Tang J; Cao W; Wu Z - *Nanjing,Tech University; Nanjing Haoqi Advanced Materials Co.Ltd.*

Ceram.Int. 44,No.18,2018,p.22467-22472

The optical properties of Er3+/Yb3+ co-doped phosphate glass were studied to determine its potential in laser and electronic amplifiers. The Judd-Ofelt (J-O) intensity parameter (Omega.t) in the J-O model was established to determine the absorption intensity of the glass. The optical properties could be evaluated by various radiation parameters such as the radiative transition probabilities (A(rad)), stimulated emission cross sections (sigma(e)), branching ratios (beta(JJ')), maximum half-width values (Delta.lambda(p)), and the radiation lifetime (tau(rad)) of the glass. It was found that, in the case of Yb3+ as a sensitiser, the spectral properties of the Er3+ doped glass could be maximised. Values of A(rad), beta(JJ'), tau(rad), sigma(e) and Delta.lambda(p) obtained by Er3+/Yb3+ co-doping indicated that the Er3+-doped sample underwent a 4I13/2-4I15/2 transition at 1.56 micron, and the stimulated emission cross section was greatly improved. Prospects for the application of the glass in solid near-IR laser and electronic communication are discussed and it was determined that the glass has great application potential. 28 refs.

203564

EFFECTS OF La2O3 DOPING ON THE PHOTOSENSITIVITY, CRYSTALLISATION BEHAVIOUR AND DIELECTRIC PROPERTIES OF Li2O-Al2O3-SiO2 PHOTOSTRUCTURABLE GLASS

Zhao H; Zhang J; Chen H; Liang T; Wei M - *Chengdu,University of Electronic Sci.& Technology*

Ceram.Int. 44,No.17,2019,p.20821-20826

La2O3, with a large ionic radius, strong polarisation and bonding strength, was used to obstruct mobile ion migration to reduce the dielectric loss of Li2O-Al2O3-SiO2 photostructurable glass. Results indicated that moderate La2O3 doping could effectively reduce the dielectric loss. When the dopant amount was 3%, the dielectric loss was reduced to a minimum of 4 x 10 exp(-3) with a dielectric constant of 6.6 at 1 GHz, and this sample also had the optimum dielectric-temperature stability. The effects of doping on the photosensitivity and crystallisation behaviour were also analysed and results suggested that La2O3 doping did not affect the photosensitivity and selective crystallisation characteristics. However, La2O3 restrained the precipitation of silicate from the [SiO4] tetrahedron, which resulted in a reduced nucleation rate and delayed crystallisation. 29 refs.

203565

PHYSICAL, STRUCTURAL, OPTICAL AND THERMOLUMINESCENCE BEHAVIOUR OF Dy2O3 DOPED SODIUM MAGNESIUM BOROSILICATE GLASSES

Kaur R; Bhatia V; Kumar D; Rao S M D; Singh S P; Kumar A - *Punjab,University; Taipei,Academia Sinica; Benra Dhuri,University College*

Result.Physics. 12,2019,p.827-839

Rare earth doped borosilicate glass materials of composition (60-x) B2O3-20 SiO2-10 Na2O-10 MgO-x Dy2O3 were prepared by melt quenching. XRD confirmed the amorphous nature of the glasses and FTIR spectra revealed the structure. The density, molar volume, average molecular weight, ion concentration, polaron radius and field strength were determined. The optical parameters, including optical band gap, refractive index, dielectric constant, optical dielectric constant, molar polarisability, reflection loss, molar refractivity, metallisation and Urbach energy were also calculated. The glow curve behaviour of all the glass samples irradiated with 50 Gy, 100 Gy, 500 Gy, 1 kGy, 5 kGy and 10 kGy gamma ray doses was investigated in the temperature range 50-400 C. The TL dose response showed that the sample with 0.6 mol% doping with Dy3+ was most suitable for dosimetric applications. 51 refs.

203566

SYNTHESIS, MECHANICAL AND OPTICAL FEATURES OF Dy2O3 DOPED LEAD ALKALI BOROSILICATE GLASSES

Shaaban Kh S; Ali A M; Saddeek Y B; Aly K A; Dahshan A; Amin S A - *Assiut,Al-Azhar University; Abha,King Khalid University; Jeddah,University; Port Said,University*

Silicon. 2018, doi.org/10.1007/s12633-018-0004-0, pp9

Characterisations of the pseudo penta-glass system 60 PbO-(40-x) SiO2-x (0.1 Li2O-0.86 B2O3-0.04 Dy2O3) with x = 0-30 mol% were performed using ultrasonic and spectroscopic techniques. The increase of (0.1 Li2O-0.86 B2O3-0.04 Dy2O3) content caused borate structural variations such as the transformation of [BO3] to [BO4] structural units and enhancement of the compactness of the glasses. These physical parameters played an important role in modifying the mechanical and the optical properties of the lead silicate glasses. The improvement of the mechanical properties was indicated from the increment of the density, ultrasonic velocities, elastic moduli (experimentally determined and theoretically computed) and the glass transition temperature. The borate structural variations and the presence of Dy2O3 decreased both the UV transmission and the optical energy gap, increased the refractive index and created several transitions at different wavelengths. 48 refs.

203567

DRIVING THE FUTURE OF TECHNOLOGY WITH GLASS

James W - *Schott North America Inc.*

Ceram.Ind. 168,No.12,2018,p.8-10

Some new applications of glass are discussed to provide insight into the current state of glass technology and prospects for the future. Float glass can be used for the channels in neutron guides for imaging applications and this can be improved by a method developed by SwissNeutronics to coat the float glass with multiple layers of nanothin reflective materials. The use of nano-coated super mirrors for neutron guides has resulted in a six-fold increase of available neutrons in one case study. Technical glass with highly specific optical properties will play a key role in the development of augmented reality glasses. Weight saving is of importance for this application. A recently developed ultrathin glass with a refractive index of up to 2.0 can be used to support the waveguides. A third application is the use of ultrathin glass licence plates for drones to provide labelling and registration. Such materials need to be able to withstand high temperatures. Roboterwerk have developed a glass-titanium-carbon compound suitable for drones which is lightweight, flexible and can withstand temperatures up to 870 C. Other applications briefly mentioned include glass-ceramics for space telescopes, optical glasses for the LIDAR systems of autonomous cars, fire-rated glass for buildings and speciality glass for the pharmaceutical industry to limit the risk of interaction between the drug and its container.

203568

SINTERING AND ROUNDING KINETICS OF IRREGULAR GLASS PARTICLES

Reis R M C V; Barbosa A J; Ghussn L; Ferreira E B; Prado M O; Zanotto E D - *Volta Redonda,Universidade Federal Fluminense; Sao Carlos,Federal University; Rio de Janeiro,Universidade Estadual; Sao Paulo,University; Comision Nacional de Energia Atomica*

J.Am.Ceram.Soc. 102,No.2,2019,p.845-854

Compacts of irregular glass particles sinter up to five times faster than spherical particle compacts of the same composition. This effect has been attributed to the sharp edges of irregular particles. A phenomenological model for the sintering kinetics of jagged glass particles considering their rounding during sintering is presented. It is assumed that the small radii of curvature of the particle edges increase as the particles round off and control the sintering rate. The model was tested by measuring the sintering shrinkage of spherical and irregular particle compacts of a diopside (MgO.CaO.2SiO2) glass and using literature sintering data for particles of different shapes of a soda-lime-silica glass. The sintering rate of irregular-particle compacts is initially much higher but tends to reach that of their spherical counterparts as they round off. The model describes the experimental shrinkage of both glasses and explains the shrinkage anisotropy of irregular-particle compacts in the initial stages of sintering, providing a significant step toward the understanding and description of the sintering kinetics of jagged glass particles. 27 refs.

203569

PHOTOLUMINESCENCE BEHAVIOUR OF MO3-B2O3-CeO2-Bi2O3 (M = Mo OR W) GLASSES AND THEIR COUNTERPARTS NANO-GLASS-CERAMICS

Abo-Naf S M; Abdel-Hameed S A M; Fayad A M; Marzouk M A; Hamdy Y M - *Cairo,National Research Centre*

Ceram.Int. 44,No.17,2019,p.21800-21809

8MO3-30B2O3-xCeO2-(62-x)Bi2O3 glasses (M = Mo or W and x = 2,5, and 8 mol%) were fabricated by the conventional melt-quench method. DTA was used to determine the peak crystallisation temperatures at which nano-crystallisation was achieved. The nano-glass-ceramics obtained included nanocrystallites of monoclinic bismuth molybdate (Bi2MoO6) and orthorhombic russellite (Bi2WO6) as major crystalline phases within the Mo- and W-containing glassy matrices, respectively. The morphology of these phases was investigated by HR-TEM which showed average crystallite sizes between 6 and 26 nm. The effect of CeO2 on the photoluminescence (PL) of the as-quenched glasses and their counterpart nano-glass-ceramics was studied. PL spectroscopy indicated that the glasses were pure red phosphors emitting red light at 600 and 610 nm after UV excitation at 300 nm where no blue emission band was resolved, neither due to Bi3+ ions or Ce3+ ions. This was attributed to the oxidising power of CeO2 in the glass system which produced more Bi2+ ions which emitted red light in conjugation with the deactivation effect of Ce3+ ions which suppressed the blue emission of Bi3+ ions. The nano-glass-ceramics had broad emission spectra which extended over a wide range in the visible region and consisted of prominent blue emissions with a minority of green and red emission bands under UV excitation at 254 and 280 nm. 29 refs.

203570

PREDICTING GLASS TRANSITION TEMPERATURES USING NEURAL NETWORKS

Cassar D R; de Carvalho A C P L F; Zanotto E D - *Sao Carlos,Federal University; Sao Paulo,University*

Acta Mater. 159,2018,p.249-256

An artificial neural network was designed to induce a model that could predict the glass transition temperature (Tg) of multicomponent oxide glasses using a dataset containing more than 55,000 inorganic glass compositions and their respective experimental values of Tg. The compositions contained from 3 to 21 of the 45 chemical elements studied. An optimisation procedure to find artificial neural network hyperparameter values that were able to induce a model with high predictive performance were implemented. The resulting neural network model correctly predicted with 95% accuracy the published Tg value within less than plus or minus 9% error, whereas 90% of the data were predicted with a relative deviation lower than plus or minus 6%. This level of uncertainty was equivalent to the level present in the original dataset and allowed a satisfactory description of the Tg for multicomponent oxide glasses containing combinations of the 45 studied chemical elements. The prediction uncertainty did not depend on the number of elements in the glass composition but it was larger for glasses with a very high Tg (above 1250 K). The most important aspect was the algorithm's ability to predict the Tg of glasses that were not included in the experimental dataset used for training, thus showing a high generalisation ability. The procedure used is general and could be extended to predict several other properties as a function of the glass composition. 67 refs.

203571

SIMULATION STUDY OF THE VERTICAL STIRRING EFFECT IN 600 t/d FLOAT GLASS FURNACE

Xing Z; Xu S; Jin D; Li Y; Liu S - *Qinhuangdao,Yanshan University*

Glass Technol. 59,No.6,2018,p.177-187

The homogeneity of the molten glass significantly affects the product quality in float glass production, as regions with slight compositional variations can have different refractive indices from the bulk glass. Stirring is an effective measure to improve the homogeneity of molten glass. The vertical stirring process in a float glass furnace was simulated and analysed using ANSYS Fluent 14.0 software. The particle track method was used to qualitatively describe the stirring effect, and the stretch rate was used to quantitatively evaluate it. The effect of stirring on the backward flow in the waist was studied. The relationship between the stirrer insertion depth and the optimal rotational speed was obtained. The particles had an S-shaped distribution after stirring. The rotation effect of the stirrer can bring the backward flow upward into the forward flow at a high rotational speed. The optimal rotational speed decreased with the insertion depth of the stirrer and showed a linear relationship. A physical simulation method was used to verify the correctness of the particle tracks obtained in the numerical simulation. The effective stirring depth was 0.5 m less than the stirrer insertion depth. In the study, the appropriate stirrer insertion depth was 0.17 m and the optimal rotational speed was 5.3 rpm. 20 refs.

203572

GLASS TRANSITION TEMPERATURE ITS EXPLOITATION AND NEW CONCEPTION OF FRAGILITY

Kozmidis-Petrovic A; Sestak J - *Novi Sad,University; Pilsen,West Bohemian University*

Phys.Chem.Glasses. 59,No.6,2018,p.259-266

Relationships between the magnitude of the change of the ratios of crystallisation and melting temperature with glass transition temperature, i.e. Tc/Tg and Tm/Tg, determine the order of the values of relative change of glass stability (GS) parameters dK(H)/K(H), dK(W)/K(W) and dK(LL)/K(LL). The linear correlation of new GS parameters F(K) and F(KA), which include fragility and reduced glass transition temperature, with logRc is a better correlation of K(LL). The stretching exponent increases as a linear function of T/Tg in the interval 1 less than or equal to T/Tg less than 1.1 for given values of the dynamic fragility parameter m. As a result, the kinetic term in fragility can be neglected. The thermodynamic term, which has a dominant role in fragility, can be determined by expressions for configurational entropy and configurational heat capacity. Sc(T), a function of temperature dependence of configurational entropy obtained by Sipp et al, was compared with ScVFT (T), a function proposed by Yue. Both Sc(T) and ScVFT(T) had the same temperature dependence and almost overlap. Therefore, both Sc(T) and ScVFT(T) gave the same value of fragility index. From the dependence of lnSc(T) versus lnT it is possible to successfully predict the relations between the values of m for different glass formers. 85 refs.

203573

STRUCTURAL ROLE OF ALUMINA IN ALKALI PHOSPHOSILICATE GLASSES: A MULTINUCLEAR SOLID STATE NMR STUDY

Nizamutdinova A; Kirchhain H; Van Wullen L; Sawangboon N; Brauer D S - *Augsburg,University; Jena,Friedrich-Schiller-Universitat*

Phys.Chem.Glasses. 59,No.6,2018,p.267-276

The structural role of aluminium incorporation into phosphosilicate glasses containing sixfold coordinate silicon and the evolution of the structure at high temperatures were studied. The organisation of the glass network was analysed by advanced NMR techniques (REDOR (rotational echo double

resonance) and REAPDOR (rotational echo adiabatic passage double resonance) NMR spectroscopy) enabling the structural motifs on short (1-2 Angstrom) and intermediate (2-5 Angstrom) length scales to be analysed, as well as by in-situ MAS spectroscopy using a novel high-temperature setup. The added Al competes with Si for connections to phosphate polyhedra. The total number of sixfold coordinate network former cations was found to correlate with the evolution of the glass transition temperature in the two glass series (60P2O5.30Na2O.10SiO2 and 50P2O5.17Na2O.33SiO2) studied. 64 refs.

203574

SPECTROSCOPIC AND CHROMATOGRAPHIC ANALYSES OF ZINC BOROPHOSPHATE GLASSES

Freudenberger P T; Brow R K - *Missouri,University of Science & Technology*

Phys.Chem.Glasses. 59,No.6,2018,p.277-284

Thirteen zinc borophosphate glasses with compositions defined by constant O/P ratios of 3.1, 3.4, and 3.7 were prepared, and their structures were characterised by Raman spectroscopy, high pressure liquid chromatography (HPLC) and 11B MAS NMR spectroscopy. The 11B MAS NMR spectra showed that boron was predominantly incorporated into the tetrahedral sites with four phosphate next-nearest neighbours, B(OP)4, although some of these tetrahedra appeared to have another borate unit as a next-nearest neighbour, B(OP)3(OB)1. HPLC and Raman spectroscopy showed that, as the O/P ratio increased, the phosphate anions became progressively smaller due to the formation of B-O-P bridges. The effects of composition on structure are discussed by considering the availability of oxygens on the phosphate anions to coordinate Zn- and B-polyhedra, and these structures were compared to those reported for zinc aluminophosphate glasses. 34 refs.

203575

GAMMA RAY SHIELDING PROPERTIES AT 129.5 MBq AND STRUCTURAL INVESTIGATIONS OF THE Bi2O3-B2O3-K2O-Li2O-V2O5 GLASS SYSTEM

Dogra M; Singh K J; Kaur K; Anand V - *Punjab,Guru Nanak Dev University*

Phys.Chem.Glasses. 59,No.6,2018,p.293-300

Glass samples of composition xBi2O3-(0.65-x)B2O3-0.15K2O-0.15Li2O-0.05V2O5 where x = 0-17 mol% were prepared by melt quenching and characterised by XRD, FTIR, Raman and UV-vis studies. Gamma ray shielding parameters were measured at low absorption doses (129.5 MBq). The mass attenuation coefficients were obtained experimentally and theoretically using NIST XCOM software at photon energies of 662, 1173 and 1332 keV. Experimental and theoretical values of mass attenuation coefficients were found to agree well. These coefficients were then used to calculate the half value layer parameter, mean free path and effective atomic number. The mass attenuation coefficients and half value layer parameters of the glass system were also compared with nuclear reactor shield "barite concrete". The bismuth-containing samples had better values than the barite concrete at the same photon energies. Conversion of [BO3] to [BO4] units along with [VO4] and [VO5] structural units was seen by FTIR spectroscopy. UV-vis studies were used to calculate the optical band gap using Tauc's plots. The optical band gap was seen to increase with increasing content of Bi2O3, which is an indication of an increase in bridging oxygens. Optical properties, including optical basicity, molar refraction, refractive index and optical electronegativity, were calculated and explained on the basis of structural changes occurring in the glass system. 38 refs.

203576

DISSOLUTION OF SODIUM SILICATE GLASSES FOR THE PRODUCTION OF WATER GLASS. PT.2. DEPENDENCE OF CORROSION PROCESS ON pH IN BASIC AQUEOUS MEDIA

Dathe M; Roggendorf H - *Halle-Wittenberg,Martin-Luther-Universitat*

Phys.Chem.Glasses. 59,No.6,2018,p.301-310

One basic process for the production of liquid sodium water glasses is the dissolution of sodium silicate glasses, which can be regarded as an extreme case of glass corrosion. Dissolution occurs at high pH values and achieves highly concentrated liquid sodium water glasses. The methods of glass corrosion studies were adapted and used to help to understand the dissolution process. The corrosion and dissolution of Na2O.xSiO2 glasses (x = 2.0, 2.5, and 3.3) was studied by static and dynamic corrosion tests at pH values between 7 and 14 using corrosion temperatures of 30 and 50 C. The investigated glass compositions were close to those used for water glass production. The corrosion of sodium silicate glasses generally follows linear time laws at short corrosion times. The release rates of Na2O and SiO2 were correlated with the glass composition and to the thermodynamics of glass hydrolysis. There were two distinct pH regimes. Between pH 7 and a certain pH value between 11 and 13 (depending on the glass composition and corrosion temperature) the corrosion rate increased slightly with pH and the glasses developed extensive reaction layers. In general, published corrosion models predict such a rate increase, but at a higher extent than observed here. Above a pH of 11 to 13 the corrosion rates declined with pH by a factor up to 100 and the glasses developed almost no reaction layer. A possible explanation of the rate decrease at higher pH is the shielding of the silicate surface by alkalis which increases with alkali concentration. The pH dependence of reaction layer formation is discussed in terms of solubility or diffusion through a boundary layer with pH and silica concentration gradients in the leachate near the glass surface. 23 refs.

Glass-ceramics

See also Abstract(s): 203567 203569 203628

203577

MICROSTRUCTURAL CHARACTERISATION AND WEAR PROPERTIES OF SILVER AND GOLD NANOPARTICLE DOPED K-Mg-Al-Si-O-F GLASS-CERAMICS

Garai M; Murthy T S R Ch; Karmakar B - *Indian Institute of Technology; Bhabha Atomic Research Centre; Homi Bhabha National Institute; Central Glass & Ceramic Research Institute*

Ceram.Int. 44,No.18,2018,p.22308-22317

In order to determine the effects of Ag and Au nanoparticles on the crystallisation of the boroaluminosilicate system, K2O-MgO-Al2O3-SiO2-B2O3-F glasses doped with and without 0.2 wt% Ag and Au were melt quenched at 1550 C. Doping with the nanoparticles considerably increased the glass transition temperature and softening point, but decreased the thermal expansion. A sharp crystallisation exotherm in DSC was seen at 750 plus or minus 1 C for glass without nanoparticles which broadened to 800-855 C when containing nanoparticles. Opaque glass-ceramics were derived from the glasses by controlled heat treatment at 1050 C with the predominant crystalline phase being fluorophlogopite (KMg3AlSi3O10F2) mica.

Traces of Ag and Au particles were also identified using XRD. The activation energy of crystallisation (344 plus or minus 17 kJ/mol) decreased to 233 plus or minus 12 and 307 plus or minus 15 kJ/mol (Kissinger method) on doping with Ag and Au nanoparticles, respectively. A compact microstructure (FESEM) composed of rock-like and plate-like mica crystals was developed in the base glass-ceramic which was restructured to interlocked type morphology in the presence of Ag nanoparticles. Significant microstructural changes induced by nanoparticle addition caused the decrease in microhardness (4.31-4.66 GPa) and increase in thermal expansion. Friction and wear testing under reciprocative sliding (using WC-Co ball) showed that the average coefficient of friction (COF) was 0.60 plus or minus 0.2 for all glass-ceramics at 20 N load and 10 Hz frequency. At the lower load of 5 N, the average COF value increased from 0.69 to 0.92 when using Au nanoparticles. A similar trend was also seen at 10 N load as the COF increased from 0.62 to 0.78. The increased thermal expansion material is suitable for solid oxide fuel cell sealing applications. 32 refs.

203578

SINTERING AND THERMOMECHANICAL BEHAVIOUR OF A LOW TEMPERATURE CO-FIRED CERAMIC

Heux A; Antou G; Pradeilles N; Delhote N; Karnfelt C; Gallee F; Maitre A - *Limoges,University; Brest,Ecole Mines-Telecom*

Ceram.Int. 44,No.18,2018,p.22609-22615

The thermoelastic, viscoplastic and sintering properties of a commercial LTCC (low temperature co-fired ceramic) belonging to the glass-ceramic system were characterised and correlated to its microstructure. The thermomechanical properties and the sintering behaviour of the LTCC were determined since these data are essential to build reliable numerical models of the co-sintering step of LTCC-based multi-material systems. The LTCC consisted of rhombohedral quartz and an amorphous phase composed of silicon, oxygen and some trace amounts of aluminium, carbon and potassium. The dependences of the elastic response vs. temperature and density were characterised by various techniques from nano- to macro-scales. A stable Young's modulus around 54.0 plus or minus 3.5 GPa was measured up to 500 C before a sharp fall. It was associated with the exceeding of the glass transition temperature (around 576 plus or minus 4 C). Based on constant heating rate and master sintering curve methodologies, it was shown that the apparent activation energy for free sintering was stable during the whole densification process, with an average value of approximately 291 plus or minus 11 kJ/mol. The uniaxial viscosity ranged from 0.1 to 2.0 GPa.s for relative densities between 0.56 and 0.92. The activation energy identified for viscous flow was similar to that for free sintering. A low and stable value of viscous Poisson's ratio was determined, with an average value around 0.14 plus or minus 0.01 during the initial and intermediate stages of sintering. 34 refs.

203579

STRUCTURAL AND PHOTOLUMINESCENCE INVESTIGATIONS OF Cr3+ MIXED Li2O-Bi2O3-ZrO2-SiO2 GLASS CERAMICS FOR OPTOELECTRONIC DEVICE APPLICATION

Ravi Kumar G; Rao M C - *Sreenidhi Institute of Science & Technology; Andhra Loyola College*

Optik. 181,2019,p.721-731

Chromium oxide mixed Li2O-Bi2O3-ZrO2-SiO2 (Cr3+:LBZS) glasses were crystallised by heat treatment to form Cr3+:LBZS glass ceramics. The structural properties were investigated using XRD, surface morphology, energy dispersion, DTA, FT-IR and Raman spectroscopy. The optical absorption and luminescence were also studied. XRD patterns of Cr3+: LBZS glass ceramic samples showed distinct crystalline peaks, and SEM images revealed well identified and distributed crystals of reformed size. The glass transition (Tg) and various crystallisation temperatures (Tc1), (Tc2) and (Tc3) were identified using DTA analysis. The shift in the wavenumbers of different symmetrical and asymmetrical band positions of the glass ceramics were analysed by FT-IR and Raman studies. The optical bandgap (Eo), CFSE (Dq) and nephelauxetic ratio were calculated, and the photoluminescence properties were also investigated. 28 refs.

203580

CLARIFYING THE MECHANISM OF FABRICATING TRANSPARENT POWDER SINTERED GLASS-CERAMICS

Kong Y; Liu S; Zhang Y; Shan Z; Tao H - *Jinan,Qilu University of Technology; Wuhan,University of Technology*

Phys.Chem.Glasses. 59,No.6,2018,p.285-292

Transparent glass-ceramics can be prepared by pressureless sintering in an air atmosphere using glass particles of irregular shape and with a wide size distribution. The effect of densification and crystallisation on the transparency of powder-sintered glass-ceramics was studied by non-isothermal sintering dynamic simulation and experimental micro-morphological observation. Over a range of particle sizes, the smaller glass particles with higher surface nucleation probability tended to preferentially cluster compared to the larger ones. This is favourable for complete densification prior to crystallisation, and hence relatively high transparency. There are two types of pores within the sintered glass-ceramics, i.e. large pores formed by viscous flow and fine pores formed by crystallisation, respectively. The latter type has a more profound impact on the reduction of transparency than the former. 26 refs.

Vitreous enamel

203581

INFLUENCE OF ADDITION OF HARD PARTICLES ON THE MECHANICAL AND CHEMICAL BEHAVIOUR OF VITREOUS ENAMEL

Rossi S; Calovi M; Velez D; Munoz J - *Trento,University; CIDETEC*

Surf.Coatings Technol. 357,2019,p.69-77

The good chemical resistance and corrosion protection properties of vitreous enamel coatings are due to the glassy nature of the deposits. Good wear behaviour is also necessary for some applications. The use of composite layers obtained by the addition of hard particles to the enamel could increase the hardness. There has been some research on the chemical nature of the added particles, but the effect of the dimension and quantity of these particles has not been well studied. An attempt was made to study composite enamel layers deposited on a low carbon steel substrate with the addition of Al2O3 (corundum) particles characterised by macro and micro dimensions with different concentrations (5, 10 and 20 wt%). After microstructural characterisation, the abrasion resistance behaviour was evaluated by the Taber test following ASTM C501 for 1500 cycles. Mass loss, gloss and roughness changes were determined. Electrochemical impedance spectroscopy measurements were used to evaluate the change in protection properties. The addition of micro dimension particles gave the best behaviour. Macro dimension particles reduced the abrasion resistance, probably due to the increase of porosity levels during firing. The corrosion protection properties were investigated by the Kesternich test (aggressive fog with the presence of SO2), simulating an industrial environment. In this case, the presence of the microparticles showed a limited resistance. The presence of the particles probably produced an increase of surface roughness and the presence of a higher quantity of particles in the surface, favouring the onset of enamel degradation with a loss of protection properties. When the quantity of particles was increased, a

reduction of chemical resistance was seen. 27 refs.

DOMESTIC CERAMICS

See also Abstract(s): 203548

203582

EFFECT OF BENTONITE ADDITION ON SOME PROPERTIES OF PORCELAIN

Zaidan S A; Abdull-Razzak S S - *Baghdad,University*

J.Eng. 25,No.1,2019,p.84-99

The effect of bentonite on the sintering and burning of porcelain was studied. The porcelain mixture consisted of the following Iraqi raw materials: 30 wt% kaolin, 30 wt% non-plastic clay (grog), 10% wt sodium feldspar, 10 wt% potassium feldspar and 20 wt% flint. The material was mechanically mixed and the powder was transferred to slurry by adding distilled water. Different weight percentages of sodium bentonite (0, 2.5, 5, 7.5 and 10 wt%) were then added. The samples were prepared using the solid casting method, and after the drying process, the samples were burned at 1100 C. XRD showed that bentonite reduced the crystallisation of the main ceramic phases (mullite, quartz), which stimulated the appearance of amorphous glass phases. The loss of mass on ignition increased with the addition of bentonite from 5.66 to 8.2%. There was also a great convergence between the granules of porcelain when adding bentonite and this increased the shrinkage of the dimensions from 9.33% to 12.37%. This led to an increase in the bulk density from 1.97 to 2.67 g/cm3 at a firing temperature of 1100 C, and the porosity decreased from 17.1 to 1.44%. The diametrical strength and flexural strength also increased with bentonite addition (14.88 to 34.46MPa, and 6.2 to 8.65 MPa), respectively. 17 refs.

203583

WILD CLAYS AND GLAZES

Bloomfield L

Ceram.Rev. No.294,2018,p.57-61

The work and methods of three recent ceramics graduates (Simon Kidd from Northern Ireland, Robert Hunter from Scotland and Natalia Kasprzycka from Poland) who use locally sourced clays and glaze materials for their pottery are discussed and illustrated. The materials used include Irish granite, peat or turf, olive wood ash, seaweed, sandstone, and Scottish, Welsh and French clays. Guidelines are given on the use of such materials and where to source them. 2 refs.

Glazes, colours and decoration

See also Abstract(s): 203533 203551 203583 203586 203587 203644

203584

GREEN CERAMIC PIGMENT BASED ON CHROMIUM RECOVERED FROM A PLATING WASTE

Gayo G X; Lavat A E - *Buenos Aires,Universidad Nacional del Centro*

Ceram.Int. 44,No.18,2018,p.22181-22188

The development of pigments with new formulae, departing from lower cost raw materials, is driven by the market growth and competitiveness required by the ceramics sector. The use of a residue from a metallurgical plant, containing a high amount of chromium (III), in ceramic glazes was studied. Cr_2O_3 was successfully separated from the chrome plating waste, resulting in a suitable ceramic pigment, based on this chromophore. The residue was washed followed by calcination at 1000 C prior to use as a pigment. The satisfactory purity of Cr_2O_3 recovered from waste was confirmed by XRF, XRD, DTA-TG, FTIR and SEM-EDX. The glazes, containing 5 wt% of recovered Cr_2O_3, were characterised using frits and transparent micronised glaze for single and double firing processes. The materials were characterised by XRD and FTIR, and the CIELab parameters determined. The resulting glazes containing the waste were within the range of typical pigments based on Cr_2O_3 in silicate and aluminate glazes for single firing, showing dark green hues compared with previous data obtained from commercial grade Cr(III) oxide. However the presence of small amounts of other chromophores in the waste modified the tonality, affecting the purity of the chroma by increasing the darkness. Leaching tests performed on the glazes suggested that Cr(III) was stable in the ceramic matrix. These results show that use in glazes for floor tiles and roofing tiles is a suitable process for the solidification and stabilisation of this waste. 27 refs.

203585

CADMIUM PIGMENTS IN CONSUMER PRODUCTS AND THEIR HEALTH RISKS

Turner A - *Plymouth,University*

Sci.Total Environ. 657,2019,p.1409-1418

Cadmium is a toxic heavy metal that has been increasingly regulated over the past few decades. The uses of Cd in consumer goods are reviewed, focusing on brightly coloured Cd sulphide and sulphoselenide pigments. Measurements of Cd in historical and contemporary products determined by XRF are reported. The principal current use of Cd pigments is in ceramic products where the metal is encapsulated and overglazed. Leaching tests on new and secondhand items of hollowware indicate compliance with respect to the current Cd limit of 300 microg/L, but that non-compliance could occur for items of earthenware or damaged articles, should a proposed limit of 5 microg/L be introduced. The greatest consumer risk identified is the use of Cd pigments in the enamels of decorated drinking glasses. Thus, while decor is restricted to the exterior, any enamel within the lip area is subject to attack from acidic beverages because the pigments are neither encapsulated nor overglazed. Glass bottles decorated with Cd-based enamel do not appear to represent a direct health hazard, but could contaminate recycled glass products. It is recommended that decorated glassware is better regulated and that old, brightly coloured toys are treated cautiously. 57 refs.

Tableware

See also Abstract(s): 203527 203529 203531 203585

203586

LEACHABLE LEAD AND CADMIUM IN MICROWAVE-HEATED CERAMIC CUPS: POSSIBLE HEALTH HAZARD TO HUMAN

Mandal P R; Das S - *Silchar,Assam Univeristy*

Environ.Sci.Pollut.Res. 25,No.29,2018,p.28954-28960

The leachability and health risks associated with consumption from glazed, colourful ceramic cups, containing lead and cadmium were studied. Both metals leached into the 2.5-min microwave-heated (convection mode, at 140 C) double-distilled water in concentrations above 0.5 mg/L, the permissible limits of leachable Pb and Cd in ceramic mugs set by United States Food and Drug Administration (US FDA). On average, significantly higher Pb leached in new cups (7.69 plus or minus 0.56 mg/L) compared to that in old cups (3.15 plus or minus 0.15 mg/L). Cd leached similarly in both old (1.97 plus or minus 0.14 mg/L) and new cups (1.57 plus or minus 0.005 mg/L). The chronic daily intake of Pb by children and adults, respectively, consuming from new cups were 1.3-5 and 1.28-6 times more than that from old cups. In both the cases, intake values far exceeded WHO reference dose of 0.0006 mg Pb/kg bw/day in children under 11 years and 0.0013 mg Pb/kg bw/day in adults. Such levels of Pb consumption in children might be predicted to be associated with decrement in IQ by at least 1 point and adverse effects in adults, especially women of childbearing age. The daily intake of Cd from these cups ranged from 0.002-0.049 mg/kg bw/day, which was also above the permissible limit. Consequently, high hazard quotient and hazard indexes (both > 1) were observed for these metals, which may impart individual as well as cumulative effects on health. Apart from other dietary as well as inhalation sources of contaminants (which were not studied here), regular consumption of beverages alone in glazed, ceramic cups increased chances of Pb- and Cd-related health risks to humans. 40 refs.

203587

ANALYSING THE EARLIEST CHINESE PROTO-PORCELAIN: STUDY ON THE MATERIALS FROM LIAOTIANJIANSHAN KILN SITES, DEHUA COUNTY, FUJIAN PROVINCE (CHINA)

Yu G; Jin Z; Chen L; Wang F; Wang X; Wu X; Fan A; Xia Q - *Anhui,University of Science & Technology of China; Dehua Ceramics Museum; Shaanxi,University of Science & Technology*

Ceram.Int. 44,No.17,2019,p.21648-21655

Proto-porcelain and stamped stoneware manufactured at the Liaotianjianshan kiln was analysed using XRF, EPMA-WDS and dilatometry. Results indicated that the two types of samples had similar body chemical characteristics and consistent firing temperature. The elemental composition of the kiln shards had low iron and calcium content, which was different from the materials from other areas. The samples had high calcium glazes and two different types of glaze recipes were studied that contained minor elements, which corresponded to the changes in the glaze colour. The glaze composition and colour reflected the advanced ability of the craftsman to control the glaze recipes. The ceramic properties and the technical maturity revealed that the manufacturing technology of proto-porcelain at the Liaotianjianshan sites was at the highest level in southern China during the Xia and Shang periods, and Quanzhou is thought to be one of the original production locations of proto-porcelain in China. 33 refs.

Sanitaryware

See also Abstract(s): 203529 203530 203534 203544

Tiles

See also Abstract(s): 203529 203532 203533 203534 203545 203546 203723 203726

203588

COLOUR MY GROUT

Simpson J

Tile Today. No.99,2018,p.32-34,36

Tiling grouts are now available in a wide range of colours and coloured grouts are becoming more popular, either to match the tile colour or to contrast with it. Some large format tiles are produced pre-scored to emphasise the grout lines, there is a growing trend for coloured grouts in glass and ceramic mosaic installations, and metallic and glitter effects are also being used. Grout products from Mapei, Laticrete, Davco, ACT Australia and Custom Building Products are described, which include features such as antimicrobial protection, mould resistance, stain resistance, acid resistance and colour consistency.

203589

DIGITAL GUIDE TO TILES AND TILING

Australian Tile Council

Tile Today. No.99,2018,p.42-43

The Australian Tile Council has created an online fully illustrated 130 page Tiles & Tiling Guide. It features the key ceramic products most commonly used and explains where and how they can be used, installed and maintained. Although not a standard, it does refer to the main local and national standards relating to tile production, installation and maintenance. Properties such as dimensions, mechanical properties, chemical properties, water absorption, fire rating, slip resistance and green credentials are included. Installation on walls and floors and in pools is covered, including details on grouting methods and adhesive selection. The document will be edited frequently to ensure that it is current.

203590

RHEOLOGICAL PROPERTIES OF WASTE WATER FROM THE CERAMIC TILE INDUSTRY TREATED WITH DIFFERENT COAGULANTS

El-Zahed E-S M; Amin Sh K; Abdel Salam N F; Barakat F I; Abadir M F - *Ramadan City,Higher Technological Institute; Giza,National Research Centre; Cairo,University*

Eur.J.Sci.Res. 148,No.1,2017,p143-154

The rheological properties of wastewater sludge emanating from a ceramic tiles factory were investigated using a Brookfield type rheometer. Three coagulants were used in different proportions: carboxymethyl cellulose, aluminium sulphate, and polyacrylamide. The effect of the coagulant type and percentage addition on the non-Newtonian behaviour of the suspension was studied. The results showed that adding 0.6 wt% aluminium

sulphate yielded the lowest viscosity among the chosen coagulants, reflecting positively on the power required to pump the waste sludge and move it to the filtration or sedimentation units. 17 refs.

203591

HI-TILE TECHNOLOGY MATERIALS BY EGE SERAMIK

Seramik Turk. No.54,2019,p.18-21

In English; Turkish - Tiles manufactured by Ege Seramik using Hi-Tile Technology with different surface effects are described. These include: Galaxy with a crystal shine effect; Indiana with deep ink effect application which makes it almost indistinguishable from marble; Jungle, a wood effect tile with a glossy effect ink; Peace with deep effect ink application and a micro-textured surface; Santorini, a mosaic look tile achieved with deep effect ink application; and Thassos which looks like a combination of mini mosaic pieces and uses a deep effect ink application.

203592

ECO-INNOVATION PRACTICES IN THE BRAZILIAN CERAMIC TILE INDUSTRY: THE CASE OF THE SANTA GERTRUDES AND CRICIUMA CLUSTERS

Vieira de Souza W J; Scur G; de Castro Hilsdorf W - *Sao Bernardo do Campo,Centro Universitario da FEI*

J.Clean.Prod. 199,2018,p.1007-1019

In the ceramic tile chain, several environmental impacts can be generated from the stage of raw material extraction to industrial processes, commercialisation, consumption, maintenance and final placement. The environmental impacts are mostly related to the incidence of atmospheric emissions (dust particles and gases), high energy consumption, the use of materials with toxic substances, the emission of pollutant liquids, the generation of solid waste and the inappropriate disposal of packaging and finished products. Ways in which practices of eco-innovation have been implemented by the ceramic tile producers of Santa Gertrudes, Sao Paulo State, and Criciuma, Santa Catarina State in Brazil, clusters that are responsible for approximately 80% of Brazilian production, are identified. The results show that most eco-innovations implemented are incremental and that process and product eco-innovations are consolidated in both clusters. The clusters face unexplored opportunities for structuring organisational actions that may help companies organise their efforts towards sustainability. Another finding is that eco-innovation deployment in Brazilian ceramic clusters is mainly driven by specific legislation (e.g., particulate matter emissions) and market requirements (e.g., retailer audits). 54 refs.

INTERMEDIATE PRODUCTS AND AUXILIARIES

See also Abstract(s): 203548 203557 203558 203560 203590 203594 203643 203684 203711 203726

203593

HIGHLY POROUS GRANULATED CORUNDUM FILLER OF ALUMINA-FOAM POLYSTYRENE MIXTURE. PT.5. EFFECT OF MOULDING MIXTURE FINENESS AND MOISTURE CONTENT ON FILLER GRANULATION CAPACITY AND PHYSICOTECHNICAL PROPERTIES

Sokov V N - *Moscow,State Construction University*

Refract.Ind.Ceram. 59,No.1,2018,p.54-58

It is established that there are three stages in moulding mixture pelletisation: nucleus formation, granule growth, and mass transfer between them. The addition of a surfactant improved the granulation capacity, reduced the moulding moisture content and increased the raw granule strength. The fineness of the starting material had a significant effect on the capillary reaction forces that are fundamental during moulding mixture pelletisation.

Binders

See also Abstract(s): 203700 203715

Fibres and whiskers

See also Abstract(s): 203655

RELATED TO PARTICULAR INDUSTRIES AND FIELDS OF USE

See also Abstract(s): 203689

203594

INFLUENCE OF ALKALINE OXIDE ON THE DEFORMATION OF CERAMIC SHELL MOULD AT HIGH TEMPERATURES DURING INVESTMENT CASTING

Wei Y; Lu Z; Guo X - *Beijing,Tsinghua University; Beijing,University of Chinese Academy of Sciences*

Ceram.Int. 44,No.17,2019,p.21197-21204

The effect of alkaline oxides, including Na2O and K2O, on the deformation of ceramic shell moulds was studied at high temperatures. Two groups of ceramic shell mould samples were prepared by impregnating them with a solution of NaOH and KOH with different concentrations. A systematic creep test was conducted under different compression loads at 2, 4 and 6 MPa using specially designed creep testing equipment between 1200 and 1350 C. The results were analysed based on the Norton-Bailey-Arrhenius (NBA) equation and the phase transformation and micromorphological evolution of different samples were analysed by XRD and SEM, respectively. Results showed that the activation energy of the ceramic shell mould used was about 198 kJ/mol below 1300 C, but it increased to 325 kJ/mol near 1350 C with a stress exponent of about 1.50 at all the temperatures. Adding Na2O and K2O reduced the activation energy at low temperature and increased it at high temperature. The stress exponent decreased to nearly 1.00 below 1300 C which indicated the dominance of an interfacial sliding mechanism, which then increased to 1.30-1.60 at 1350 C which suggested a combined creep mechanism. XRD and SEM results showed that during the creep process the temperature played an important role in changing the interfacial structure. 30 refs.

Automotive

See also Abstract(s): 203603 203704

203595

EFFECT OF CERAMIC COATED PISTONS ON THE PERFORMANCE OF A COMPRESSED NATURAL GAS ENGINE

Ali H L; Li F; Wang Z; Shuai S - *Beijing,Tsinghua University*

IOP Conf.Series Mater.Sci.Eng. 417,2018,Paper 012021,pp8

An internal combustion (IC) engine with ceramic wall coating is usually used to reduce the heat losses and is referred to as a low heat rejection (LHR) engine. While high fuel price and environmental hazards are of major concern, the LHR engine type is gaining importance due to its low emissions and efficient fuel consumption. A simulation study was conducted using commercial software (AVL Boost) to analyse the effect of thermal barrier coatings (TBCs) on the performance of a single cylinder, naturally aspirated, compressed natural gas (CNG) engine. The results were carried out on a conventional (uncoated) piston, as well as two different thermal barrier ceramic titanium dioxide (TiO2) and yttria-stabilised zirconia (YSZ) insulated pistons, which were coated with a thickness of 0.5 mm. The simulation results were validated against the experimental results. The insulated pistons results showed better performance at all operating conditions compared to the uncoated piston. The maximum exhaust gas temperature was increased by about 57.35 C. Improvements in indicated specific fuel consumption (ISFC) up to 9.1%, and maximum 9.78% improvement in indicated thermal efficiency (ITE) were predicted in the insulated pistons, as compared to the conventional piston. 14 refs.

Aerospace

See also Abstract(s): 203607

Iron and steelmaking

See also Abstract(s): 203594 203683 203688 203691 203692 203693 203694 203695 203696 203697

Chemical (including filtration)

See also Abstract(s): 203704

203596

SYNTHESIS OF Bi2O3/TiO2 NANOSTRUCTURED FILMS FOR PHOTOCATALYTIC APPLICATIONS

Correia F C; Calheiros M; Marques J; Ribeiro J M; Tavares C J - *Guimaraes,Minho University*

Ceram.Int. 44,No.18,2018,p.22638-22644

Bismuth oxide films with a dendritic growth of nanocone-like structures were deposited by reactive magnetron sputtering. The deposition of the Bi2O3 template layers used a vapour-liquid-solid mechanism in order to develop a 3D growth morphology with high surface area templates for photocatalytic applications for water and air decontamination. TiO2 photocatalytic thin films were deposited at a later stage onto the Bi2O3 layers. The obtained heterostructured films were characterised by SEM, XRD and AFM, and the photocatalytic efficiency was assessed using methylene blue dye as a testing pollutant under a UV-A illumination. The photocatalytic tests revealed that the Bi2O3 layers functionalised with TiO2 thin films were more efficient at degrading the pollutant, by a factor of 6, when compared with the individual layered films. 31 refs.

203597

PHOTOCHEMICALLY CATALYSED POLYMERISATION OF 3-TRIMETHOXYSILYLPROPYL METHACRYLATE CONTAINING SILVER, COPPER AND ZINC IONS

Makova V; Spina M; Mullerova J; Exnar P - *Liberec,Technical University*

Ceramics-Silikaty. 62,No.4,2018,p.325-331

Photocurable organic-inorganic monomers generate much research interest due to their unique properties, leading to a wide range of applications including electronics, energetics and medicine. One of them, 3-trimethoxysilylpropylmethacrylate (TMSPM), belongs to the class of monomers with a wide range of relatively good mechanical, chemical and physical properties. This monomer can be cured by different processes including heat treatment and light. The photochemically catalysed polymerisation of sol prepared from TMSPM hybrid monomer and titanium tetraisopropoxide containing silver, copper and zinc ions was tested with two commercially available photoinitiators, a Darocur 1173 and an Irgacure 819. The aim was to propose conditions for effective polymerisation leading to the maximal conversion of double bonds present in the organic part of the hybrid monomer and observe the potential effect of the ions. In particular, the copper ions by themselves and/or in combination with silver ions inside the hybrid matrix may affect the speed and conversion degree of the photochemically catalysed polymerisation processes. 38 refs.

203598

FABRICATION OF SUPER FLUX AND HIGH THERMAL SHOCK RESISTANCE CERAMIC MEMBRANE SUPPORT

Zhang W; Guan K; Liu D; Peng C; Wu J - *Guangzhou,South China University of Technology*

Ceram.Int. 44,No.17,2019,p.21221-21228

Porous fused silica ceramic supports were fabricated using hexagonal boron nitride as a sintering aid. Results showed that hexagonal boron nitride inhibited the crystallisation of the fused silica particles at high temperature and reduced the firing temperature. The obtained supports had an average pore size of 72 micron, an open porosity of 42%, a bending strength of 16.5 MPa, a Weibull modulus of 8.67 and a gas permeability of 4.23 x 10 exp(5) m3/(m2 h bar). The bending strength of the support remained at 16 MPa after 30 cold-hot cycles, which showed high thermal shock resistance. After corrosion in 20 vol% H2SO4 solution for 8 h, the weight and bending strength of the support were reduced by 0.6% and 24.32% respectively, showing good acid corrosion resistance. 23 refs.

203599

EFFECT OF SiO2 COATING ON ALUMINA MICROFILTRATION MEMBRANES ON FLUX PERFORMANCE IN MEMBRANE FOULING PROCESS

Lee J; Ha J-H; Song I-H; Park J-W - *Korea,Institute of Materials Science; Korea,University of Science & Technology; Nano Co.Ltd.*

J.Ceram.Soc.Jap. 127,No.1,2019,p.35-43

Inorganic surface modification was performed using a SiO2 sol-gel technique to mitigate the fouling of alumina microfiltration membranes. A positively charged alumina membrane was coated with SiO2 to generate a negative charge, and as a result, electrostatic repulsion prevented the serious adsorption (or deposition) of model foulants on the membrane. After the formation of the SiO2 layer, small changes in the surface morphology, pore size, and surface roughness were detected. As the pore size decreased, the pure water permeability gradually decreased. When the membrane fouling was accelerated with model foulants, the highest normalised flux level and the lowest flux decline ratio (%) were observed in the smallest SiO2-coated microfiltration membrane (0.1 M SiO2). The SiO2 coating contributed to the optimisation of the antifouling properties of the ceramic membranes, although the pore size was reduced. 30 refs.

203600

Nd2Sn2O7 NANOSTRUCTURES AS HIGHLY EFFICIENT VISIBLE LIGHT PHOTOCATALYST: GREEN SYNTHESIS USING POMEGRANATE JUICE AND CHARACTERISATION

Zinatloo-Ajabshir S; Morassaei M S; Salavati-Niasari M - *Bonab,University; Kashan,University*

J.Clean.Prod. 198,2018,p.11-18

Fabrication of lanthanide stannate structures has not been cheap or environmentally friendly due to the use of hazardous chemical compounds, or a complex preparation process, and so a non-hazardous and greener approach for their fabrication is of interest. Nanostructured Nd2Sn2O7, a highly efficient visible light driven photocatalyst, was synthesised through a new, low-temperature and facile route utilising pomegranate juice. This is thought to be the first attempt to exploit pomegranate juice as a novel and renewable fuel as well as a green capping agent to produce nanostructured Nd2Sn2O7. The as-fabricated nanostructured Nd2Sn2O7 was characterised by TEM, diffuse reflectance-UV-vis spectroscopy, XRD, EDS and FESEM. The results showed that optimisation of the preparation temperature as a key factor could be advantageous and effective to control the shape, purity and grain size of the Nd2Sn2O7. The photocatalytic efficiency of the nanostructured Nd2Sn2O7 produced with pomegranate juice at 500 C was examined by degrading eosin Y, eriochrome black T and methyl violet pollutants under visible illumination. 32 refs.

203601

SrFe2O4 NANOFERRITES AND SrFe2O4/GROUND EGGSHELL NANOCOMPOSITES: FAST AND EFFICIENT ADSORBENTS FOR DYES REMOVAL

Zafar M N; Amjad M; Tabassum M; Ahmad I; Zubair M - *Gujrat,University; Islamabad,Allama Iqbal Open University*

J.Clean.Prod. 199,2018,p.983-994

Nanomaterials are of interest for water pollution treatment due to their greater surface area and unique properties. A micro emulsion method was used to synthesise novel strontium nanoferrites, SrFe2O4 (SF), as efficient adsorbents for both anionic dye erichrome black T (EBT) and cationic dye methylene blue (MB). Eggshell powder (EgP) was used as a support or co-sorbent to produce another adsorbent (SF@EgP) by combining EgP and SF by the solvothermal method to further improve the efficiency of SF. The adsorbents were characterised by XRD and SEM, and SF was studied by impedance spectroscopy and electrochemical characterisation. The SF and SF@EgP were tuned for EBT and MB removal and were found to be novel and efficient adsorbents. Their adsorption efficiency was also compared with EgP. Using these model dyes, the effects of pH, adsorbent quantity, time and initial dye concentrations on adsorption were studied. The adsorption process of EBT and MB was examined by kinetics, isothermal and thermodynamics modelling which indicated that the removal of dyes was much faster with SF@EgP compared to EgP following pseudo second order, that it followed the Langmuir isotherm because of higher R2 and closeness between experimental/theoretical adsorption capacities, and that the adsorption was spontaneous and endothermic. The SF and SF@EgP were regenerated and recycled successfully, showing their reusability. These novel adsorbents are thus not only tunable and reusable for cationic and anionic dyes with fast adsorption, but also provide valuable information towards the synthesis and adsorption studies of other nanomaterials. 64 refs.

Engineering (including machining, tool tips and abrasives)

See also Abstract(s): 203720

203602

EFFECT OF NANO-SCALE TEXTURE PRETREATMENT ON WEAR RESISTANCE OF WC/Co TOOLS WITH/WITHOUT TiAlN COATED FLANK-FACE IN DRY TURNING OF GREEN Al2O3 CERAMICS

Liu Y; Deng J; Liu L; Wang W; Meng R; Duan R; Ge D; Li X - *Shandong,University; Henan,Institute of Technology*

Ceram.Int. 44,No.17,2019,p.21176-21187

During the dry turning of green ceramics, the flank-wear of tools and the processing quality of compacts were assessed to evaluate the cutting performance of tools. A polished tool, a tool with nano-scale textured flank-face, a tool with TiAlN coating deposited on polished flank-face and a tool with a TiAlN coating deposited on the nano-scale textured flank-face were prepared. The effect of the nano-scale texture pretreatment on the wear resistance of WC/Co tools with/without TiAlN coated flank-face was studied during the turning of green Al2O3 ceramics. Results showed that nano-scale textures on the flank-face had effects on the enhanced flank-wear resistance of the tools. The relevant mechanisms showed that the nano-scale textures exhibited “derivative cutting” to protect the unworn face from abrasion, and nano-scale textures pretreated on the flank-face enhanced the adhesion strength between coating and matrix. The tools developed could significantly improve the processing quality of the machined surfaces. 46 refs.

Energy applications

203603

ON-LINE LIFE CYCLE HEALTH ASSESSMENT FOR LITHIUM-ION BATTERY IN ELECTRIC VEHICLES

Liu D; Song Y; Li L; Liao H; Peng Y - *Harbin,Institute of Technology; Arkansas,University*

J.Clean.Prod. 199,2018,p.1050-1065

Lithium ion batteries are critical in many industrial applications, but in practice, their performance degrades over time. To maintain the battery performance and ensure their reliability, it is important to implement on-line life cycle health state assessments in a battery management system.

However, there are two major challenges in on-line battery actual capacity estimation: the on-line extraction of measurable degradation features; and the on-line mapping from the degradation feature space to the battery capacity space. A self-adaptive life-cycle health state assessment method based on the on-line measurable parameters of lithium ion batteries is proposed. Ten different degradation features are extracted from the voltage, electric current and critical time during operation, which are then fused to achieve a higher adaptability to complex operating conditions. The lithium ion battery health state is assessed with a mapping model that links the feature space to the capacity space. The model is trained by the least squares support vector machine method for less computational complexity. Experimental results based on the real battery testing data showed that the correlation between the degradation feature and the battery capacity was > 0.7 and the mean error of capacity estimation was < 0.05. For dynamic operation conditions, the mean error of capacity estimation was < 11 mAh. The adaptability and applicability of the proposed on-line life-cycle health state assessment approach is illustrated in various electric vehicle applications. 44 refs.

Nuclear including disposal of nuclear waste

See also Abstract(s): 203658 203660

203604

HYDROTHERMAL CORROSION BEHAVIOUR OF SiCf/SiC COMPOSITES CANDIDATE FOR PWR ACCIDENT TOLERANT FUEL CLADDING

Yang H; Li X; Liu C; Zhao Y; Chen B; Yang X; Cheng L; Zhang L - *Xian,Northwestern Polytechnical University*

Ceram.Int. 44,No.18,2018,p.22865-22873

The corrosion behaviour of multi-layer SiCf/SiC composite tubes in pressurised 360 C purified water was investigated for their application as candidate materials for accident tolerant fuel cladding in pressurised water reactors. The weight change and hoop strength of specimens, the micro-morphology, phase and micro-constitution of the corrosion layers were analysed and compared periodically over 30 days. The weight loss of samples in static water was severe and showed a linear trend. It was seen that the grain boundaries of the SiC dissolved preferentially and then exhibited typical columnar structure. The corrosion products SiCxOy and SiO2 were amorphous and readily dissolved into water, eventually leading to the mass loss of the samples. 42 refs.

203605

COMPARATIVE PERFORMANCE OF CEMENT AND METAKAOLIN BASED-GEOPOLYMER BLOCKS FOR STRONTIUM IMMOBILISATION

Tan Q; Li N; Xu Z; Chen X; Peng X; Shuai Q; Yao Z - *China,Southwest University of Science & Technology*

J.Ceram.Soc.Jap. 127,No.1,2019,p.44-49

The comparative performance of ordinary Portland cement and metakaolin-based geopolymer blocks for strontium immobilisation were investigated. The geopolymer solidified blocks had better leaching resistance in deionised water, sulphuric acid, magnesium sulphuric and acetic acid buffer solutions than the cemented blocks. The geopolymer solidified blocks also had lower compressive strength loss after freeze-thaw cycles and high-temperature tests. The more dense and compact structure of the geopolymer specimens was more beneficial for the retention of the strontium radionuclide. Most of the strontium radionuclide within the geopolymer and cement solidified blocks could be incorporated into the amorphous gels. It was concluded that the metakaolin based-geopolymer matrix had better solidification performance and appeared to be more suitable for radioactive waste immobilisation. 51 refs.

APPLICATIONS

Adhesives and sealants

See also Abstract(s): 203577

Films and coatings

203606

SUPERSONIC ATMOSPHERIC PLASMA SPRAYED ZrO2 AND ZrB2-SiC/ZrO2 COATINGS ON Cf/Mg COMPOSITES FOR ANTICORROSION

Shi X-H; Yang L; Qi L-H; Yan N-N; Wang C-C; Zhang H-R - *Xian,Northwestern Polytechnical University*

Ceram.Int. 44,No.18,2018,p.22318-22328

There is increasing interest in the use of carbon fibre reinforced magnesium matrix (Cf/Mg) composites as structural materials for applications in the aerospace and automotive industries. ZrO2 and ZrB2-SiC/ZrO2 composite coatings were prepared by supersonic atmospheric plasma spraying (SAPS) on Cf/Mg composites in order to improve their corrosion resistance. The microstructure and phase composition of the coatings before and after corrosion tests were investigated. Open circuit potential and potentiodynamic polarisation tests were conducted at room temperature. The results showed that the corrosion current density of the ZrO2 coated Cf/Mg composites decreased by one order, while that of the ZrB2-SiC/ZrO2 coated composites reduced by two orders. Compared with Cf/Mg composites, the corrosion potential of the ZrO2 and ZrB2-SiC/ZrO2 coated Cf/Mg composites increased by 220.5 mV and 1021.8 mV respectively, indicating that the ZrB2-SiC/ZrO2 composite coatings greatly improved the corrosion resistance. The uniform distribution of the SiC particles with small grain size in ZrB2 was responsible for the densification of the coating. The ZrB2-SiC/ZrO2 composite coatings provided a barrier for the substrate to impede the entry of Cl- in the corrosion solution, and so provided better corrosion resistance than the ZrO2 coating. 37 refs.

203607

HIGH-TEMPERATURE INTERACTIONS OF DESERT SAND CMAS GLASS WITH YTTRIUM DISILICATE ENVIRONMENTAL BARRIER COATING MATERIAL

Wiesner V L; Harder B J; Bansal N P - *NASA,Glenn Research Center*

Ceram.Int. 44,No.18,2018,p.22738-22743

Yttrium disilicate (Y2Si2O7) is an environmental barrier coating (EBC) candidate material for the protection of the underlying ceramic matrix composites in gas turbine engines. EBCs are susceptible to environmental degradation caused when aircraft engines ingest siliceous particles which can infiltrate parts of the turbine engine. A calcium-magnesium aluminosilicate (CMAS) glass was prepared by melting a sample of desert sand to evaluate the high-temperature interactions between molten CMAS and Y2Si2O7. Cold-pressed pellets of 80 wt% Y2Si2O7 powder and 20

wt% CMAS glass powder were heat treated at 1200, 1300, 1400 and 1500 C for 20 h in air. The resulting phases were evaluated using powder XRD. In a second set of experiments, free standing hot-pressed Y2Si2O7 substrates with cylindrical wells were filled with CMAS powder to a loading of about 35 mg/cm2 and heat treated in air at 1200, 1300, 1400 and 1500 C for 20 h. SEM, EDS and EMPA were used to evaluate the microstructure and phase compositions of specimens after heat treatment. An oxyapatite silicate (Ca2Y8(SiO4)6O2) phase was identified in all specimens after CMAS exposure, regardless of heat treatment temperature. Apatite appeared to form by dissolution of Y2Si2O7 into molten CMAS, reacting with CaO in the melt according to the reaction 4Y2Si2O7 + 2CaO to Ca2Y8(SiO4)6O2 + 2SiO2, and followed by precipitation of the apatite phase. 26 refs.

203608

INFLUENCE OF COMPOSITION ON MOLTEN SULPHATE-VANADATE SALT CORROSION RESISTANCE OF LANTHANUM ZIRCONATE COATINGS

Zhu C; Yang L; Zhang C; Yang G; Chen H; Li Q; Li F; Gao Y; Liu B - *Shanghai,University; China Academy of Engineering Physics*

Ceram.Int. 44,No.18,2018,p.22911-22918

Three lanthanum zirconate (LZO) thermal barrier coatings with different La/Zr ratios (0.7:1 (LZO-7), 1:1 (LZO-10), and 2:1 (LZO-20)), were fabricated by laser enhanced CVD. Their corrosion resistance in 40 wt% V2O5 + 60 wt% Na2SO4 mixture was studied at 900 C. The reaction between the LZO coatings and NaVO3 produced LaVO4 and ZrO2, which formed a layer which prevented deeper penetration of the corrosive sulphate-vanadate molten salt. No severe transverse cracks were found in any of the coatings due to the columnar crystalline microstructures. LZO-20 showed better corrosion resistance than the others due to the decreased concentration of corrosive molten salts at the contacting interface, which was attributed to the fact that the excess lanthanum consumed maximum NaVO3. Correspondingly, the LaVO4/ZrO2 ratios rose with the increase of lanthanum content. These results indicated the key role of the lanthanum content on the corrosion resistance of the sulphate-vanadate molten salt and are expected to help optimise future thermal barrier coating design by tailoring the composition. 49 refs.

203609

HOT CORROSION BEHAVIOUR OF PLASMA SPRAYED 8YSZ-ALUMINA- CNT COMPOSITE COATING IN Na2SO4-60% V2O5 MOLTEN SALT ENVIRONMENT

Thakare J G; Mulik R S; Mahapatra M M; Upadhyaya R - *Indian Institute of Technology; Metallizing Equipment Co. Pvt. Ltd*

Ceram.Int. 44,No.17,2019,p.21533-21545

The hot corrosion (HC) behaviour of air plasma sprayed 8% yttria stabilised zirconia (8YSZ) -alumina (YA) composite thermal barrier coatings containing 1%, 3% multiwall carbon nanotube (MCNT) was evaluated. One coating was obtained without any MCNT reinforcement. Creep strength enhanced ferritic P91 steel was used as the substrate material for the coatings. Na2SO4 and V2O5 salts mixed in 2:3 ratio were applied to the coatings and subjected to 800 C for 120 h in an electric furnace. The microstructure and phase characterisation of the coatings was carried out before and after HC using SEM and XRD respectively and EDS/SEM was used for elemental analysis of the coatings. Results showed improved isothermal HC behaviour of the 1% MCNT reinforced coating. The dominant effect of the HC was the depletion of yttria which led to the destabilisation of 8YSZ. The formation of YVO4 corrosion product contained the depleted Y2O3 of YSZ. The 1% and 3% MCNT reinforced coatings had a monoclinic phase content of about 9% and 34% respectively. Nanoindentation was carried out along the cross-section before and after isothermal HC. The Young's modulus after HC increased by 46%, 42%, 12.5% and 38% for 8Y, 8YA, 8YA1C and 8YA3C coatings, respectively, and the Weibull modulus of the Young's modulus of the bond coats was used to identify the efficiency of the top coat in retarding the infiltration of molten salt. The bond coat of the 8YA1C coating had the lowest modulus value (m = 8.55) which indicated the non-uniform infiltration of detrimental species. The 1% MCNT reinforced thermal barrier coating (TBC) system was more resistant to degradation than the conventional 8YSZ and YA composite coatings. 51 refs.

203610

INFLUENCE OF PORES ON MECHANICAL PROPERTIES OF PLASMA SPRAYED COATINGS: CASE STUDY OF YSZ THERMAL BARRIER COATINGS

Qiao X; Wang Y M; Weng W X; Liu B L; Li Q - *Fuzhou,University*

Ceram.Int. 44,No.17,2019,p.21564-21577

The effect of pores on the mechanical properties of 8 wt% Y2O3-stabilised ZrO2 (8YSZ) plasma-sprayed coatings was investigated. The internal microstructure of the 8YSZ coatings was analysed using image processing technology combined with fractal theory and their mechanical properties were indentation tested. The stress distribution in three models with different microstructures was analysed by the finite element method. The 8YSZ coatings had a layered structure and contained microscopic defects including microcracks and pores. The pore size distribution of the 8YSZ coatings obeyed a logarithmic normal distribution and the pore diameter inside the coatings was concentrated between 1 and 10 micron. Increased high-temperature thermal exposure reduced the average pore diameter from 9.30 to 5.96 micron and the porosity of the ceramic top coat was reduced from 9.38 to 5.79%. Fractal characterisation results showed that after a certain period of thermal exposure, the ceramic top coat was densified and the internal pore structure was regularised when the fractal dimension decreased from the initial value of D1 = 1.26 to the D6 = 1.12 after 200 h. Indentation results showed that after 200 h of high temperature thermal exposure, the hardness of the 8YSZ coatings increased from 2.52 to 3.12 GPa, and the elastic modulus increased from 32.3 to 43.6 GPa. Finite element analysis showed that the complex pore structure inside the coating led to stress concentration which affected the mechanical properties of the 8YSZ coatings. 35 refs.

203611

CORROSION PROTECTION OF CARBON STEEL BY ALUMINA-TITANIA CERAMIC COATINGS USED FOR INDUSTRIAL APPLICATIONS

Pinzon A V; Urrego K J; Gonzalez-Hernandez A; Ortiz M R; Galvis F V - *Bucaramanga,Santander Industrial University; Medellin,Universidad de Antioquia*

Ceram.Int. 44,No.17,2019,p.21765-21773

Alumina ceramic coatings, containing 14 and 48 wt% TiO2, were thermally sprayed on carbon steel substrates by oxy-fuel using a neutral and oxidising flame. The permeation of aggressive ions into these coatings was evaluated at different times and their protective behaviour was compared with hard chromium coatings. Results showed that, in the first 24 h, the hard chromium coating was the most protective. However, its ability to protect the substrate substantially decreased after 7 days. Moderate performance was observed after 24 h for the alumina-14 wt% TiO2 coatings that were manufactured using the oxidising flame, but after 7 days of exposure, these coatings displayed protective properties that

exceeded those achieved by the hard chromium coating at 24 h. The other alumina-titania coatings behaved relatively weakly due to the ease with which the aggressive ions permeated through the pores and cracks of each coating. 49 refs.

203612

ROLES OF COMPOSITION AND TEMPERATURE IN SILICATE DEPOSIT-INDUCED RECESSION OF YTTRIUM DISILICATE

Summers W D; Poerschke D L; Park D; Shaw J H; Zok F W; Levi C G - *California,University at Santa Barbara*

Acta Mater. 160,2018,p.34-46

Reactions between silicate deposits and environmental barrier coatings (EBCs) for SiC/SiC composites can degrade the coating performance. The effects of the deposit composition and exposure temperature and time on the recession of yttrium disilicate (YDS) were investigated. Phase equilibrium calculations were used to predict the reactions of YDS with deposits of twelve different compositions at 1300 C and 1400 C. Experimental observations were reported for three compositions at both temperatures and compared with the thermodynamic predictions. For initial deposit thicknesses of about 100 micron, recession depths reached terminal values after exposures of about 100 h. Terminal recession depths were sensitive to the deposit composition but were only weakly affected by temperature. Deposits with high initial Ca:Si ratios reacted severely with YDS and formed thick layers containing apatite interpenetrated by residual melt, whereas reactions with deposits that had Ca:Si ratios below a threshold for apatite formation were more benign, albeit still significant. 52 refs.

203613

INVESTIGATION OF THE FORMATION OF A FINE-CRYSTALLINE ALUMINA COATING ON THE SURFACE OF A BLANK ALUMINIUM POWDER COATING TEST PANEL AS A RESULT OF ITS FILTRATION COMBUSTION

Ivanov D A; Sitnikov A I; Val'yano G E; Shlyapin S D - *Moscow,Aviation Institute; Moscow,Joint Institute of High Temperatures; Baikov A.A.,Institute of Metallurgy & Materials Science*

Refract.Ind.Ceram. 59,No.1,2018,p.42-47

The formation of a fine-crystalline alpha-Al2O3 coating on the surface of an aluminium blank powder coating test panel by filtration combustion (FC) in air was investigated. Finely ground sodium silicate glass (1 vol%) introduced into the composition of the blank aluminium panels was used as the activating agent of the filtration combustion. It was found that a fine crystalline aluminium oxide coating with a thickness of 30-50 micron with crystals ranging 0.1-2.0 micron in size formed over the entire surface of the sample upon completion of the filtration combustion. The samples showed a density of 2.3 g/cm2, open porosity of 15%, ultimate bending stress of 120 MPa, fracture toughness of 3.6 MPa.m1/2, and Brinell hardness of 32. 14 refs.

Electrical applications

See also Abstract(s): 203564 203578 203603 203715

203614

NONDESTRUCTIVE TESTING OF THE PHYSICOMECHANICAL PROPERTIES OF ZINC-OXIDE VARISTORS PROPOSED BY DIFFERENT MANUFACTURERS

Kovarskaya E Z; Krasavina M A; Krasnov A V; Pugachev S I; Shadrina M S - *Zvuk LLC; St.Petersburg,CJSC Plant of Energy-Protective Devices; St.Petersburg,Marine Underwater Weapons-Gidropribor Concern*

Refract.Ind.Ceram. 59,No.1,2018,p.59-62

Non-destructive acousting testing was used to study the physicomechanical properties of zinc oxide ceramic varistors produced by the leading firms, such as ABB and Epcos, and the St. Petersburg Plant of Energy-Protective Devices. The impact of the results on the properties of disk-shaped varistors with various diameter-to-height ratios was studied. The results showed that the range of particle dimensions of the powders used for the formation of varistors affected their physicomechanical properties. 5 refs.

203615

SMART MATERIALS MAKE SMARTPHONES. HOW CERAMICS AND GLASS CONTRIBUTE TO THE $479B SMARTPHONE MARKET

Gocha A

Am.Ceram.Soc.Bull. 97,No.9,2018,p.11-23

The market for smartphones is reviewed. Since 2007 when the Apple iPhone was released, sales have risen from 122 million per year to > 1.5 billion in 2017. However, with market saturation approaching 80% in developed countries, annual increases have shown more modest growth recently and with increasing cost, users are replacing their phones less frequently. Future growth is thus driven by developing countries, such as India, China, Pakistan, Indonesia and Bangladesh, and by innovative technological advances. Such advances include artificial intelligence, augmented reality/virtual reality, 5G functionalities and improvements in speed, power and battery life. Ceramics and glasses serve multiple functions in smartphones - structural, display, electronics, and sensors - and make up about 15% of the phone. Examples of use include: ITO layers to enable touchscreen functionality; piezoceramics to provide antennas, inductors, and other RF components that allow the device to send and receive signals from cell towers and connect to wireless networks, and piezoceramics also enable timers, acoustic elements, actuators, and sensors; quartz crystals within the GPS; and casing materials. Ceramics also assist in manufacturing processes which contribute to smartphone components, such as cutting tools and wear resistant parts, and serve as substrates for various components, which enable further miniaturisation. The role of ceramics in the semiconductor industry is also discussed. Companies supplying ceramics and glasses for smartphones are listed. Developments in OLED displays, which will provide higher image and colour quality and, when sandwiched between multilayer encapsulation films can be flexible, are also discussed. Flexible glass is another option for display substrates and gives rise to the possibility of foldable phones. Ceramics and glass contribute greatly to the miniaturisation and integration necessary for smartphones and the materials will continue to rise to the challenge to enable the devices of tomorrow. 41 refs.

Optical, photographic and scientific equipment

See also Abstract(s): 203563 203565 203567 203579 203615 203650 203652

203616

SYNTHESIS AND PHOTOLUMINESCENT PROPERTIES OF HIGH-EFFICIENT COLOUR-TUNABLE Ba3Y2B6O15: Ce3+, Tb3+ PHOSPHORS

Pan J; Guo Z; Zhu Z; Sun Z; Zhang T; Zhang J; Zhang X - *Guangzhou,Southern Medical University; Changsha,Hunan Normal University*

Ceram.Int. 44,No.17,2019,p.20732-20738

Highly-efficient Ce3+/Tb3+ co-doped Ba3Y2B6O15 phosphors, with multicolour-emission, were prepared and their structural and luminescent properties were studied using XRD Rietveld refinement, emission/excitation spectra, fluorescence lifetime and temperature-variable emission spectra. Upon 365 nm excitation, the characteristic blue Ce3+ band and the green Tb3+ peaks were simultaneously found in the emission spectra. By increasing the Tb3+ concentration, a blue-to-green tunable emitting colour could be realised due to Ce3+ to Tb3+ energy transfer. Also, all the Ba3Y2B6O15: Ce3+, Tb3+ phosphors had a high internal quantum efficiency of about 90%, while the temperature-variable emission spectra revealed that the phosphors had colour stability and good thermal stability (T50 = about 120 C). Results indicated that the efficient colour-tuning Ba3Y2B6O15: Ce3+, Tb3+ phosphors could be candidates for UV-excited light-emitting diodes. 21 refs.

203617

DEVELOPMENT OF LIQUID SCINTILLATORS LOADED WITH ALKALINE EARTH MOLYBDATE NANOPARTICLES FOR DETECTION OF NEUTRINOLESS DOUBLE-BETA DECAY

Arai S; Noguchi T; Aida T; Yoko A; Tomai T; Adschiri T; Koshimizu M; Fujimoto Y; Asai K - *Tohoku,University*

J.Ceram.Soc.Jap. 127,No.1,2019,p.28-34

Transparent liquid scintillators were prepared using surface-modified nanoparticles and 100Mo as the isotope. AMoO4 alkaline earth molybdates (A = Ca, Sr, and Ba) were synthesised by a subcritical hydrothermal method so that they were well dispersed in the organic solvents. The crystalline phase of the nanoparticles was confirmed by XRD, and TEM showed that the particle size of the SrMoO4 nanoparticles was the smallest. The SrMoO4 nanoparticles were incorporated in liquid scintillators which resulted in high transparency and efficient scintillation. 24 refs.

Insulation (non-electrical)

See also Abstract(s): 203643

203618

AEROBRICK: INSULATING WITH MICROSCOPIC BUBBLES

EMPA

Ceram.Forum Int./Ber.DKG. 95,No.11/12,2018,p.E39

A new type of brick, an aerobrick which is filled with aerogel, could make thin and highly insulating walls possible without any additional insulation layer. Empa researchers have now replaced perlite in insulating bricks with aerogel, a highly porous solid with very high thermal insulation properties that can withstand temperatures of up to 300 C. With a measured thermal conductivity of 59 mW/m2.K, the aerobrick is currently the best insulating brick available. To achieve the same insulation values as a 165 mm thick wall of aerobricks, a wall of perlite bricks would need to be 263 mm thick and an uninsulated wall would be 1240 mm. At present, the filling material in aerobricks is too expensive, but it is assumed that costs will fall.

Building parts, structures, flooring and roofing

See also Abstract(s): 203528 203543 203551 203554 203556 203588 203618 203644

203619

DESIGN OF REINFORCED CONCRETE ENCLOSURES INFILLED WITH CLAY BLOCK MASONRY. PT.2

Butenweg C; Marinkovic M; Kubalski T; Fehling E; Pfetzing T; Meyer U - *SDA-engineering GmbH; Belgrade,University; Aachen,RWTH University; Kassel,University; Arbeitsgemeinschaft Mauerziegel eV*

ZI Int. 71,No.6,2018,p.36-43

In English; German - Within the scope of the joint European project INSYSME (Innovative Systems for Earthquake Resistant Masonry Enclosures in Reinforced Concrete Buildings), the German partners developed two systems - IMES (Infill Masonry Enclosure System) and INODIS (Innovative Decoupled Infill System) - to improve the seismic behaviour of masonry infilled reinforced concrete frames. The purpose of both systems was to decouple the frame and infill instead of working to improve their load-bearing capacity by means of elaborate, expensive, supplementary reinforcing elements. Initial findings for the IMES system with regard to the loads acting in-plane and perpendicular to the wall plane (out-of-plane) are presented. Numerical models used and test results and simulations for reinforced concrete frames either unfilled, with infill, or with infills and decoupling elements are discussed. 19 refs.

203620

RISING TO THE CHALLENGE. DELIVERING A COMPLEX FACADE SOLUTION

Yu H; Tan H; Rochereau F; Jin S; Leduc N - *RFR*

Asian Glass. AG 18-5,2018,p.54-56,58,60,62,64,66

The Chaoyang Park Plaza Tower in Beijing has one of the most complex double curved facade systems anywhere in the world. The design and construction of the facade, by MAD Architects, is described. The system consists of cylindrical facades and twisted roof strips and the design was integrated with fully automated manufacture with the complex three-dimensional geometry of each glass component being achieved by 3D BIM digital manufacturing techniques. The components were then assembled with a small amount of cold bending in the factory and installed on site.

Medical, dental and veterinary application

203621

CALCIUM PHOSPHATES OF BIOLOGICAL IMPORTANCE BASED COATINGS DEPOSITED ON Ti-15Mo ALLOY MODIFIED BY LASER BEAM IRRADIATION FOR DENTAL AND ORTHOPAEDIC APPLICATIONS

dos Santos M L; dos Santos Riccardi C; de Almeida Filho E; Guastaldi A C - *Sao Paulo,Universidade Anhanguera-UNIAN; Sao Paulo,State University*

Ceram.Int. 44,No.18,2018,p.22432-22438

Ti-15Mo alloy samples were irradiated by pulsed Yb:YAG pulsed laser beam under air and atmospheric pressure, and then calcium phosphate coatings were deposited on the irradiated surfaces by the biomimetic method. The formation of calcium phosphates (CaP) under biological medium and SBF occurred in the presence of Ca2+ and PO4(3-) ions, as well as ions such as Mg2+, HCO3(-), K+ and Na+, which facilitated the mimicking of the biological process. The biomimetic CaP-based surfaces were heat treated at 350 and 600 C. Four conditions of fluency (1.91, 3.17, 4.16 and 5.54 J/cm2) were found to have sufficient energy to promote ablation on the laser beam irradiated surfaces. It was shown that the processes of fusion and fast solidification from the laser beam irradiation, under ambient atmosphere, induced the formation of stoichiometric (TiO2) and non-stoichiometric (TiO, Ti3O, Ti3O5 and Ti6O) titanium oxides with different oxide percentages depending on the fluency applied. Laser modification enabled a clean and reproducible process, providing no traces of contamination, an important feature for clinical applications. Morphological and physico-chemical analysis indicated the formation of multiphase coatings depending on the heat treatment temperature used (350 C - ACP1-2, CDHA, HA phases and 600 C - CDHA, HA and beta-TCP phases). Multiphasic bioceramic systems have been gaining interest for biomedical applications. The laser beam irradiation method for CaP bioactive coatings of biological interest is promising and economically feasible for use in clinical applications. 35 refs.

203622

DEVELOPMENT AND IN VIVO RESPONSE OF HYDROXYAPATITE/WHITLOCKITE FROM CHICKEN BONES AS BONE SUBSTITUTE USING A CHITOSAN MEMBRANE FOR GUIDED BONE REGENERATION

Luna-Dominguez J H; Tellez-Jimenez H; Hernandez-Cocoletzi H; Garcia-Hernandez M; Melo-Banda J A; Nygren H - *Tamaulipas,Universidad Autonoma; Puebla,Benemerita Universidad Autonoma; Madero,Instituto Tecnologico; Gothenburg,University*

Ceram.Int. 44,No.18,2018,p.22583-22591

Biomaterials which can stimulate bone tissue formation are important in orthopaedics and dentistry. Chitosan and a biphasic, non-cytotoxic material, hydroxyapatite/whitlockite (HAp/WH), were obtained from natural sources, available as organic waste. The HAp/WH was obtained from chicken bones and the chitosan from waste shrimp skeletons. The osteogenic activity was assessed using a rabbit model animal with a chitosan barrier membrane combined with a bone-filling graft substitute composed of HAp/WH. FTIR showed the typical absorption bands of the chitosan and hydroxyapatite. XRD patterns revealed a typical hexagonal phase of hydroxyapatite and rhombohedral structures related to whitlockite. Masson's trichrome stain showed an early formation of mineralised extracellular matrix, in agreement with the surface morphology of a cortical mature bond observed by SEM. The immunocytochemistry results showed a significant increase of positive immunoreactive cells to osteonectin in the treated defects compared with the control defects 6 and 8 weeks postoperatively. The results confirmed that this low-cost and versatile biomaterial could be used as a barrier membrane and a bone substitute graft in guided bone regeneration treatments in biomedical areas, specifically in dentistry. 55 refs.

203623

SYNTHESIS AND CHARACTERISATION OF Sr AND Mg-DOPED HYDROXYAPATITE BY A SIMPLE PRECIPITATION METHOD

Nagyne-Kovacs T; Studnicka L; Kincses A; Spengler G; Molnar M; Tolner M; Lukacs I E; Szilagyi I M; Pokol G - *Budapest,University of Technology & Economics; Szeged,University; Budapest,Res.Inst.for Technical Physics & Materials Science; Budapest,Research Centre for Natural Sciences*

Ceram.Int. 44,No.18,2018,p.22976-22982

Pure, Sr and Mg-doped hydroxyapatite (HAP) was prepared by precipitation. Sr-doped HAPs (SrHAPs) and Mg-doped HAPs (MgHAPs) were fabricated with a Sr molar ratio of 2, 4, 6, 8 and 12% and Mg molar ratio of 2 and 4%, respectively. Ca(NO3)2, Sr(NO3)2, Mg(NO3)2, (NH4)2HPO4 were used as the starting materials. The Ca/P molar ratio was maintained at 1.67 during each synthesis and heat treatment was conducted at 900 C to enhance the crystallinity. All the products were analysed by XRD, SEM and EDX, and lattice parameter and crystallite size calculations were performed to demonstrate the ion incorporation into the crystal structure. The HAP structure was maintained when 2 and 4 Sr and 2 Mg % were applied and EDX confirmed the Sr and Mg content in these samples. In all other cases, various Sr and Mg-containing phases (Sr0.13Ca2.87(PO4)2, Ca2P2O7, Mg0.29Ca2.71(PO4)2) were identified while the HAP structure disappeared. It was shown that the lattice parameters and the unit cell volume of Sr-doped HAPs increased slightly compared to pure HAP, due to the larger radius of Sr2+ than Ca2+. As the ionic radius of Mg2+ was smaller than Ca2+, the distortion in the unit cell was demonstrated. Crystallite sizes increased with increasing amount of Sr and Mg. SEM demonstrated that ion incorporation had little influence on the morphology, i.e. pure, Sr- or Mg-doped HAPs were mostly homogenous, consisting of strongly sintered nanometre sized grains. Antimicrobial tests indicated that SrHAP with 4% Sr and MgHAP with 2% Mg had a positive effect on the inhibition of cell viability. 36 refs.

203624

LOW PRESSURE SPARK PLASMA SINTERED HYDROXYAPATITE AND BIOGLASS COMPOSITE SCAFFOLDS FOR BONE TISSUE REPAIR

Rizwan M; Hamdi M; Basirun W J; Kondoh K; Umeda J - *Malaya,University; Karachi,NED University of Eng.& Technol.; Osaka,University*

Ceram.Int. 44,No.18,2018,p.23052-23062

In order to overcome the major limitations of hydroxyapatite (HA) such as the lack of osseointegration, and inadequate bioactivity and biodegradation, HA-based composite scaffolds were prepared by combining HA with Bioglass (BG). Earlier attempts to prepare BG-reinforced HA composites by conventional sintering resulted in excessive reactions between the constituents and/or crystallisation of BG which are known to lengthen the bioactivity response. Low pressure spark plasma sintering (SPS) was used to prepare HA-BG composite scaffold materials with a BG content up to 30 wt%. The milder processing conditions during SPS compared to conventional sintering such as the compaction pressure, sintering time and temperature produced HA-BG composite scaffolds without the excessive reactions between the constituents and prevented the crystallisation of BG. All the developed composites were composed of calcium phosphate (HA and beta-tricalcium phosphate phases) and glassy phases only. The effect of BG addition on properties such as bulk density, relative density and hardness agreed well with XRD and FESEM analyses. The in-vitro bioactivity study from the immersion of samples in simulated body fluid confirmed the improved bioactivity of the composite samples with increased BG content. 62 refs.

203625

INFLUENCE OF THE ADDITION OF CARBONATED HYDROXYAPATITE AND SELENIUM DIOXIDE ON MECHANICAL PROPERTIES AND IN VITRO BIOACTIVITY OF BOROSILICATE INERT GLASS

Youness R A; Taha M A; El-Kheshen A A; Ibrahim M - *Giza,National Research Centre*

Ceram.Int. 44,No.17,2019,p.20677-20685

Five nanocomposite samples, containing different percentages of carbonated hydroxyapatite (CHA), selenium dioxide (SeO2) and inert glass (IG) were prepared by high-energy ball milling to improve the in-vitro bioactivity of the nanocomposites. FTIR and XRD were used for the nanopowders and sintered nanocomposites to record the structural changes and examine the resulting sintered phases and their mechanical properties were measured using an ultrasonic non-destructive technique. The bioactivity of the sintered specimens was assessed after soaking in simulated body fluid for 14 days. FTIR and XRD spectra showed that the glasses encouraged partial HA decomposition to tricalcium phosphate (TCP) and calcium silicate (CaSiO3) phases. The formation of the latter phase and the remaining HA content was responsible for good bioactivity and mechanical properties of the nanocomposites. Successive additions of selenium dioxide to the nanocomposites led to improved bioactivity without any recorded changes in the mechanical properties. Based on the results, the prepared nanocomposites could be used in various tissue-engineering applications. 55 refs.

203626

PHYSICOCHEMICAL, OSTEOGENIC AND CORROSION PROPERTIES OF BIO-FUNCTIONALISED ZnO THIN FILMS: POTENTIAL MATERIAL FOR BIOMEDICAL APPLICATIONS

Trino L D; Albano L G S; Bronze-Uhle E S; George A; Mathew M T; Lisboa-Filho P N - *Sao Paulo,State University; Illinois,University at Chicago; Illinois,University Rockford College of Medicine*

Ceram.Int. 44,No.17,2019,p.21004-21014

The bio-functionalisation of ZnO thin films with dentin matrix protein 1 (DMP1) peptides was proposed as an apatite crystal nucleator. Ti was coated with ZnO and functionalised with two different spacers, 3-(4-aminophenyl) propionic acid (APPA) or 3-mercaptopropionic acid (MPA) to facilitate binding with DMP1 peptides. Attenuated total reflection FTIR and XPS confirmed the presence of the peptides on the ZnO thin film surface through characteristic bands related to amine and carboxylic acid groups and by the incidence of N 1 s spectra, respectively. AFM images indicated that a more uniform layer of DMP1 peptides was formed in the presence of the APPA and MPA spacers. Results showed that the bio-functionalised ZnO thin films with APPA spacer, ZnO APPA P sample, had increased wettability (17 degrees) and surface energy (72 dyn/cm), with an osteogenic surface and apatite nucleating properties. Furthermore, electrochemical analysis showed increased corrosion resistance. The results indicate the promising applications of ZnO APPA P in biomedical devices once it can accelerate the osteointegration process and improve the corrosion resistance of implants. 55 refs.

203627

NOVEL SYNTHESIS AND ANTIMICROBIAL STUDIES OF NANOSCALE TITANIA PARTICLES

Anwar A; Akbar S; Kazmi M; Sadiqa A; Gilani S R - *Lahore,University of Engineering & Technology*

Ceram.Int. 44,No.17,2019,p.21170-21175

Continuous microwave-assisted flow synthesis (CMFS) was used and compared to traditional synthesis procedures (sol-gel and chemical precipitation methods) for the rapid production of TiO2 nanoparticles. XRD and TEM were used to determine the structure and particle morphology of the resultant samples. The particles formed using CMFS were less agglomerated and the particle size (about 6 nm) was smaller compared with other particles obtained using sol-gel (about 9 nm) and chemical precipitation methods (about 15 nm). XRD established the generation of anatase phase with preferential [101] dimension. Zeta potential results were used to assess the colloidal stability of the nanoparticles and the antimicrobial nature of the TiO2 nano-samples was analysed by using various bacterial and fungal strains. The TiO2 nanoparticles were uniform and had strong antimicrobial activity with potential bone tissue engineering applications. 43 refs.

203628

ANTIBACTERIAL AND STRUCTURAL PROPERTIES OF MESOPOROUS Ag DOPED CALCIUM BOROSILICATE GLASS-CERAMICS SYNTHESISED VIA A SOL-GEL ROUTE

Kumar A; Mariappan C R; Sarahan B S - *Kurukshetra,National Institute of Technology; Kurukshetra,University*

J.Non-Cryst.Solids. 505,2019,p.431-437

The structural, electrical, bioactivity and antibacterial properties of mesoporous Ag doped calcium borosilicate glass-ceramics are reported. A simple sol-gel route was used to synthesise the mesoporous glass-ceramics. N2 adsorption-desorption studies revealed the mesoporous structure of the samples. The embedment of nano-sized Ag metallic particles in the glass matrix was confirmed for the Ag doped sample calcined at 600 C by XRD, UV-visible, and TEM analyses. Ac conductivity was used to study the electrical relaxation processes. Ag doped samples showed good antibacterial properties without compromising the bone-like apatite layer formation. The antibacterial effect against Gram negative bacteria was higher for the Ag doped sample calcined at 600 C which exhibited a dominant nearly constant dielectric loss feature. 37 refs.

203629

SURFACE REACTIVITY AND SILANISATION ABILITY OF BOROSILICATE AND Mg-Sr-BASED BIOACTIVE GLASSES

Ferraris S; Nommeots-Nomm A; Spriano S; Verne E; Massera J - *Turin,Polytechnic; Tampere,University of Technology*

Appl.Surf.Sci. 475,2019,p.43-55

Borosilicate bioactive glasses are attracting an increasing interest due to their good hot forming ability, low crystallisation tendency and high bioactivity. Surface functionalisation of bioactive glasses is a versatile tool for modulation of their properties and consequently of their biological response and it is still an unexplored topic in the case of borosilicate glasses. The possibility of grafting 3-aminopropyltriethoxysilane (APTES) to various borosilicate bioactive glasses was investigated. The glasses were produced by melting and characterised using SEM-EDS, density measurement, FTIR-ATR, Raman, NMR, zeta potential and reactivity in SBF and TRIS/HCl). APTES was then grafted onto the surface of the glasses and its presence was verified using XPS, contact angle and zeta potential measurements. The results show the possibility of silanising borosilicate bioactive glasses for the first time. However, this silanisation protocol does not induce the formation of a continuous coating on the glass surface. 67 refs.

203630

GEL CASTING OF ZIRCONIA-BASED ALL-CERAMIC TEETH COMBINED WITH STEREOLITHOGRAPHY

Liu K; Zhang K; Bourell D L; Chen F; Sun H; Shi Y; Wang J; He M; Chen J - *Wuhan,University of Technology; Texas,University at Austin; Zibo,Advanced Ceramics Research Institute; Huazhong,University of Science & Technology*

Ceram.Int. 44,No.17,2019,p.21556-21563

A reliable method for fabricating zirconia-based all-ceramic teeth by combining stereolithography with gel casting is reported. The effects of the ZrO2 particle size on the stability and rheological properties of the zirconia slurry were studied and the effects of powder properties, including slurry solids content and sintering temperature, on the properties and microstructure of the zirconia ceramics were also investigated. Results showed that the optimal parameters were a 0.2 micron grain size, solids content of 37 vol% in the zirconia slurry and a sintering temperature of 1550 C. The density was up to 98.6%, the flexural strength was 1170 MPa and the fracture toughness was 19.0 MPa.m1/2. 21 refs.

203631

DEVELOPMENT AND ANTIBACTERIAL APPLICATION OF NANOCOMPOSITES: EFFECTS OF MOLAR RATIO ON Ag2O-CuO NANOCOMPOSITE SYNTHESISED VIA THE MICROWAVE-ASSISTED ROUTE

Rajabi A; Ghazali M J; Mahmoudi E; Azizkhani S; Sulaiman N H; Mohammad A W; Mustafah N M; Ohnmar H; Naicker A S - *Malaysia,Universiti Kebangsaan; Malaysia,Universiti Putra; Malaysia,Universiti Teknologi MARA*

Ceram.Int. 44,No.17,2019,p.21591-21598

A rapid and simple method for the synthesis of Ag2O-CuO nanocomposites was developed via the microwave-assisted reduction of Ag and Cu ions in an aqueous solution at different molar ratios of precursor. The effects of the chemical composition on the microstructure and antibacterial properties of the materials were determined. XRD confirmed the presence of the main phases (Ag2O and CuO) that were synthesised in-situ to form a nanocomposite. FESEM and TEM verified that increased Cu ion concentration affected the microstructure of the nanomaterials. The antibacterial activity of the synthesised materials was evaluated using Escherichia coli by estimating the diameter of the inhibition zone. Results indicated that increased Cu ion concentration was associated with increased strong antibacterial activity toward E. coli. 45 refs.

203632

APPLICATION OF ZIRCONIA SURFACE COATING TO IMPROVE FRACTURE RESISTANCE AND STRESS DISTRIBUTION OF ZIRCONIA CERAMIC RESTORATIONS

Farhan F A; Sulaiman E; Kutty M G - *Baghdad,University; Malaya,University*

Ceram.Int. 44,No.17,2019,p.21633-21640

Different surface treatments were used to improve the fracture performance of zirconia ceramic restoration (ZCR) including grit blasting (GB) using alumina powder. This type of surface treatment generated residual stresses in the veneering ceramic which caused crack initiation and ended in fracture. To overcome the stress generated by GB, a zirconia surface coating was used as a surface treatment to improve the fracture resistance and accommodate stresses along the ZCR layers. Fifty zirconia crowns were fabricated and divided according to the type of surface treatment into three groups; the first group was ZG, which involved coating 20 cores with a mixture of partially-sintered zirconia powder (PZP) and glaze ceramic powder; the second group was ZL, involving 20 cores coated with PZP and a liner ceramic paste. The third group was grit blasted (GB), when 10 fully sintered cores were prepared at 1350 C which were then abraded by 50 micron alumina powder. The groups ZG and ZL were further subdivided into ZG26, ZG47, ZL26 and ZL47 based on two PZP sizes (47 and 26 micron). Each treated core was then veneered with the veneering ceramic layer. The fracture resistance (FR) was then measured using a universal testing machine and finite element analysis (FEA) was used to simulate the stress distribution in the coated and non-coated zirconia crown models. The ZG47 group had higher FR (647.92 plus or minus 97.33 N) and a significant difference ($P < 0.00$) compared to GB and other coated groups. FEA showed lower and evenly distributed stresses in the zirconia glaze model than the zirconia liner and the non-coated models. The ZG47 coating, considered as an alternative method to GB treatment, increased the FR which improved the clinical performance of the ZCR. 30 refs.

203633

ENHANCEMENT OF OSTEOGENESIS USING A NOVEL POROUS HYDROXYAPATITE SCAFFOLD IN VIVO AND VITRO

Ren X; Tuo Q; Tian K; Huang G; Li J; Xu T; Lv X; Wu J; Chen Z; Weng J; Wang Q; Mu Y - *Sichuan Province,People's Hospital; China,University of Electronic Science & Technology; Southwest Jiaotong University; Luzhou,Southwest Medical University; China,Nuclear Power Institute; Chengdu,Institute of Biology*

Ceram.Int. 44,No.17,2019,p.21656-21665

The repair of large maxillofacial bony defects using regular scaffolds is restricted by the osteogenic effect. It was postulated that a novel porous hydroxyapatite (HA) scaffold with a 25-30 micron groove structure (HAG) may counter this limitation. The biocompatibility of porous hydroxyapatite scaffolds with a groove structure (HAG) was investigated in vitro and in vivo in beagle dogs by investigating the enhanced bioactivity and osteogenesis. Compared with a regular HA scaffold, the HAG scaffolds promoted human placenta-derived mesenchymal stem cell (hPMSC) osteogenic differentiation and the maturation of osteoblasts. This was achieved by increasing protein adsorption and promoting the directed growth and expression of osteogenic genes in-vitro. The compressive strength of the HAG scaffolds was greater than HA in both dorsal muscle and the mandibular distraction area after in-vivo implantation, and haematoxylin and eosin staining demonstrated new bone formation and vasculogenesis. Immunochemical staining and micro-CT scanning showed increased osteogenic factors (BMP2, OCN and COL-1) and bone density in the HAG scaffolds compared with HA. Based on the results, it was concluded that HAG scaffolds with a groove structure induced greater osteogenesis and possessed improved ostoegenesis which could be used in clinical treatment. 46 refs.

203634

FLUORINE SUBSTITUTED NANO HYDROXYAPATITE: SYNTHESIS, BIO-ACTIVITY AND ANTIBACTERIAL RESPONSE STUDY

Nasker P; Mukher M; Kant S; Tripathy S; Sinha A; Das M - *Central Glass & Ceramic Research Institute; Indian Institute of Engineering Science & Technology; Indian Institute of Chemical Biology; Ghaziabad,Academy of Scientific & Innovative Research*

Ceram.Int. 44,No.17,2019,p.22008-22013

Nano hydroxyapatite (HAp) and fluorine substituted hydroxyapatite (FHAp), with different fluorine concentrations, were prepared by the hydrothermal method. The synthesised powders were characterised using XRD, FTIR, HRTEM and IC for fluorine content analysis. XRD showed shifting of HAp peaks as the fluorine substitution increased, and detected calcium fluoride (CaF2) phase in the powders where theoretically 100% or more OH ions were substituted by F ions. The crystallinity of the HAp powder gradually increased and the cell volume decreased as the fluorine substitution increased. HRTEM showed a nanorod-like morphology. The IC test for in-vitro fluorine ion leaching indicated that the fluorine concentration in the aqueous medium depended on the degree of fluoridation in the synthesised powder. The antimicrobial activity of the as synthesised powders was assessed using Gram-negative (Escherichia coli) and Gram-positive (Staphylococcus aureus) strains. The powder with about 33% fluorine substitution had the optimum bactericidal effect. In-vitro fluorine ion release studies showed a high fluorine concentration in the

aqueous medium for the HAp powders with < 50% fluorine substituted, and the in-vitro cell viability assay using mouse osteoblast cell line (MC3T3-E1) confirmed that the powders were non-cytotoxic. 26 refs.

203635

CONTROL OF SURFACE POTENTIAL AND HYDROXYAPATITE FORMATION ON TiO2 SCALES CONTAINING NITROGEN-RELATED DEFECTS

Hashimoto M; Ogawa T; Kitaoka S; Muto S; Furuya M; Kanetaka H; Abe M; Yamashita H - *Japan Fine Ceramics Center; Nagoya,University; Tohoku,University; Osaka,University*

Acta Mater. 155,2018,p.379-385

The hydroxyapatite (HAp) formation ability and related surface potentials of rutile-type TiO2 scales formed on Ti were controlled by varying the Ti heat treatment conditions in a N2 atmosphere containing a trace amount of O2. The zeta potentials of the samples heated at 873 and 973 K for 1 h were large negative and positive values, respectively, where HAp formation on the surface was enhanced in both cases. After longer heat treatment at those temperatures, the HAp forming ability was reduced and the zeta potential became more neutral. Kelvin probe force microscopy indicated that, under dry conditions, the surface charge on the TiO2 scales formed at 873 and 973 K in 1 h were positive and negative, respectively, opposite to the signs of the zeta potentials measured under wet conditions. SEM/TEM, EELS and calculations of defect formation energies revealed that nitrogen atoms incorporated into TiO2 during scale formation produced the charged defects (NO)0(-) and (N2)0(2+) for the scales formed in 1 h at 873 and 973 K, respectively. In the case of longer treatments, nitrogen-related defects transformed into more stable states, including N2 gas, in voids, which resulted in a neutral surface. Results led to physical models of surface charge distributions that showed the relationship between nitrogen-related defects, charged surfaces and HAp formation mechanisms. 40 refs.

TECHNICAL CERAMICS

See also Abstract(s): 203550 203719 203728 203729

203636

EFFICIENT PRODUCTION OF MgAl LAYERED DOUBLE HYDROXIDE NANOPARTICLE

Intasa-Ard S; Bureekaew S; Ogawa M - *Vidyasirimedhi Institute of Science & Technology*

J.Ceram.Soc.Jap. 127,No.1,2019,p.11-17

A large amount of MgAl-layered double hydroxide (LDH) nanoparticles were obtained from a single batch of a highly concentrated (as high as 1 M) metal salt solution. LDH were obtained by precipitation at room temperature under ambient pressure and subsequent ageing. The phase purity, crystallinity, anion composition and morphology (shape and size of the LDH crystals) were investigated to characterise the products. Chloride type MgAl LDH, with well-defined platelike particles 50 nm in size, were obtained with high efficiency (approximately 10 g from the 160 mL of the starting solution). 45 refs.

Borides

203637

THERMOCHEMICAL MODEL ON THE CARBOTHERMAL REDUCTION OF OXIDES DURING SPARK PLASMA SINTERING OF ZIRCONIUM DIBORIDE

Pham D; Dycus J H; LeBeau J M; Manga V R; Muralidharan K; Corral E L - *Arizona,University; North Carolina State University*

J.Am.Ceram.Soc. 102,No.2,2019,p.757-767

Carbon was used to reduce oxides in spark plasma sintered ZrB2 ultra-high temperature ceramics. A thermodynamic model was used to evaluate the reducing reactions to remove B2O3 and ZrO2 from the powder. Powder oxygen content was measured and carbon additions of 0.5 and 0.75 wt% were used. A C-ZrO2 pseudo binary diagram, ZrO2-B2O3-C pseudo ternaries, and Zr-C-O potential phase diagrams were generated to show how the reactions can be related to an open system experiment in the tube furnace. STEM was used to identify impurity phases composed of amorphous Zr-B-O with lamellar BN and a Zr-C-O ternary model was calculated under SPS conditions at 1900 C and 6 Pa to understand how oxides can be retained in the microstructure. 39 refs.

203638

MEDIUM-TEMPERATURE SINTERING EFFICIENCY OF ZrB2 CERAMICS USING POLYMER-DERIVED SiBCN AS A SINTERING AID

Feng B; Zhang Y; Li B; Hu S - *Beijing,Beihang University; China Academy of Space Technology*

J.Am.Ceram.Soc. 102,No.2,2019,p.855-866

Polymer-derived SiBCN, with superior thermal stability and amorphous activity, was introduced into ZrB2 powders. This sintering aid highly improved the sintering efficiency of ZrB2 ceramics at medium temperature (1000-1600 C), which showed a different service temperature range from that of traditional crystal additives. The microstructure and densification behaviour of ZrB2-SiBCN samples were mainly studied. The polymer structural evolution including construction, rearrangement, and crystallisation of the amorphous SiBCN network, made a large contribution to the densification of ZrB2 ceramics. The carbothermal reduction of pyrolysis carbon with oxide impurities could not only decrease the oxygen content, but also develop the activity of chemical bonds in the SiBCN network. Diffusions and reactions at the interface also improved the microstructure and consolidation of ZrB2-SiBCN ceramics. 38 refs.

Carbides

203639

SYNTHESIS MECHANISMS AND THERMAL STABILITY OF TERNARY CARBIDE Mo2Ga2C

He H; Jin S; Fan G; Wang L; Hu Q; Zhou A - *Henan,Polytechnic University*

Ceram.Int. 44,No.18,2018,p.22289-22296

The synthesis mechanism of Mo2Ga2C, a novel layered ternary carbide, was studied. Thermal analysis and theoretical calculation indicated that 650 C was a suitable temperature to synthesise highly pure Mo2Ga2C. Higher temperatures would result in the decomposition of the synthesised Mo2Ga2C. Based on this analysis and further analysis on the synthesis time and materials ratio, 91.3 wt% pure Mo2Ga2C was successfully synthesised at 650 C for 60 h from a Mo2C/Ga = 1:5 mixture sealed in quartz-glass tubes. The thermal stability of the as-synthesised Mo2Ga2C was

reported. In air, Mo2Ga2C started to oxidise at 600 C, the main oxidation products being MoO3 and Ga2O3. MoO3 could be released due to volatilisation at high temperature. The final oxidation product at temperatures > 800 C was GaO3. In Ar, Mo2Ga2C started to decompose at 700 C with Mo2C and MoGa3 being the main decomposing products. At 900 C, another ternary carbide, Mo2GaC, could be formed. At temperatures > 1000 C, the samples completely transformed to Mo2C and MoGa3. This work is significant for the synthesis and application of Mo2Ga2C, and its derivative, Mo2C MXene. 34 refs.

203640

SHOCK-INDUCED AMORPHISATION IN SILICON CARBIDE

Zhao S; Flanagan R; Hahn E N; Kad B; Remington B A; Wehrenberg C E; Cauble R; More K; Meyers M A - *California,University at San Diego; Los Alamos National Laboratory; Lawrence Livermore National Laboratory; Oak Ridge National Laboratory*

Acta Mater. 158,2018,p.206-213

The recovery of amorphous SiC from laser-ablation-driven shock compression, with a peak stress of approximately 50 GPa, is reported. TEM revealed that the amorphous regions were localised and formed bands as narrow as a few nanometres. In addition to the amorphous bands, planar stacking faults were observed. Large-scale non-equilibrium molecular dynamic simulations showed the process and suggested that the planar stacking faults served as the precursors to amorphisation. Results suggested that the amorphous phase produced was a high-density form, which enhanced its thermodynamic stability under high pressures combined with the shear stresses generated by the uniaxial strain state in shock compression. 40 refs.

203641

HIGH DENSITY BORON CARBIDE CERAMICS

Perevislov S N; Shcherbak P V; Tomkovich M V - *St.Petersburg,State Technological Institute; St.Petersburg,Ioffe Physico-Technical Institute*

Refract.Ind.Ceram. 59,No.1,2018,p.32-36

Porous preforms of B4C + C and B4C + C + Si materials were impregnated by molten silicon to obtain a high-density product with a relative density of 99.0 % and porosity of 0.9%. Silicon impregnation was carried out by saturating the samples through the pores of the SiC + C sacrificial preforms. This method allowed the reduction of both the dissolution of boron carbide grains in the silicon solution and the formation of the B12(C, Si, B)3 phase. This reduced the fragility of the product and thereby improved the mechanical properties of the B4C ceramics. 22 refs.

Nitrides

See also Abstract(s): 203553 203715

203642

EFFECT OF HEATING RATE ON PROPERTIES OF TRANSPARENT ALUMINIUM OXYNITRIDE SINTERED BY SPARK PLASMA SINTERING

Shan Y; Wei X; Sun X; Torresani E; Olevsky E A; Xu J - *Dalian,Maritime University; San Diego,State University*

J.Am.Ceram.Soc. 102,No.2,2019,p.662-673

High heating rates ranging from 50 to 250 C/min were selected to rapidly sinter transparent aluminium oxynitride (AlON) ceramics by spark plasma sintering (SPS) at 1600 C under 60 MPa using a bimodal AlON powder synthesised by the carbothermal reduction and nitridation method. With a 1 min holding time before cooling, all the specimens showed high density and high transparency. The maximum transmittance was up to 74.5-80.6%, where the maximum transmittance was positively correlated with the heating rate. Further analysis revealed that faster heating rates enabled the decrease in the amount of the AlON phase decomposed into the alpha-Al2O3 and AlN phases during heating. These alpha-Al2O3 and AlN phases had to be converted back to AlON at the final stage of sintering, which indicated that a decrease in the amount of the alpha-Al2O3 and AlN phases via the boosted heating led to the higher transmittance of the AlON ceramics. The high heating rates and short holding duration of the SPS used in this study resulted in the fine grain size of the obtained ceramics (1-6 micron), compared to that of the AlON ceramics fabricated by the conventional sintering method. This effect of high heating rates was confirmed by the coupled densification-grain growth modelling. The obtained AlON specimens showed a Vickers hardness of 15.87-16.62 GPa. 37 refs.

Oxides

See also Abstract(s): 203549 203593 203596 203598 203599 203613 203616 203617 203722 203724 203725

203643

POROUS ALUMINA CERAMICS WITH ENHANCED MECHANICAL AND THERMAL INSULATION PROPERTIES BASED ON SOL-TREATED RICE HUSK

Wei Z; Li S; Li Y; Li X; Xiang R; Xu N - *Wuhan,University of Science & Technology*

Ceram.Int. 44,No.18,2018,p.22616-22621

Porous alumina ceramics are typically prepared by adding pore-forming agents. Rice husk (RH) was pretreated with zirconia sol and used as a pore-forming agent to try to improve the properties of the porous alumina. The effects of sol-treatment on the thermal conductivity and compressive strength of the resultant ceramics were characterised. The pore size distribution, pore shape, microstructure, and phase evolution were also studied. The results showed that the RH pretreatment optimised the microstructure of the ceramic pores. Complete morph-genetic RH was clearly seen in the pores, which was established as a key factor in improving the properties. The thermal insulation properties were found to significantly improve, although the thermal conductivity increased slightly with the increment of zirconia sol concentration from 5 to 10 wt%. After sintering at 1550 C, the compressive strength was significantly greater for the specimen prepared with 10 wt% zirconia sol-treated RH (65.56 MPa) than that with untreated RH (43.37 MPa). It was therefore shown that the use of zirconia sol-pretreated RH as a pore-forming agent could enhance the mechanical and thermal insulation properties of porous alumina ceramics. 23 refs.

203644

IMPROVED COLORISTIC PROPERTIES AND HIGH NIR REFLECTANCE OF ENVIRONMENT-FRIENDLY YELLOW PIGMENTS BASED ON BISMUTH VANADATE

Dolic S D; Jovanovic D J; Strbac D; Far L D; Dramicanin M D - *Belgrade,Vinca Nuclear Institute; Novi Sad,University*

Ceram.Int. 44,No.18,2018,p.22731-22737

Near-IR reflective pigments, or cool pigments, have been increasingly used to reduce urban heat islands. There is a need to develop non-toxic cool pigments to aid energy saving. Fine powders of yellow pigments based on BiVO4 were prepared in two crystalline forms (tetragonal zircon-structured and monoclinic scheelite-structured) using an ethylene glycol-assisted method subjected to a thermal treatment at two different temperatures. The obtained materials were brightly coloured with different hues of yellow, with high reflection in the near-IR region and visible luminescence under excitation by UV light. The new preparation method had a considerable effect on the chromatic properties of the scheelite-structured BiVO4 pigments. The sample with the most vivid and bright shade of yellow had L*a*b* and L*C*ab h*ab colour coordinates of (87.28, 0.37, 91.53) and (87.28, 91.53, 89.79), which indicate exceptionally good chromatic properties superior and/or comparable to those of other inorganic yellow pigments, both those commercially available and recently described. The near-IR reflectance of this powder was also very high (at least 80%). 35 refs.

203645

PREPARATION AND CHARACTERISATION OF MULLITE FOAM CERAMICS WITH POROUS STRUTS FROM WHITE CLAY AND INDUSTRIAL ALUMINA

Zhou W; Yan W; Li N; Li Y; Dai Y; Han B; Wei Y - *Wuhan,University of Science & Technology*

Ceram.Int. 44,No.18,2018,p.22950-22956

Mullite foam ceramics with high porosity and low thermal conductivity, which are efficient heat insulation refractories, show great potential for energy saving in high-temperature furnaces. It is necessary to develop mullite foam ceramics with lower cost, porous struts and higher volume stability at high temperature. Four mullite foam ceramics with porous struts and low thermal conductivities were prepared by direct foaming from white clay and industrial alumina using sodium carboxymethyl cellulose (CMC) as a foam stabilising agent. The effect of the CMC addition on the phase composition, pore characteristics and strength was analysed by XRD, SEM and EDS. The majority of the struts for the foam ceramics were needle-like mullite, the rest being minor corundum and quartz. The addition of CMC decreased the apparent porosity of the foam ceramics and the pore area fractions of their struts, while the phase composition was hardly affected. The compressive strengths and thermal conductivities of the foam ceramics increased. The optimised product contained 0.15 wt% CMC, which combined a high porosity of 81.3%, a low thermal conductivity of 0.095 W/m.K (at 350 C) and a minor positive reheating linear change. 42 refs.

203646

FROM NANOPARTICLES TO NANORODS: INSIGHTS INTO THE MORPHOLOGY CHANGING MECHANISM OF CERIA

Wang Y; Su H-J; Hua Q-R; Wang S-D - *Dalian,Institute of Chemical Physics; Beijing,University of Chinese Academy of Sciences; Wuxi Weifu Environmental Catalysts Co.Ltd.*

Ceram.Int. 44,No.18,2018,p.23232-23238

It is important to be able to synthesise ceria with tunable morphology and exposed surfaces controllably and facilely for its various applications. A series of nanosized ceria with different morphology were synthesised by a simple precipitation method under an inert atmosphere with no surfactant or template. Nanoparticles and 1D nanostructures of ceria were prepared with Ce(NO3)3 and CeCl3 as cerium precursors, respectively. With different mole ratios of [Cl-: NO3(-)], transition morphologies from nanoparticles to nanorods were synthesised. The shape-controlling effect of these ions is due to their different roles in the oxidation of Ce(OH)3 to Ce(OH)4. FTIR showed that the composite of Ce(OH)3 could be oxidised by NO3(-) and the NO3(-) be reduced to NO. However, the existence of Cl- can inhibit the oxidising capacity of NO3(-). This anion-induced controllable synthesis, which is a surfactant- and template-free facile precipitation method, offers a potential route for fabricating ceria nanostructures. 29 refs.

203647

PREDICTION OF CONTINUOUS POROSITY GRADIENTS IN CERAMICS USING ZnO AS A MODEL MATERIAL

Cramer C L; Aguirre T G; Holland T B; Ma K - *Colorado,State University; Oak Ridge National Laboratory; Veloxint*

J.Am.Ceram.Soc. 102,No.2,2019,p.587-594

Materials with gradient microstructures have a wide range of applications such as cutting tools, armour, and electronic devices. However, it is difficult to predict and control the gradient microstructure during processing. A continuous porosity gradient was successfully achieved in ZnO material via spark plasma sintering with a large induced thermal gradient. The porosity can be overestimated if isothermal prediction is applied. The current work proposed a more accurate prediction of the porosity by considering the stress-shielding effect caused by the thermal gradient. The shielding effect resulted from different stress states in the sample due to differential sintering; the hotter side of the specimen experienced a higher strain rate and more shrinkage while the colder side experienced a lower strain rate and less shrinkage simultaneously. Therefore, the axial strains were varied throughout the sample thickness. Using the constituent equations in advanced sintering analysis, the shield stress was calculated to be approximately 13 MPa for the viscoelastic assumption of sintering. In order to improve the accuracy of the prediction of the porosity gradient, it was necessary to add a load to overcome the shield stress when the materials were sintered with a thermal gradient. 41 refs.

203648

IN SITU OBSERVATIONS OF CRACKING IN CONSTRAINED SINTERING

Carazzone J R; Bonar M D; Baring H W; Cantu M A; Cordero Z C - *Houston,Rice University*

J.Am.Ceram.Soc. 102,No.2,2019,p.602-610

The long-standing problem of cracking during constrained sintering of a copper oxide powder aggregate was studied. Using binder jet 3D printing, ceramic green bodies were prepared in the form of centre-notched panels. In-situ imaging was used to observe how the cracks nucleated and grew from the notch as the material was sintered under restraint. Quantitative image analysis was used to identify important characteristics of the sinter-cracking process, indicating a framework for analysing the problem and developing methods for avoiding it, including representation of sinter-cracking as a creep crack growth process, use of fracture mechanics parameters to design specimen geometries that do not exceed critical stress intensities, and the possibility of exploiting the inherently ductile nature of sinter-cracking to mitigate damage. 19 refs.

203649

ALPHA-ALUMINA AND SPINEL REACT INTO SINGLE-PHASE HIGH-ALUMINA SPINEL IN < 3 SECONDS DURING FLASH SINTERING

Kok D; Yadav D; Sortino E; McCormack S J; Tseng K-P; Kriven W M; Raj R; Mecartney M L - *California,University at Irvine; Colorado,University at Boulder; Illinois,University at Urbana Champaign*

J.Am.Ceram.Soc. 102,No.2,2019,p.644-653

In-situ XRD measurements at the Advanced Photon Source show that alpha-Al2O3 and MgAl2O4 react nearly instantaneously and completely, and nearly completely to form single-phase high-alumina spinel during voltage-to-current type flash sintering experiments. The initial sample was composed of powders of alpha-Al2O3, MgAl2O4 spinel, and cubic 8 mol% Y2O3-stabilised ZrO2 (8YSZ) mixed in equal volume fractions, with the spinel to alumina molar ratio being 1:1.5. The specimen temperature was measured by thermal expansion of the platinum standard. These measurements correlated well with a black-body radiation model, using appropriate values for the emissivity of the constituents. Temperatures of 1600-1736 C were reached during the flash, which promoted the formation of alumina-rich spinel. In a second set of experiments, the flash was induced in a current-rate method where the current flowing through the specimen was controlled and increased at a constant rate. The formation of two different compositions of spinel, MgO.3Al2O3 and MgO.1.5Al2O3, were observed, which evolved into a single composition of MgO.2.5Al2O3 as the current continued to increase. In summary, flash sintering is an expedient way to create single-phase, alumina-rich spinel. 40 refs.

203650

HIGH-TEMPERATURE STABLE INVERSE OPAL PHOTONIC CRYSTALS VIA MULLITE-SOL-GEL INFILTRATION OF DIRECT PHOTONIC CRYSTALS

Bueno P; Furlan K P; Hotza D; Janssen R - *Hamburg,University of Technology; Sao Carlos,Federal University of Sta.Catarina*

J.Am.Ceram.Soc. 102,No.2,2019,p.686-694

Three-dimensionally ordered macroporous materials for photonic or refractory applications have been developed by an innovative approach based on mullite sol-gel infiltration of direct photonic crystals followed by burn-out and calcination. Direct photonic crystals were obtained using polystyrene spheres templates either by vertical convective self-assembly or by drop casting. The samples were then infiltrated by spin coating with mullite sol-gels prepared with two different compositions (74 wt% Al2O3, 26 wt% SiO2 and 80 wt% Al2O3, 20 wt% SiO2). The inverse opal photonic crystals prepared with both sol-gels presented a highly ordered porosity, and the high-alumina composition showed stability up to 1500 C. After structural inversion (polymeric template burn-out), the high-alumina composition showed roundness of the PS templated pores closer to an ideal sphere (phi = 0.967) when compared to the low-alumina composition (phi = 0.954). Although the inverse opal photonic crystals did not present a photonic bandgap, they showed structural stability at high temperatures, which enable their application as refractory materials. 40 refs.

203651

NEW ROUTE TO MESOPOROUS SILICA VIA A SILSESQUIOXANE PRECURSOR

Przekop R E; Sztorch B; Zielinski M; Pietrowski M; Marciniak P; Martyla A; Osinska-Broniarz M; Marciniec B - *Poznan,A.Mickiewicz University; Poznan,Institute of Non-Ferrous Metals*

Ceramics-Silikaty. 62,No.4,2018,p.403-410

The effect of the addition of octakis(tetramethylammonium)-t8-silsesquioxane (octaanion) on the modification of the porous structure of silica gel obtained by the sol-gel method and catalysed by acetic acid was studied. The obtained silica gel was characterised by the low-temperature nitrogen adsorption/desorption method (BET), XRD, TGA and TEM. The octaanion was found to act as a textural promoter, as shown by an almost 25% increase in the surface area of the obtained silica. As a result of the stabilisation in the porous structure of the silica gel, the tetramethylammonium groups of the octaanion showed higher thermal stability than the groups present in the octaanion structure or those introduced in the form of tetramethylammonium hydroxide. It was proved that tetramethylammonium ions showed increased thermal resistance, which was related to the porous properties of the SiO2 matrix. 19 refs.

203652

LANTHANIDE-DOPED Y2O3 - THE PHOTOLUMINESCENT AND RADIOLUMINESCENT PROPERTIES OF SOL-GEL PREPARED SAMPLES

Rubesova K; Thor T; Jakes V; Mikolasova D; Maixner J; Jankovsky O; Cajzl J; Nadherny L; Beitlerova A; Nikl M - *Prague,University of Chemistry & Technology; Prague,Institute of Physics*

Ceramics-Silikaty. 62,No.4,2018,p.411-417

Rare earth-metals sesquioxides (including Y2O3) represent a group of materials with extraordinary properties which can be used in various technologies, but the high melting temperature hinders the wide application of monocrystalline materials. It is therefore still important to test other synthesis methods, even for relatively well-known materials and even in the form of bulk ceramics. The series of lanthanide-doped Y2O3 (with Eu3+, Pr3+, Dy3+ and Tb3+ dopants) prepared by a Pechini-based method is presented. It is shown that this method produces single-phase material with luminescence properties comparable to those of single crystals, as proved by the photoluminescence and radioluminescence excited by UV light and X-rays, respectively. The doped Y2O3 is applicable either as a luminophore or a scintillation material. 32 refs.

203653

PREPARATION OF MULLITE FROM ALUMINA/ALUMINIUM NITRATE AND KAOLIN CLAY THROUGH SPARK PLASMA SINTERING PROCESS

Saeidabadi E K; Ebadzadeh T; Salahi E - *Iran,Materials & Energy Research Centre*

Ceram.Int. 44,No.17,2019,p.21053-21066

In-situ synthesised mullite was prepared by mixing kaolinite with alumina and aluminium nitrate nonahydrate (ANN) powders using high-energy milling followed by spark plasma sintering (SPS). Using a high-energy ball mill, the stoichiometric compositions of the starting powders, considering their final transformation to Al2O3 and SiO2, were mixed. The SPS process was performed at 1400 and 1375 C for specimens containing Al2O3 and ANN, respectively. XRD patterns of the milled powders after 30 h showed the formation of quartz from kaolinite for both starting batches. The displacement-temperature-time (DTT) curves and the corresponding vacuum changes indicated the dehydration and phase transformation of ANN and kaolinite at different stages of the sintering process. The XRD patterns of the sintered samples revealed the formation of mullite with un-reacted Al2O3 and cristobalite for the batches containing Al2O3 and ANN, respectively. Physical and mechanical property results showed higher bending strength (397 plus or minus 18 MPa), Vickers hardness (16.32 plus or minus 0.21 GPa) and fracture toughness (3.81 plus or minus 0.24 MPa.m1/2) with a lower porosity (0.070 plus or minus 0.02%) for the sample containing Al2O3, than samples containing ANN. 51 refs.

203654

OXIDATION EFFECTS ON SPARK PLASMA SINTERING OF MOLYBDENUM NANOPOWDERS

Lee G; Maniere C; McKittrick J; Gattuso A; Back C; Olevsky E A - *San Diego,State University; California,University at San Diego; General Atomics Inc.*

J.Am.Ceram.Soc. 102,No.2,2019,p.801-812

Surface-oxidised molybdenum nanopowders were compacted by spark plasma sintering (SPS). The oxide impurity behaviour was analysed under various sintering temperatures. The densification mechanism of the nanopowders with a melted oxide phase was identified in situ by regression analysis of the experimental data on the temperature-dependent porosity change and on the SPS multistep pressure dilatometry. To increase the density of the compacted pellets, the nanopowders with the oxide phase were consolidated by SPS using two in-situ oxide removal methods: carbothermic reduction and particle surface cleaning by electric current flow through the powders. The advantages and disadvantages of these methods in terms of the density, grain size and mechanical properties of the final products are discussed. 59 refs.

203655

FABRICATION OF MULLITE FIBRE POROUS CERAMICS WITH EVEN STRUCTURES BY FILTRATION FREEZE-DRYING

Zhang D; Li L; Chen X; Yang L; Hu X; Guo A; Xie D; Wang W; Du H - *Tianjin,University*

J.Ceram.Soc.Jap. 127,No.1,2019,p.5-10

Mullite fibrous porous ceramics (MFPCs) were fabricated by freeze-drying wetted bodies formed by vacuum filtration and the effects of the freezing temperatures on their microstructure and mechanical properties were investigated. Results showed that freeze-drying could effectively stop silica sol migration and a uniform porous ceramic microstructure was obtained in which the binder covered the fibre surfaces and bonded the fibres at nodes. Due to the homogeneous microstructure, the compressive strength of the MFPCs with an open porosity of 85.4% was more than 2.0 MPa. There were two elastic regimes and one plastic regime in the stress-strain curve of the MFPCs, which revealed that the MFPCs underwent step-by-step fracture under compression. In addition, the freezing temperatures affected the properties of the MFPCs due to the formation of plates derived from the binder. 23 refs.

203656

SYNTHESIS AND MICROSTRUCTURE OF CuFeO2 POWDERS VIA MICROWAVE HYDROTHERMAL REACTION

Zhai J; Wang H; Su W; Wang T; Wang X; Chen T; Wang C - *Shandong,University*

J.Ceram.Soc.Jap. 127,No.1,2019,p.22-27

CuFeO2 powders were synthesised by a microwave hydrothermal reaction at different reaction temperatures. Pure rhombohedral phase CuFeO2 was formed and confirmed by XRD. The microstructure and morphology of all the CuFeO2 samples were scanned by TEM. Powders with different particle sizes that ranged from several to hundreds of nanometres were produced and some micron-sized grains occurred. The average grain size of all the powders was calculated based on XRD patterns which showed the change of grain size with temperature. The grain size distribution was also studied by counting grain numbers in TEM images. The grain growth mechanism was assessed based on the results and was found to be classical Ostwald ripening. 21 refs.

203657

IN-SITU HIGH TEMPERATURE MICROMECHANICAL TESTING OF ULTRAFINE GRAINED YTTRIA-STABILISED ZIRCONIA PROCESSED BY SPARK PLASMA SINTERING

Cho J; Li J; Li Q; Ding J; Wang H; Xue S; Holland T B; Mukherjee A K; Wang H; Zhang X - *Purdue University; Colorado,State University; California,University at Davis*

Acta Mater. 155,2018,p.128-137

The high-temperature (up to 670 C) in-situ micromechanical testing of spark plasma sintered ultrafine grained YSZ is reported. The mechanical behaviour of YSZ tested below 400 C showed a large inelastic strain (about 7%) due primarily to phase transformation toughening. Above 400 C, martensitic transformation toughening was gradually superseded by grain boundary sliding triggered by the ultrafine grains. The micropillars tested at 670 C exhibited enhanced plastic flow which arose mainly from dislocation activity along with grain boundary sliding. 59 refs.

203658

THERMODYNAMICS OF RADIATION INDUCED AMORPHISATION AND THERMAL ANNEALING OF Dy2Sn2O7 PYROCHLORE

Chung C-K; Lang M; Xu H; Navrotsky A - *California,University at Davis; Los Alamos National Laboratory; Tennessee,University*

Acta Mater. 155,2018,p.386-392

The amorphisation enthalpy, which reflects all the complex chemical and structural characteristics, was used as a more effective parameter to correlate the radiation damage resistance of pyrochlores with their compositions. It explained the superior radiation damage resistance of the stannate pyrochlores compared with titanate pyrochlores. DSC revealed a strong exothermic event starting at 978 K, which was attributed to long-range recrystallisation based on XRD analysis, similar to the effect previously observed in Dy2Ti2O7. A second pronounced heat event beginning at around 1148 K, which resulted from local structural rearrangement, was decoupled from the first event for irradiated Dy2Sn2O7. Both the heat releases measured by DSC on heating to 1023 and 1473 K, and the excess enthalpies of the annealed samples indicated that the recovery to the original, ordered state was not fully achieved even at 1473 K, despite XRD showing the apparent restoration of crystalline pyrochlore structure. The remaining metastability was attributed to local disorder in the form of weberite-like short-range domains in the recrystallised material. The second event for different pyrochlores generally began at similar temperatures while the onset of the long range recrystallisation was compositionally dependent. The amorphisation and thermal annealing behaviour observed in irradiated Dy2Sn2O7 could provide insights into the general mechanisms of radiation damage and recovery of pyrochlores relevant to their nuclear applications. 44 refs.

203659

RESIDUAL STRESS IN POLYCRYSTALLINE ALUMINA: COMPARISON OF TWO-DIMENSIONAL MAPS AND INTEGRATED SCANS IN FLUORESCENCE-BASED MEASUREMENTS

Michaels C A; Cook R F - *National Institute of Standards & Technology*

Acta Mater. 159,2018,p.309-319

The spatially heterogeneous residual stress fields in three polycrystalline alumina materials were compared using two fluorescence-based

measurement techniques. In the first, 18 hyperspectral arrays of the Cr-based R1 and R2 ruby fluorescence line shifts were formed into two-dimensional maps of stress components and experimental stress distributions were calculated using both spectral lines jointly. In the second, the data were formed into integrated scans reflecting the average spectra within the maps and assumed Gaussian stress distributions were calculated, using the spectral lines singly. Comparison of the distribution parameters showed that the single-peak-based integrated scan technique overestimated the variation of the mean crystallographic stresses relative to the two-peak-based two-dimensional map technique. In addition, the integrated scan technique suggested standard deviations for the crystallographic stress distributions that were greater than those determined from two-dimensional map observations. When a sufficient area of the microstructure was examined, the average results of the two techniques agreed, but the two-dimensional map method was preferred as it made full use of the two-peak spectra and provided explicit stress distribution determination. For the approximately 15 micron grain size materials examined the c-axis stress distributions determined from the mapping technique were characterised using plus or minus standard deviations of approximately (190 plus or minus 40) MPa. 21 refs.

203660

GRAIN SIZE EFFECTS ON IRRADIATED CeO2, ThO2, AND UO2

Cureton W F; Palomares R I; Walters J; Tracy C L; Chen C-H; Ewing R C; Baldinozzi G; Lian J; Trautmann C; Lang M - *Tennessee,University; Stanford,University; Paris-Saclay,University; Rensselaer Polytechnic Institute; GSI Helmholtzzentrum fur Schwerionenforschung; Darmstadt,Technical University*

Acta Mater. 160,2018,p.47-56

Microcrystalline and nanocrystalline UO2, ThO2, and CeO2 (around 2 micron and 20 nm particle size, respectively) were irradiated with 946 MeV Au ions at room temperature and characterised by XRD, Raman spectroscopy and TEM. All the samples showed a small increase in the unit cell parameter as a function of the ion fluence (0.17 plus or minus 0.03% for CeO2 and 0.11 plus or minus 0.03% for ThO2), except for microcrystalline UO2, which displayed a small contraction of the unit cell (-0.06 plus or minus 0.02%). Raman spectroscopy measurements of microcrystalline UO2 indicated an increase in the non-stoichiometry after irradiation. All the bulk materials were subject to an increase in the heterogeneous microstrain, most notably UO2, which implied that the relatively small changes in the unit cell parameter were accompanied by substantial local disorder induced by isolated defects. The magnitude of the volumetric swelling of all the materials was larger in the nanocrystalline form as compared with the microcrystalline form (0.38 plus or minus 0.60% for CeO2, 0.14 plus or minus 0.03% for ThO2, and 0.52 plus or minus 0.13% for UO2). ThO2 showed the smallest difference in swelling between the microcrystalline and nanocrystalline samples (about 0.03%). All the nanocrystalline materials exhibited irradiation-induced grain coarsening with a decrease in heterogeneous microstrain with increased ion fluence, except nanocrystalline CeO2, which showed no observable change in the grain size and a slight increase in heterogeneous microstrain attributed to the accelerated formation of a secondary Ce11O20 present in both nanocrystalline and microcrystalline materials. Nanocrystalline UO2 exhibited a degree of swelling indicative of a decrease in oxygen content along with an increase in disorder induced by oxygen loss at grain boundaries during irradiation, based on XRD and Raman spectroscopy results. 73 refs.

203661

DENSE MULLITE CERAMIC SINTERED BY SPS AND ITS BEHAVIOR UNDER THERMAL SHOCK

Wang P; Luo X; Wei S; Xie Z; Sun J - *Beijing,University of Science & Technology; SUMEC International Technology Co. Ltd; Liaoning,University of Science & Technology; Beijing,Tsinghua University*

Refract.Ind.Ceram. 59,No.1,2018,p.37-41

Dense mullite ceramics were sintered by spark plasma sintering (SPS). The influence of raw material, sintering temperature, particle size, and Al2O3 content on the densification of the mullite ceramics was investigated. Thermal cycling treatments were conducted to evaluate the thermal shock resistance of the samples. The microstructures were also investigated in order to study the effects of various parameters and thermal tests. The flexural strength retention increased while the density decreased, resulting from increasing extra space for stress release. Tridymite precipitation was found to be detrimental to the thermal shock resistance. 15 refs.

ABRASIVES

See also Abstract(s): 203672

ELECTROCERAMICS

See also Abstract(s): 203600 203614 203715

203662

IMPROVED BREAKDOWN STRENGTH AND ENERGY DENSITY OF Al2O3/NANO-ZrO2 COMPOSITE FILMS VIA ENHANCED INTERFACIAL REPAIRING BEHAVIOUR

Li M; Yao M; Su Z; Gao W; Yao X - *Shanghai,Tongji University; Xian Jiaotong,University*

Ceram.Int. 44,No.17,2019,p.21428-21436

The addition of ZrO2 nanoparticles into the matrix of sol-gel Al2O3 films enhanced their dielectric strength under an applied electric field, using Al as a top electrode, since the ZrO2 nanoparticles formed an interfacial repairing layer. Analysis of the ac conduction properties showed that the introduction of nano-ZrO2 resulted in a lower potential barrier and a longer hopping distance for ionic migration. Simulation results indicated that nano-ZrO2 addition induced a local region of high electric field that accelerated ionic migration which resulted in the nanocomposite Al2O3/nano-ZrO2 structure being capable of providing more ions for the formation of an interfacial repairing layer. With stronger repairing behaviour, the Al2O3/nano-ZrO2 composite films had an enhanced breakdown strength of about 576 MV/m and energy density of 14.7 J/cm3, in contrast with 385 MV/m and 5.9 J/cm3 for pure Al2O3 films with Al electrodes. 40 refs.

203663

ELECTRONIC STRUCTURES AND OPTICAL PROPERTIES OF CuMgVO4 AND AgMgVO4: A FIRST-PRINCIPLES STUDY

Gake T; Matsushima S; Arai M; Obata K - *Kitakyushu,National College of Technology; Ibaraki,Nat.Inst.for Materials Science*

J.Ceram.Soc.Jap. 127,No.1,2019,p.50-55

The electronic structures and optical properties of CuMgVO4 and AgMgVO4, with optimised structures, were investigated using the generalised gradient approximation proposed by Perdew-Burke-Ernzerhof and the Heyd-Scuseria-Ernzerhof hybrid functional. From the energy band calculation, CuMgVO4 and AgMgVO4 had indirect band gaps. The upper valence band was mainly composed of fully occupied Cu 3d (Ag 4d) states and the lower mainly comprised O 2p states. The conduction band could be divided into two regions because of the crystal-field splitting by the interaction between the V 3d and the O 2p states. The optical properties of CuMgVO4 and AgMgVO4 were predicted from the complex dielectric function, epsilon(omega) = epsilon1(omega) + iepsilon2(omega). The static dielectric constants were estimated from the real part of the dielectric functions, epsilon1(omega). The imaginary part of the dielectric functions, epsilon2(omega), showed optical anisotropy, with the component along the z (y) direction being larger than the others for CuMgVO4 (AgMgVO4) in the wavelength range of visible light. The absorption coefficient I(omega) was also calculated from the dielectric function. 16 refs.

Ferrites

See also Abstract(s): 203601 203716

203664

SYNTHESIS AND MAGNETIC PROPERTIES OF MONODISPERSE CoFe2O4 NANOPARTICLES COATED BY SiO2

Hu D; Zhao F; Zhang Z; Miao L; Ma R; Zhao W; Ren L; Zhang G; Zhai L; Wang D; Dou S - *Baoji,University of Arts & Sciences*

Ceram.Int. 44,No.18,2018,p.22462-22466

Monodisperse CoFe2O4 nanoparticles were synthesised by a modified chemical coprecipitation method and coated with SiO2 to prevent single domain particles from interacting with the cubic magnetocrystalline anisotropy. The Curie temperatures (Tc) of the monodisperse CoFe2O4 nanoparticles could be accurately measured because the SiO2 shells prevented the aggregation and growth of nanoparticles at high temperature. The magnetic properties of the CoFe2O4@SiO2 nanoparticles with core-shell structure were studied in a wide temperature range (300-950 K). The coercive field (Hc) of the CoFe2O4 nanoparticles increased from about 760 Oe to 1806 Oe after being coated with SiO2, which increased by 137.6% compared to the uncoated samples at 300 K. The saturation magnetisation (Ms) of the CoFe2O4@SiO2 nanoparticles was 34.59 emu/g, about 52% of the value for the uncoated CoFe2O4 nanoparticles (66.51 emu/g) at 300 K. The hysteresis loops of the CoFe2O4@SiO2 nanoparticles showed an ordered magnetic behaviour at high temperature, with the Ms, remanent magnetisation (Mr) and Hc decreasing as the temperature increased, being equal to zero near Tc. This is a good indication that the CoFe2O4@SiO2 nanoparticles are suitable for a wide variety of technological applications at high temperature. 22 refs.

Titanates, zirconates and niobates

See also Abstract(s): 203615

203665

EFFECTS OF Fe2O3 DOPING ON THE ELECTRICAL PROPERTIES OF Na0.47Bi0.47Ba0.06TiO3 LEAD-FREE CERAMICS

Wang C; Xia T; Lou X - *Lanzhou,University of Technology; Xian Jiaotong,University; Gansu,Construction Vocational Technical College*

Ceram.Int. 44,No.18,2018,p.22053-22058

Na0.47Bi0.47Ba0.06Ti1-xFexO3-Delta lead-free piezoelectric ceramics (BNBT-100xFe, x = 0, 0.01, 0.02, 0.03) were synthesised by solid-state reaction. XRD patterns showed that the doping Fe2O3 totally diffused into the crystal lattice of the ceramics and formed a pure perovskite structure. Enhanced piezoelectric properties were obtained at x = 0.01, reflected in the enhanced remanent polarisation and a giant piezoelectric constant (d33) up to 168 pC/N. The increasing ferroelectric-to-relaxor phase transition temperature on dielectric permittivity curves suggested enhanced ferroelectric characteristics with increasing Fe3+ content. Complex ac impedance analysis showed that the grain, grain boundary and electrode effects were all found at the appropriate composition. The resistivity behaviour of the samples was sensitive to the doping Fe3+ concentration, and the oxygen vacancies also played an important role in this. 50 refs.

203666

ABNORMAL GRAIN GROWTH IN (K, Na)NbO3-BASED LEAD-FREE PIEZOCERAMIC POWDERS

Thong H-C; Xu Z; Zhao C; Lou L-Y; Chen S; Zuo S-Q; Li J-F; Wang K - *Beijing,Tsinghua University*

J.Am.Ceram.Soc. 102,No.2,2019,p.836-844

Abnormal grain growth (AGG) is frequently observed in sintered (K, Na)NbO3 (KNN)-based piezoceramics. However, in the present study, abnormal grain growth was unexpectedly discovered in calcined KNN-based powders. To explain the phenomenon, three well-established models that account for the AGG in sintered ceramics were discussed, including (a) liquid-phase-assisted grain growth, (b) two-dimensional nucleation grain growth, and (c) complexion coexistence. However, the AGG in calcined powders was concluded to be a consequence of the A-site compositional inhomogeneity in the K2CO3-Na2CO3-Nb2O5 ternary system. Since repeated calcination and ball milling have low efficiency on solving AGG and the accompanied compositional inhomogeneity, abnormal grains were found to coexist with normal grains at a very high calcination temperature of 1000 C. The compositional inhomogeneity is believed to remain even after sintering and consequently the comprehensive performances were deteriorated, which could be a determinant for the unstable reproduction of KNN-based piezoceramics. 47 refs.

Fuel cell and sensor applications

See also Abstract(s): 203603 203615 203722

203667

EFFECT OF CARBONACEOUS COUNTER ELECTRODES ON THE PERFORMANCE OF ZnO-GRAPHENE NANOCOMPOSITES BASED DYE SENSITISED SOLAR CELLS

Siwach B; Mohan D; Singh K K; Kumar A; Barala M - *Hisar,Guru Jambheshwar University of Science & Technology; Murthal,DCR University of Science & Technology*

Ceram.Int. 44,No.17,2019,p.21120-21126

The photovoltaic behaviour of dye sensitised solar cells (DSSCs) fabricated using graphene, multiwalled carbon nanotubes (MWCNTs), and Pt film counter electrodes (CEs), respectively, were compared. The graphene and MWCNTs CEs films were prepared by doctor blading the graphene and

MWCNTs pastes on indium tin oxide (ITO) glass substrates. The structural, morphological and compositional properties of the carbon CEs were investigated using XRD, FE-SEM and EDX, respectively. Cyclic voltammetry (CV) and electrochemical impedance spectroscopy (EIS) were used for examination of the electrochemical and catalytic properties of Pt and carbonaceous CEs. The low-cost graphene and MWCNTs CEs were used in the sandwich-structured DSSCs with ZnO-graphene nanocomposite films as photoanodes. The photoconversion efficiency values of the as-prepared DSSCs were measured under AM 1.5 illumination (100 mW/cm2). The DSSCs with graphene CE and MWCNTs CE had efficiency values of 2.26% and 2.04%, respectively. The performance of these carbonaceous CEs was comparable to that of Pt CE which indicated the practicability of carbon-based nanomaterials in DSSCs as low cost alternatives to expensive Pt. 61 refs.

203668

OXYGEN PUMPING BASED ON C-AXIS-ORIENTED LANTHANUM SILICATE CERAMICS: CHALLENGE TOWARD LOW OPERATING TEMPERATURE

Watanabe K; Ide S; Kumagai T; Fujino T; Suematsu K; Shimanoe K - *Kyushu,University; Mitsui Mining & Smelting Co.Ltd.*

J.Ceram.Soc.Jap. 127,No.1,2019,p.1-4

A new electrochemical oxygen separation pump was developed using c-axis-oriented La9.66Si5.3B0.7O26.14 (c-LSBO), with a high oxide-ionic conductivity (> 10 exp(-3) S/cm) up to 300 C. The interfacial resistance between the electrode and c-LSBO was investigated to realise the full potential of LSBO as an oxygen separation material. The formation of a Sm-doped CeO2 (SDC) thin film (thickness: 300 nm) between the electrode and c-LSBO was effective for suppressing the interfacial resistance. Mixed conductive La0.6Sr0.4Co0.78Ni0.02Fe0.2O3-delta (LSCFN) was applied to the electrode to enhance the oxygen reduction/evolution activity at the electrode. The LSCFN/SDC/c-LSBO symmetric cell had an oxygen permeation flux of 3.5 mL/cm2/min (1.0 A /cm2) at 600 C under an applied DC voltage of 1.5 V, which was 67 times that of Pt/c-LSBO. This oxygen pump based on the LSCFN/SDC/c-LSBO symmetric cell could be used for oxygen separation at intermediate temperatures and the reduced interfacial resistance and polarisation resistance of the electrode could reduce the operating temperatures to below 400 C. 21 refs.

203669

EFFECT OF Li3BO3 ADDITION TO NASICON-TYPE SINGLE-PHASE ALL-SOLID-STATE LITHIUM BATTERY BASED ON Li1.5Cr0.5Ti1.5(PO4)3

Nishio A; Inoishi A; Kitajou A; Okada S - *Kyushu,University; Yamaguchi,University*

J.Ceram.Soc.Jap. 127,No.1,2019,p.18-21

The electrochemical properties of a single-phase all-solid-state battery based on Li1.5Cr0.5Ti1.5(PO4)3 and the effect of a Li3BO3 additive as a flux to Li1.5Cr0.5Ti1.5(PO4)3 were investigated. The Li1.5Cr0.5Ti1.5(PO4)3 pellet containing Li3BO3 additive had a higher density due to filling the voids of Li1.5Cr0.5Ti1.5(PO4)3, which due to the low electronic conductivity of Li3BO3 increased the overpotential, but the electron leakage was suppressed. However, the operational voltage and reversible capacity were improved due to the high lithium-ionic conductivity of Li3BO3. 16 refs.

203670

INFLUENCE OF ANISOTROPIC SURFACE STRESSES AND BULK STRESSES ON DEFECT THERMODYNAMICS IN LiCoO2 NANOPARTICLES

Stein P; Moradabadi A; Diehm M; Xu B-X; Albe K - *Darmstadt,Technical University; Berlin,Freien Universitat*

Acta Mater. 159,2018,p.225-240

The distribution of surface-induced bulk stresses in a LiCoO2 nanoparticle and their impact on the migration of Li vacancies was investigated. LiCoO2 is a prototypical cathode material, where the diffusion of Li is mediated by the vacancy mechanism. For this investigation, elastic parameters and anisotropic surface stress components were computed using density functional theory calculations. They were incorporated into a surface-enhanced continuum model, implemented by the finite element method. The particle geometry was derived from a Wulff construction, and changes in the formation energy and migration barriers of a Li vacancy were determined using the defect dipole tensor concept. Within the considered nanoparticle, the surface stresses resulted in a highly heterogeneous bulk stress distribution with a vortex-like transition region between the tensile particle core and its non-uniformly stressed boundaries. Both the centre and the exterior of the particle showed enhanced formation energy and migration barriers for a Li vacancy. These experienced a reduction in the transition region in the particle, which culminated in a peak increase in vacancy diffusivity and ionic conductivity by about 10% each. A particle with a length-scale of 10 nm yielded an overall increase in ionic conductivity by 0.8%. This surface stress-enhanced conductivity decayed rapidly with increased particle size. 77 refs.

203671

IMPACT OF POINT DEFECTS ON THE ELASTIC PROPERTIES OF BaZrO3: COMPREHENSIVE INSIGHT FROM EXPERIMENTS AND AB INITIO CALCULATIONS

Hoedl M F; Makagon E; Lubomirsky I; Merkle R; Kotomin E A; Maier J - *Max-Planck-Institut fur Festkorperforschung; Weizmann Institute of Science; Latvia,University*

Acta Mater. 160,2018,p.247-256

The elastic properties of dry and hydrated Y-doped BaZrO3 (1.5-17 mol% Y) were determined using ultrasound time of flight (TOF) measurements and complemented by ab-initio calculations which allowed analysis of the different contributions. The experimental and theoretical findings were consistent and revealed a decrease in the Young's, shear and bulk moduli with increased dopant concentration. This decrease was attributed to the combined effect of macroscopic lattice chemical expansion, mainly caused by differing ionic radii, and the presence of point defects including acceptors Acc'(Zr) (with decreased cation charge), oxygen vacancies V**(0), and protonic defects OH*(0) (hydroxide ions on oxide ion sites) that locally weaken the chemical bonds in the perovskite structure. The effect from a modified lattice parameter was minor relative to the decrease in moduli caused by Acc'(Zr), V**(0), OH*(0) weakening the chemical bonds. The elastic moduli differed only slightly between the dehydrated and hydrated samples. The decrease in the elastic moduli with increased acceptor and oxygen vacancy concentrations was stronger in Y-doped BaZrO3 (-5.8% in Y:BaZrO3 per mol% of vacancies) compared to similar earlier investigations on Gd-doped CeO2 (-2% in Gd:CeO2). This result indicated the greater effect of oxygen vacancies on the elastic properties in ABO3 perovskites with the linear B-O-B bonds as compared to fluorites with bent M-O-M bonds. 56 refs.

ENGINEERING CERAMICS

203672

MICROSTRUCTURAL FEATURES AND THERMAL STABILITY OF ALUMINA-BONDED NANO-POLYCRYSTALLINE DIAMOND SYNTHESISED BY DETONATION SINTERING

Yan X; Li X; Wang X; Yan H; Xie X - *Shangrao,Normal University; Jiangxi Province Key Lab.Polymer Preparation & Processing; Dalian,University of Technology; Anhui,University of Science & Technology*

Ceram.Int. 44,No.18,2018,p.22045-22052

Nano-polycrystalline diamond (NPD) is a product obtained by the direct bonding and transformation of nano diamonds at high temperatures and pressures with the addition of sintering aids. Alumina-bonded NPD was synthesised by detonation sintering in the temperature range 3000-3500 K and pressure range 15-25 GPa. The microstructures and thermal stability of the NPD detonation sintered at 3255.05 K and 24.51 GPa were studied. TEM and electron diffraction revealed that the polycrystalline diamond had a unique formation process and no graphitisation. SEM indicated that the size of polycrystalline particles increased in three of the samples. TGA indicated that the thermal stability of the diamond particles was improved. The 18% mass loss of specimen corresponded to the oxidation and decomposition of the amorphous carbon and carbon-containing compounds synthesised by detonation. Graphitisation calculations showed that the graphitisation probability of polycrystalline diamond produced at 3255.05 K and 24.51 GPa was 15.04%. 15 refs.

203673

HIGH TEMPERATURE OXIDATION BEHAVIOUR OF ZrB2-SiC ADDED MoSi2 CERAMICS

Tong Z; He R; Cheng T; Zhang K; Dai D; Yang Y; Fang D - *Beijing,Institute of Technology; Tianjin,University; Shanghai,Second Military Medical University*

Ceram.Int. 44,No.17,2019,p.21076-21082

MoSi2, MoSi2-20 vol% (ZrB2-20 vol% SiC) and MoSi2-40 vol% (ZrB2-20 vol% SiC) ceramics were prepared by pressureless sintering and their oxidation behaviour was investigated at 1600 C for different soaking times of 60, 180 and 300 min, respectively. The oxidation behaviour of the MoSi2-(ZrB2-SiC) ceramics was studied using a weight change test, oxide layer thickness measurement and microstructural analysis. Further investigation of the oxidation behaviour of the MoSi2-(ZrB2-SiC) ceramics was conducted at a higher temperature of 1800 C for 10 min. The microstructural evolution of the ceramics was also analysed. The oxidation resistance of MoSi2 was improved by adding ZrB2-SiC additives, and the MoSi2-20 vol% (ZrB2-20 vol% SiC) ceramic had the optimal oxidation resistance behaviour at elevated temperatures. This study could provide a fundamental understanding and promote the engineering application of MoSi2-based ceramics at high temperatures. 27 refs.

203674

INTEGRATED COMPUTATIONAL CERAMICS ENGINEERING - AN APPROACH TO RADICALLY REDUCE TIME-TO-MARKET

Raether F; Seifert G - *Fraunhofer-Institut fur Silicatforschung*

Ceram.Forum Int./Ber.DKG. 95,No.11/12,2018,p.E21-E27

Integrated Computational Materials Engineering (ICME) combines various simulation tools on different scales to identify adequate composition, structure and process parameters of materials according to the performance requirements of new components. It includes inductive methods of data analysis and pattern recognition. The benefit is a drastic reduction of development cost and time. Although in its infancy, particularly in the ceramics industry, some progress has been achieved. Structure-property simulation methods, methods to describe microstructural development during sintering and the correlation of the properties with the final product are discussed. Opportunities for Integrated Computational Ceramics Engineering (ICCE) are new lightweight ceramic components, amongst others available now by additive manufacturing methods, and sustainable production routes. The implementation of digital twins of production units would significantly contribute to a faster up-scaling of processes and better process control during production, provided the reliability of the digital twins is sufficient. 14 refs.

Borides

203675

SPARK PLASMA SINTERING AND MECHANICAL PROPERTIES OF COMPOUNDS IN TiB2-SiC PSEUDO-DIAGRAM

Singlard M; Tessier-Doyen N; Chevallier G; Oriol S; Fiore G; Vieille B; Estournes C; Vardelle M; Rossignol S - *Limoges,Institut de Recherche sur les Ceramiques; Centre National d'Etudes Spatiales; CIRIMAT*

Ceram.Int. 44,No.18,2018,p.22357-22364

The effect of the spark plasma sintering parameters (temperature, time and pressure) and the role of particle size on the densification, microstructure and mechanical properties of commercial additive-free TiB2, SiC and their composites were studied by XRD, SEM, ultrasonics and indentation. Three particle sizes of SiC and two of TiB2 were used. The optimal cycle for TiB2 and SiC was found to be 2000 C, 3 min dwell time, and 100 MPa applied at 600 C. The relative density of pure SiC increased linearly from 70 to 90% when the initial particle size decreased from 1.75 to 0.5 micron. Pure TiB2 was densified up to 87%. When 2.5 wt% SiC was used in TiB2, the relative density increased to 97%. The Young's modulus and hardness of all the samples were measured. The higher properties were obtained for additive-free TiB2-5%SiC with a relative density of 97%, with the Young's modulus and Vickers hardness values being close to 378 GPa and 23 GPa, respectively. 55 refs.

Carbides

See also Abstract(s): 203675

203676

MICROSTRUCTURE AND MECHANICAL PROPERTIES OF GEL CASTED Ti3AlC2

Liu Y; Zhu D; Grasso S; Hu C - *Southwest Jiaotong University*

Ceram.Int. 44,No.18,2018,p.23254-23258

Dense Ti3AlC2 components with a complex shape were fabricated by gel casting followed by pressureless sintering. A low viscosity slurry was prepared using an aqueous based acrylamide monomer with a 50% solids loading to obtain homogeneous and crack free Ti3AlC2 green bodies. The sintering temperatures were 1500, 1550 and 1600 C, and the highest relative density of 93% was achieved at 1550 C. There was a drop of relative density in samples sintered at 1600 C because of the abnormal grain growth and entrapped porosity. The pressureless sintered samples had

mechanical properties comparable to hot pressed counterparts with a Vickers hardness of 3.1 plus or minus 0.2 GPa, fracture toughness of 4.2 plus or minus 0.2 MPa.m1/2 and flexural strength of 302.3 plus or minus 25.0 MPa. Final machining was still needed to obtain net shape components free from surface defects. 15 refs.

203677

SUPPRESSING ETA-PHASE DEVELOPMENT IN STEEL-CEMENTED TUNGSTEN CARBIDE: A SPARK PLASMA SINTERING STUDY

Cahill J T; Kelly J P; Novitskaya E; McKee M; Bahena J A; Graeve O A - *California,University at San Diego; New York,Alfred University; Advanced Materials & Devices Inc.*

J.Am.Ceram.Soc. 102,No.2,2019,p.595-601

A cemented tungsten carbide was prepared using a high-vanadium tool steel as the cementing/binder phase, and its phase stability was studied. The suppression of (Fe, W)6C eta-phase formation, attributed to the preferential formation of a V0.78W0.22C1-x phase that exists as islands within the Fe-rich binder matrix, was also investigated. The samples were prepared using spark plasma sintering (SPS), starting from commercially available WC and A11-LVC tool steel powders. The starting powders were ball milled with 10, 15 and 20 vol% steel. A11-LVC tool steel was chosen as a low-cost hard steel (49 HRC) that does not contain Ni or Co but has a high vanadium (about 9 wt%) and carbon (about 1.75 wt%) content. Sintering by SPS produced high density (> 98%) WC-steel specimens in which the matrix wetted the WC grain surfaces and formation of the brittle eta phase was avoided. The eta phase is often regarded as embrittling and undesirable, and its presence can result in the degradation of mechanical properties. Microhardness values for the WC-10 and WC-15 vol% steel samples were 12.3 plus or minus 1.2 and 13.0 plus or minus 0.9 GPa, respectively, whereas the fracture toughness values were 8.83 plus or minus 0.48 and 8.81 plus or minus 0.61 MPa.m1/2, respectively. 24 refs.

203678

LASER ADDITIVE MANUFACTURING AND HOMOGENEOUS DENSIFICATION OF COMPLICATED SHAPE SiC CERAMIC PARTS

Liu K; Wu T; Bourell D L; Tan Y; Wang J; He M; Sun H; Shi Y; Chen J - *Wuhan,University of Technology; Texas,University at Austin; Huazhong,University of Science & Technology*

Ceram.Int. 44,No.17,2019,p.21067-21075

The density of complex-shaped SiC ceramic components were prepared by combining laser sintering (LS), cold isostatic pressing (CIP) and reaction sintering (RS). In the LS/CIP/RS process, phenol formaldehyde resin (PF)-SiC composite powder was prepared by mechanical mixing and cold coating methods, with an optimised content of PF at 18 wt%. To obtain improved density in the sintered body after reaction sintering, carbon black was added into the initial mixed powder. The material preparation, LS forming and densification steps were optimised throughout the whole fabrication process. The final sintered SiC bodies, with a bending strength of about 292 to 348 MPa and a density of 2.94-2.98 g/cm3, were prepared using the PF coated SiC-C composite powder and the LS/CIP/RS process. 15 refs.

203679

EFFECT OF BORON CARBIDE COMPOSITION ON ITS DENSIFICATION BEHAVIOUR DURING SPARK PLASMA SINTERING (SPS)

Firshtman N; Kalabukhov S; Frage N - *Ben-Gurion University of the Negev*

Ceram.Int. 44,No.17,2019,p.21842-21847

The effect of boron carbide composition on its sintering behaviour was investigated. Various compositions of boron carbide were synthesised by reacting stoichiometric boron carbide with TiO2. Powder mixtures containing boron carbide with different boron to carbon ratios (x in BxC was changed from 4.05 to 6.33) and different vol% of TiB2 (from 6 to 21 vol%) were synthesised by spark plasma sintering at 1800 and 1900 C combined with densification using hot pressing at 50 MPa for 30 min; a mixture of stoichiometric boron carbide with 20 vol% TiB2 was densified under the same conditions. The positive effect of the boron carbide composition on the sintering behaviour was observed, while only minor effects from TiB2 addition were detected. Results showed that the carbon concentration in boron carbide gradually decreased in the 1200-1700 C temperature range during spark plasma sintering and after sintering at 1800 and 1900 C when the B:C ratio (x) was already close to its stoichiometric value, irrespective of the initial carbon content. The mechanical properties of the sintered samples were directly linked to their relative densities. The maximum values of Young's modulus (450 plus or minus 10 GPa), bending strength (840 plus or minus 40 MPa) and hardness (35 plus or minus 4 GPa) were obtained for fully dense specimens fabricated from the synthesised B6.3C-21vol%TiB2 mixture. 30 refs.

Nitrides

See also Abstract(s): 203602

203680

HYDROTHERMAL CORROSION RESISTANCE OF SILICON NITRIDE WITH O'-SIALON GRAIN BOUNDARY PHASE

Vetrecin M; Lences Z; Galuskova D; Sajgalik P - *Bratislava,Institute of Inorganic Chemistry; Vitrum Laugaricio*

Ceramics-Silikaty. 62,No.4,2018,p.382-388

Dense Si3N4-based composites with O'-SiAlON bonding phase were prepared by hot pressing the Si3N4 matrix and polysiloxane (samples SA) and polysilazane (samples SB) based sintering aids. In both samples alpha-Si3N4 and beta-Si3N4 were identified as the major phases and O'-SiAlON with the chemical formula Si1.84Al0.16O1.16N1.84 as the minor phase. Hydrothermal corrosion tests were performed in subcritical conditions at 250 C for 100 h. The weight loss was somewhat low, 0.96 wt% and 1.32 wt% for samples SA and SB, respectively. The corrosion rate of samples SA and SB was 206 mg/m2.h and 233 mg/m2.h. The higher corrosion rate of sample SB prepared with the polysilazane-based sintering aid was probably due to the hydrothermal dissolution of Si3N4 grains producing ammonia, as the pH value of eluate of this sample was higher (8.5 compared to 8.0 for sample SA). In sample SA a continuous SiO2-based passivation layer was formed, while in sample SB the passivation layer was discontinuous and the corrosion medium could easily attack the Si3N4 grains. As the corrosion solution was more basic in sample SB, the SiO2 passivation layer did not form so effectively, or dissolved faster than in sample SA. The higher corrosion resistance of sample SA was partly improved by using Y2O3 sintering additive, which formed a rather stable Y2SiO5 phase. 31 refs.

Oxides

See also Abstract(s): 203595 203602 203606 203607 203608 203610 203612 203720

203681

REVIEW ON THE HYDROTHERMAL AGEING BEHAVIOUR OF Y-TZP CERAMICS

Ramesh S; Sara Lee K Y; Tan C Y - *Malaya,University; Malaysia,Universiti Tunku Abdul Rahman*

Ceram.Int. 44,No.17,2019,p.20620-20634

The devastating effects of hydrothermal ageing on the properties of yttria-tetragonal zirconia polycrystal (Y-TZP), when exposed to a humid environment, were reviewed. The main factors governing the ageing-induced tetragonal to monoclinic phase transformation, including the tetragonal grain size, sintering techniques (particularly two-step sintering, microwave sintering and electric field-assisted sintering), and yttria content are discussed. In addition, the beneficial effects of sintering additives or dopants in promoting sintering and suppressing ageing-induced monoclinic formation were also assessed. Selective dopants and co-dopants including copper oxide, alumina, iron oxide and magnesium oxide were beneficial in suppressing hydrothermal ageing in zirconia. Other important boundary conditions considered when evaluating the ageing behaviour of Y-TZP included the ageing environment i.e. temperature, medium and applied pressure which had an impact on the rate of phase transformation. The effects of ageing-induced monoclinic formation on the surface topography and mechanical properties of the Y-TZP are also reviewed. The ageing of Y-TZP could be intricate as there are many combinatory factors that need to be tailored to develop ageing-resistant zirconia without compromising the transformation toughening effect and other properties. 171 refs.

REFRACTORIES

See also Abstract(s): 203538 203539 203540 203541 203542 203594 203645 203650

203682

ENHANCED ALKALI VAPOUR ATTACK RESISTANCE OF BAUXITE-SiC REFRACTORIES FOR THE WORKING LINING OF CEMENT ROTARY KILNS VIA INCORPORATION OF ANDALUSITE

Ren B; Li Y; Nath M; Wang Q; Xu Y - *Wuhan,University of Science & Technology*

Ceram.Int. 44,No.18,2018,p.22113-22120

When bauxite-SiC refractories are used as the working linings of cement rotary kilns, they are subjected to severe alkali attack due to alternative fuel combustion. An attempt was made to enhance their alkali attack resistance by incorporating different types of andalusite (aggregates and powder). The results showed that the addition of andalusite reduced the penetration of alkali vapour by decreasing the pore size. In particular, the presence of andalusite aggregates trapped alkali vapour inside their pore network, retarding the corrosion of the refractory matrix. In comparison, the presence of andalusite powder contributed to the formation of liquid corrosion products to block the pores, which prevented alkali vapour from further penetration. Incorporation of andalusite into bauxite-SiC refractories is straightforward and needed, providing an effective approach for high-performance refractory materials with excellent alkali attack resistance. 27 refs.

203683

DYNAMIC INTERACTION OF REFRACTORY AND MOLTEN STEEL: EFFECT OF ALUMINA-MAGNESIA CASTABLES ON ALLOY STEEL CLEANNESS

Huang A; Wang Y; Gu H; Zou Y - *Wuhan,University of Science & Technology*

Ceram.Int. 44,No.18,2018,p.22146-22153

As alumina-magnesia refractories are the main lining materials used for steel refining, the influence of these refractories on the cleanliness of molten steel under dynamic smelting conditions was studied. The size, quantity, composition, and structural evolution of inclusions in steel were analysed. The results showed that, after smelting, the content of alloy elements in the steel was stable, and the total oxygen content and inclusions in the steel were increased by the corrosion of the alumina-magnesia castables. However, the maximum average particle size of the inclusions in the steel was limited to 20 micron, which did not cause large inclusions in the steel or seriously affect the quality of the steel. During the dynamic melting process, because of the presence of Si and Mn in the alloy steel, the inclusions changed from a homogeneous CaS wrapped Al2O3-MgO composite sphere to a MnS wrapped egg-shaped structure. The alloy elements in steel reduced the effect of alumina and magnesia inclusions on the quality of the steel. The results indicated that it is feasible to smelt high quality alloy steel using alumina-magnesia carbon-free castable, and that it would be better to limit the refining time to 45 min during smelting. 21 refs.

203684

DIFFERENCE IN PORE EVOLUTION OF CALCIUM ALUMINATE CEMENT-BONDED ALUMINA BUBBLE-BASED CASTABLES WITH MICRO-SIZED MgCO3 AND Al(OH)3

Hu S; Chen L; Ding D; Zhu L; Ye G - *Zhengzhou,University; Henan,University of Science & Technology; Leuven,Catholic University*

Ceram.Int. 44,No.18,2018,p.22897-22903

Micro-sized MgCO3 and Al(OH)3 were used as inorganic porogenic agents to increase the porosity of calcium aluminate cement-bonded alumina bubble lightweight castables. The effect of 0-4 wt% microsized MgCO3 and 0-8 wt% microsized Al(OH)3 additions on the porosity, thermal conductivity and strength of the castables after firing was studied. The results indicated that the porosities of the castables containing microsized Al(OH)3 or MgCO3 after heat treatment were raised by increasing the contents of microsized Al(OH)3 or MgCO3 due to volume shrinkage and H2O/CO2 release (void generation), leading to the decrease of thermal conductivity. It was found that MgCO3 favoured porosity formation more than Al(OH)3 in the castables because of the different formation behaviour of calcium aluminates and MgAl2O4 spinel. The dependence of the properties of castables on the addition of microsized Al(OH) or MgCO3 is discussed with respect to the pore evolution. 28 refs.

203685

REFRACTORY CERAMICS SYNTHESIS BY SOLID-STATE REACTION BETWEEN CaCO3 (MOLLUSC SHELL) AND Al2O3 POWDERS

Miranda-Hernandez J G; Ortega-Aviles M; Herrera-Hernandez H; Gonzalez-Moran C O; Garcia-Pacheco G; Rocha-Rangel E - *Mexico,Universidad Autonoma del Estado; Mexico,Instituto Politecnico Nacional; Mexico,Universidad Politecnica de Victoria*

Ceramics-Silikaty. 62,No.4,2018,p.355-363

Calcium aluminate-based refractories were developed using garden snail (Helix aspersa) shells as a natural source of CaCO3. A 1:1 molar ratio mixture of CaCO3 from snail shells and commercial Al2O3 powder was prepared by high-energy mechanical milling. The mixed powder was compacted in cylindrical samples (discs) and consolidated by sintering at 1450 C and 1500 C for 1 h. The density and porosity were evaluated using the Archimedes principle, and the mechanical properties (hardness, fracture toughness, and shear modulus) were determined by indentation and ultrasonic methods. The thermal shock resistance was tested by heating samples to temperatures between 900 and 1400 C and subsequent quenching in water at room temperature. XRD patterns of sintered samples indicated the formation of different calcium aluminate phases, such as CaAl12O19 (krotite/monoclinic), CaAl4O7 (grossite/monoclinic) and CaAl2O4 (hibonite-5H/hexagonal). The fracture toughness and shear modulus values of materials sintered at 1450 C were higher (0.48 MPa.m1/2 and 59 GPa, respectively) than those of materials sintered at 1500 C (0.43 MPa.m1/2 and 55 GPa, respectively). Changes in the bulk density, hardness and thermal shock resistance values were also seen in materials sintered at 1450 C and 1500 C. 42 refs.

203686

SPECIFICATION OF MgO-CONCENTRATE OBTAINED FROM POST MORTEM MgO-C REFRACTORY MATERIALS

Plesingerova B; Vadasz P; Sucik G; Olejar I - *Kosice,Technical University; Intocast Slovakia as*

Ceramics-Silikaty. 62,No.4,2018,p.389-395

The recycling process of post mortem periclase-carbon (MgO-C, MC) refractory materials is based on carbon removal from the crushed material. Laboratory results of the annealing of the crushed post-mortem MC bricks in a static layer, in an air atmosphere in an electric furnace are presented. The quantity and quality of the fraction size was evaluated before and after annealing. The results showed that the carbon inside the grains of size 6.3-15 mm was incompletely burnt out under the given conditions. The results from annealing of the fraction size < 6.3 mm confirmed that the carbon burn out decreased the strength and density of the agglomerates, which then partially disintegrated during annealing. A mechanical load was needed for the complete disintegration of the brittle agglomerates. Results are also discussed of the quality evaluation of the MgO-fractions, which were obtained by annealing the grit from the post-mortem MC bricks from pilot-plant experiments in a rotary kiln in the Hacava factory of the company INTOCAST Slovakia a.s. The obtained fraction size of MgO had a suitable chemical and phase composition. However, the strength of the MgO-grain core was lower. This confirmed that the post-mortem MC materials may be recycled, but waste management and the related technical equipment for the recycling processes are required. 19 refs.

203687

OVERVIEW OF MAGNESITE

Drnek T L; Naves Moraes M; Bonadia Neto P - *RHI Magnesita*

RHI Magnesita Bull. No.1,2018,p.14-22

Magnesite occurs in three forms: sparry (macrocrystalline); cryptocrystalline; and fluviatile-limnic (Bela Stena, Serbia). The main deposits are in China, North Korea and Russia, with 26%, 23% and 21% of the global resources, respectively. Magnesite is used by the refractories industry in the form of dead-burned magnesia (annual global production of approximately 7.5 million tonnes), produced by calcination at 1800-2300 C, and fused magnesia (annual global production of approximately 2 million tonnes), produced by melting in an electric arc furnace. Dead-burned magnesia consists of cubic crystals of 50-200 micron, and has a density of 3.00-3.45 g/cm3. The corresponding values for fused magnesia are 200-2000 micron and 3.43-3.54 g/cm3. The RHI group has several production facilities where the ore is crushed and purified prior to calcination or fusion. Although the specific consumption of magnesia by the steel industry is reducing, the absolute consumption is increasing due to increasing production. The market is strongly concentrated and dominated by China. Production in China, the EU and worldwide is influenced by CO2 emissions regulations. Growth in the demand for magnesia is forecast. 15 refs.

203688

REFRACTORY CONCEPT FOR GRATE KILN TECHNOLOGY INDURATION MACHINES

Estrada E J; Hebenstreit G; Stimpfl C; Nader C - *RHI Magnesita*

RHI Magnesita Bull. No.1,2018,p.24-30

In the grate kiln system, pellets of iron ore are dried and preheated on a travelling grate prior to calcination in a rotary kiln, followed by cooling on a second grate. The rotary kiln operates at 1300 C, and RHI Magnesita has developed high alumina or alumina-chromia bricks for the lining, as part of their Thrust Lock System, in which the bricks are angled relative to the axis of the kiln and experience lower mechanical stresses. The sidewalls of the cooling zone experience thermal shock and dust abrasion, and sol-bonded castables have been developed for this application. Refractories are available for installation by casting, gunning and shotcreting. Corrosion resistance and hot abrasion resistance results are reported. 10 refs.

203689

BENEFITS OF MODERN DOLOMA MAGNESIA LININGS IN MODERN CEMENT KILNS

Hartenstein J; Krischanitz R - *RHI Magnesita*

RHI Magnesita Bull. No.1,2018,p.32-37

It is proposed that doloma-magnesia refractory brick is a cost-efficient alternative to the use of dead-burned and fused magnesia for the lining of the burning zone of cement kilns, particularly in the light of the shortage of Chinese raw materials and the use of alternative fuels. Doloma-magnesia refractory has been developed since the 1980s by retaining the use of pure doloma and high-grade magnesia grains combined with the use of a dense magnesia matrix of low porosity and permeability to enhance the resistance to corrosive kiln atmospheres. The addition of zirconia has enhanced the thermal shock resistance, matching that of magnesia spinel brick, whilst the introduction of fused, coarse-grained magnesia has further enhanced corrosion resistance. Doloma magnesia brick also has the advantages of: high stability under reducing conditions at temperatures up to 1800 C; good thermal shock resistance; and the ability to form a protective coating by reaction with the clinker in the presence of lime. The coating acts as a thermal insulating layer, leading to energy savings. 5 refs.

203690

EVALUATION OF HIGH TEMPERATURE REFRACTORY CORROSION BY LIQUID FERRONICKEL SLAGS

Sagadin C; Luidold S; Wagner C; Spanring A - *Leoben,Montan-Universitat; RHI Magnesita*

RHI Magnesita Bull. No.1,2018,p.38-41

Cylindrical specimens of synthetic ferronickel slag were placed on plates of MgO refractory and heated to temperatures of 1350 or 1650 C for 1 h in

an atmosphere of 60% CO, 40% CO2. Corrosion of the refractory by the slag was assessed by SEM, chemical analyses and thermodynamic calculations. Partial dissolution of the refractory was observed, with diffusion of iron oxide from the slag into the refractory via intragranular porosity, followed by reaction with the MgO grains to form low melting point magnesium wustite. 8 refs.

203691

REFRACTORY CONDITION MONITORING AND LIFETIME PROGNOSIS

Viertauer A; Lammer G; Bloemer P - *RHI Magnesita; Agellis AB*

RHI Magnesita Bull. No.1,2018,p.42-46

Examples of the use of laser measuring equipment to determine residual lining thickness, and of IR measurement to determine shell temperatures are described. With the roof removed and the vessel empty, the lining thickness of an electric arc furnace can be automatically measured in < 20 s and software used to predict residual service life. An array of IR sensors can continually monitor the surface temperature of vessels such as RH degassers and steel teeming ladles, so as to detect developing hot spots. Ladle breakout at the slag line is illustrated. 17 refs.

203692

DEVELOPMENT AND APPLICATION OF SLAG MODEL FOR INCREASING LADLE LIFE AT INTEGRATED STEEL MILL - BRAZIL

Lopez Gonzalez F J; Souza P; Garzon M; De Souza D; Dettogne R - *RHI Magnesita*

RHI Magnesita Bull. No.1,2018,p.48-52

A software model was implemented to increase the refractory life of steel ladle furnace with a lining of Al2O3-MgO-C brick for the bottom and the barrel, and of MgO-C for the slag line. The maximum arc length used in production was established, and the phase diagram software was used to establish the optimum saturation point and the liquidus line for the quaternary diagram of CaO-MgO-SiO2-Al2O3 at 20% Al2O3. A spreadsheet was created to calculate the steel alloy recovery, and a database of fluxes established. The system displays the optimum additions required by the heat. Implementation of the model has increased the number of heats from 93 to 128. 4 refs.

203693

INVESTIGATION ON THE INFLUENCE OF EXPANSION JOINTS IN THE MECHANICAL BEHAVIOUR OF STEEL LADLES

Breder Teixeira L; Gasser A; Chaib J P; Alves Freire R - *Orleans,University; RHI Magnesita*

RHI Magnesita Bull. No.1,2018,p.54-57

The periodic linear homogenisation technique was used to develop a homogeneous equivalent material for the determination of stress and strain in steel ladle masonry with dry joints. Four joint states were considered: all open, with surface asperities in contact; horizontal joints closed, vertical joints open; vertical joints closed, horizontal joints open; and all joints closed. A complete steel ladle, consisting of a working layer, backfill and two safety layers, with empty spaces filled with a ramming mix, was modelled. The ladle was presumed to contain steel at 1600 C. Linings with joint widths of 0.0-0.5 mm were modelled, and the influence of the width on the stress distribution is discussed. It is shown that the region experiencing compressive stresses > 40 MPa decreases with increasing joint thickness. 7 refs.

203694

INVESTIGATION OF LADLE YIELD IMPROVEMENTS THROUGH NEW WELL BLOCK DESIGN

Souza da Conceicao P V; da Silva C A; Gomes Guimaraes Ananias J V; Dolabella Resende A; Borges dos Santos M; Mehmedovic A - *RHI Magnesita; Ouro Preto,University*

RHI Magnesita Bull. No.1,2018,p.58-63

A vortex may form as the level in a steel ladle becomes very low. This can entrain slag, resulting in slag carry over to the tundish. The depth of steel remaining when this occurs is the formation height (Hc). Improved well block designs were evaluated to reduce Hc and so increase the steel yield from the ladle. A physical model using water flow was used to compare a modified design, with an increased entry angle, with the standard well block design. The flow was studied for vertical and tangential filling, with and without air injection via a porous plug. Flow was also studied by numerical modelling. There was good agreement between the physical and numerical models. The modified design significantly reduced Hc for all flow rates, with tangential filling giving higher Hc values. Hc was not reduced by air injection. 12 refs.

203695

TUNDISH TECHNOLOGY AND PROCESSES: LADLE TO MOULD SYSTEMS AND SOLUTIONS (PT.3)

Arth G; Meurer D; Kappel M; Loop P; Petritz B - *RHI Magnesita*

RHI Magnesita Bull. No.1,2018,p.64-70

Impact pads and pots are used to regulate the flow and reduce the turbulence of molten steel from the ladle to the tundish. The evolution in the design of impact pads from the late 1960s is illustrated. Structured pads with regular surface features including channels and hemispherical projections, to be used with dams and sidewalls, were patented in the early 1990s. Subsequently, pots were developed which had significantly taller sidewalls, and sometimes including rows of projections to moderate the steel flow. The best results are achieved by using the refractory which provides the optimum slag resistance, established by experimental studies and thermodynamic calculations. The influence of the olivine and magnesia content on the slag resistance is illustrated for slags of different basicity. The results for alumina refractory are also reported. 13 refs.

203696

TUNDISH FURNITURE OPTIMISATION THROUGH MATHEMATICAL MODELLING

Dolabella Resende A; Nazareth Borges R; Alves Freire R; Fraga Resende R - *RHI Magnesita*

RHI Magnesita Bull. No.1,2018,p.72-76

A mathematical model of steel flow in the tundish during the continuous casting process was developed, so as to optimise the design and position of the weir and dam. Three flow regimes were considered: plug flow; well-mixed flow; and dead flow, with optimum results being achieved when the dead volume of steel was the smallest and the plug volume the highest, as this gave the maximum time for nonmetallic inclusions to separate and float out. Two configurations were modelled: with the ladle shroud centred, or with the shroud off centre relative to the impact pot; and with three furniture arrangements: just an impact pot present; with the addition of weirs and dams as used in a specific steel plant; and with the weir and dam positions optimised using the model. In the first case, using the model, an increase in plug volume from 18% to 27%, and a decrease in the dead

volume fraction from 18% to 14% was achieved. In the second case, the plug volume was increased from 8% to 21% and the dead volume reduced from 38% to 20%. 5 refs.

203697

DECARBURISATION BEHAVIOUR OF HIGH-CARBON MgO-C REFRACTORIES IN O2-CO2 OXIDISING ATMOSPHERES

Hu S; Zhu R; Liu R; Dong K - *Beijing,University of Science & Technology*

Ceram.Int. 44,No.17,2019,p.20641-20647

To alleviate the decarburisation rate of MgO-C refractories and prolong the furnace life of oxygen bottom blowing converters, a new method which consists of mixing CO2 in the bottom blowing oxygen is reported. The decarburisation behaviour of MgO-C refractories in an O2-CO2 oxidising atmosphere was studied and the microstructure of the decarburisation zone was investigated. Results showed that as the CO2 ratio increased, the weight loss of the MgO-C refractory decreased with a parabolic trend and the decarburisation zone depth decreased with a linear trend. Microscopy showed that pores formed in the decarburisation zone, and the pore content decreased as the CO2 ratio increased and results confirmed that mixing CO2 in the bottom blowing oxygen could effectively alleviate the decarburisation of MgO-C refractories. 27 refs.

203698

REFRACTORIES HAVE A NEW FUTURE WITH RENEWABLE ENERGY

Perks C

Ind.Miner. No.604,2018,p.52

Because of the extreme temperatures needed for firing temperatures for refractories (often at least 1800 C), fossil fuels have been the only suitable source of heat to date. However, a team of researchers from the University of Adelaide in conjunction with Alcoa and CSIRO are studying the viability of including solar power in the high-temperature calcination stage of the Bayer process. It is necessary to not only produce high-temperature solar energy, but also to maintain it over a long time period. Alcoa has achieved a process with temperatures of about 1000 C, and CSIRO has used higher temperatures in an experimental setting. Solar reforming, the storage of solar energy in chemical form by converting natural gas to syngas, allows a 24-h cycle of high temperatures. Plant equipment would not need to be radically altered. If the research is successful, many industrial calcining operations could implement a solar-gas hybrid system for less capital than needed to build a new plant.

203699

CORROSION TESTING OF BADDELEYITE-CORUNDUM AND CHROMIUM OXIDE MATERIALS IN ALUMINUM PHOSPHATE GLASS MELTS

Remizov M B; Kozlov P V; Kazadaev A A; Medvedev V P; Malinkovich V L - *PO Mayak FGUP; Ozersk,Technological Institute; Glass Furnace Solutions Co.*

Refract.Ind.Ceram. 59,No.1,2018,p.1-5

The corrosion and erosion resistance of refractory materials in direct heating electric furnaces for vitrification of highly active waste (HAW) was studied. Algorithms are provided for evaluating their resistance to the action of phosphate melts under electric furnace operating conditions. Comparative corrosion tests were performed for refractory materials surpassing Bk-33 objects with respect to quality in melts of aluminophosphate glass with simulation of HAW. The results are valuable for selecting lining material in planning EP-500 type vitrification electric furnaces with a prolonged service life, and also the next generation of moveable and small-scale melting units. 7 refs.

203700

USE OF SCHUNGITE ROCKS AS A BINDER IN REFRACTORY MATERIALS

Zavertkin A S; Sadovnichii R V - *Karelian Scientific Centre*

Refract.Ind.Ceram. 59,No.1,2018,p.16-18

The efficiency of using schungite rocks as a binder in refractory materials was investigated. It is demonstrated that refractory compositions with schungite binder had the better physicochemical properties than compositions with a traditional graphite binder. 12 refs.

COMPOSITES

General

See also Abstract(s): 203602 203727

203701

EVOLUTION OF CRACKS WITHIN AN Al2O3-40 wt%TiO2/NiCoCrAl GRADIENT COATING

He X; Song P; Yu X; Li C; Huang T; Zhou Y; Li Q; Lu K; Lu J; Lu J - *Kunming,University of Science & Technology; Yunnan,Academy of Science & Technology*

Ceram.Int. 44,No.17,2019,p.20798-20807

An Al2O3-40 wt%TiO2/NiCoCrAl gradient coating was deposited by atmospheric plasma spraying (APS) and the microstructure and elemental distribution of the coating were studied using SEM and EPMA. The crack propagation behaviour in the coating under an applied and thermal stress was analysed using a three-point bending and a thermal shock test, respectively. Two rapid crack propagation processes were observed during the three-point bending test, which led to two peaks in the load-displacement curves of the gradient coating. The gradual change in the composition also had an effect on the crack propagation process within the coating. Non-directional crack propagation paths and the formation of oxides were observed in the gradient region under the effect of thermal stress, which led to the spallation failure of the coating. 46 refs.

Ceramic matrix composites

See also Abstract(s): 203601 203606 203612 203624 203667 203675 203680

203702

Al2O3/Cu-O COMPOSITES FABRICATED BY PRESSURELESS INFILTRATION OF PAPER-DERIVED Al2O3 POROUS PREFORMS

Pfeiffer S; Lorenz H; Fu Z; Fey T; Greil P; Travitzky N - *Erlangen-Nurnberg,University; Tomsk,Polytechnical University*

Ceram.Int. 44,No.17,2019,p.20835-20840

Al2O3/Cu-O composites were fabricated from a paper-derived alumina matrix infiltrated with a Cu-3.2 wt% O alloy. Paper-derived alumina preforms with an open porosity, which ranged from about 14 to 25 vol%, were prepared by sintering alumina-loaded preceramic papers at 1600 C for 4 h. Pressureless infiltration of the preforms with Cu-O alloy at 1320 C for 4 h resulted in nearly dense materials with good mechanical and electrical properties, fracture toughness up to 6 MPa m0.5, four-point-bending strength up to 342 MPa, Young's modulus up to 281 GPa and electrical conductivity up to 2 MS/m depending on the volume fraction of copper alloy in the composites. The technological capability of this approach was demonstrated using prototypes in various engineering fields fabricated by lamination, corrugating and laminated object manufacturing (LOM) methods. 24 refs.

203703

PREPARATION AND MECHANICAL PROPERTIES OF BORON NITRIDE NANOSHEETS/ALUMINA COMPOSITES

Wang W; Sun G; Chen Y; Sun X; Bi J - *Shandong,University*

Ceram.Int. 44,No.17,2019,p.21993-21997

Boron nitride nanosheets (BNNSs)/alumina composites were fabricated using a flocculation method and hot pressing and the uniform dispersal of BNNSs in the alumina matrix could be controlled via pH adjustment in the flocculation technique. Results showed that as the BNNS content increased, the density of the composites decreased. Compared with monolithic alumina, the bending strength of the composite with 1.0 wt% BNNSs increased by 58.6%, while the fracture toughness was slightly increased. The addition of BNNSs changed the fracture pattern, refined the grains of the composites and inhibited abnormal grain growth, which contributed to the improved mechanical properties of the composites. 28 refs.

Fibre and whisker reinforced ceramic matrix composites

See also Abstract(s): 203604

203704

POROUS ALUMINIUM TITANATE-STRONTIUM FELDSPAR-MULLITE FIBRE COMPOSITE CERAMICS WITH ENHANCED PORE STRUCTURES AND MECHANICAL PROPERTIES

Wang X; Liu C; Li J; Qiao L; Bai Y - *Beijing,University of Science & Technology*

Ceram.Int. 44,No.18,2018,p.22686-22691

The low mechanical strength of porous aluminium titanate (AT) ceramics limits their application. The pore structures and mechanical properties of porous AT-strontium feldspar-mullite fibre (ASM) composite ceramics, where the strontium feldspar and mullite fibres served as secondary phases to improve the mechanical properties of AT, were studied. Two sets of samples were prepared by different methods: traditional reactive sintering, with Al2O3 and TiO2 as raw materials; and an improved method, using AT clinkers. The effects of the processes and raw materials on the pore structure and mechanical properties of the composite ceramics were investigated. The properties of the sintered porous ceramics, including the microstructure, density, porosity, pore size, and mechanical properties, were analysed. After sintering at 1400 C, the ASM ceramics prepared by the improved method had a porosity level of 70% and a pore size of 24 micron, twice that of the traditional ASM ceramics, while both samples had identical flexural strength values of 2.27 MPa. The improved process gave the porous ASM ceramics excellent pore structures and mechanical properties, promoting their potential use in diesel particulate filters, exhaust catalyst carriers for gasoline automobiles and gas filters. 28 refs.

203705

REPEATED TENSILE BEHAVIOUR AND DAMAGE EVOLUTION OF A 2.5D C/SiC COMPOSITE CHARACTERISED BY GREY VERHULST MODELS

Wang Y; Zhang L - *China,Civil Aviation University; Xian,Northwestern Polytechnical University*

Ceramics-Silikaty. 62,No.4,2018,p.396-402

Continuous carbon fibre reinforced silicon carbide (C/SiC) CMCs are promising candidates for many high-temperature applications such as aerospace and aircraft components because of their higher strength and enhanced fracture toughness. Application of traditional 2D laminated composites has been limited by fabrication problems and poor delamination resistance and 3D braided composites, despite having improved delamination resistance, are expensive and not suitable for all applications. A new kind of multilayer C/SiC composite, 2.5D angle-interlock woven composites, has been developed with many advantages over the conventional laminated composites, including near net-shape, better out-of-plane stiffness and strength. However, reports about damage behaviour and its prediction are still limited. The microstructure and repeated tensile behaviour of a 2.5D C/SiC composite fabricated by chemical vapour infiltration were studied and the associated damage evolution was characterised by the residual strain and reloading modulus. Both the envelope stress-strain behaviour and the associated damage evolution of the composite could be well characterised by three regimes including the matrix cracking emergence, a multiplication followed by the matrix cracking saturation. The grey Verhulst model and the inverse grey Verhulst model were established for the evolution of the damage characteristics and the constitutive behaviour, respectively. The predictions and experimental results agreed well for both the grey models, indicating the nature of intra-specific competition for these matrix cracks in the composite. Such robust relationships can be used to facilitate the modelling of the constitutive behaviour of other ceramic composite systems. 17 refs.

203706

THERMO-MECHANICAL CHARACTERISATION OF CARBON FIBRE REINFORCED SILICON CARBIDE COMPOSITES HAVING BORON NITRIDE AS AN INTERPHASE MATERIAL

Singh S; Singh V; Kumari S; Udayakumar A; Bhanu Prasad V V - *Hyderabad,Defence Metallurgical Research Lab.; Bangalore,National Aerospace Laboratories*

Ceram.Int. 44,No.17,2019,p.20755-20761

Carbon fibre-reinforced silicon carbide composites were prepared by an isothermal chemical vapour infiltration process and to achieve the required density, the carbon fibre preforms, in the form of rectangular panels, were infiltrated by a silicon carbide matrix. Prior to matrix infiltration, a thin coating of boron nitride, as an interphase, was applied on the fibre preform. Samples were subjected to the seal coating of silicon carbide using a

chemical vapour deposition process. The effect of a protective SiC seal coating was examined by testing the uncoated and seal coated samples at different temperatures using a 3-point bend test. A higher flexural strength was observed for the seal coated samples as compared to the uncoated samples, when tested at high temperature (up to 1400 C) and the fractured surfaces of the samples were investigated. 16 refs.

203707

MODELLING ON TEMPERATURE-DEPENDENT FIRST MATRIX CRACKING STRESS FOR FIBRE REINFORCED CERAMICS CONSIDERING FIBRE DEBONDING AND RESIDUAL THERMAL STRESS

Deng Y; Li W; Zhang X; Li Y; Kou H; Shao J; Zhang X; Qu Z - *Chongqing,University; Beijing,Institute of Technology*

Ceram.Int. 44,No.17,2019,p.21666-21674

The combined effects of temperature, fibre debonding and residual thermal stress on the matrix cracking stress of fibre-reinforced ceramic matrix composites were investigated. The temperature-dependent stress fields in the fibre and matrix were studied using the modified shear-lag model and a temperature-dependent interfacial debonding criterion was developed. Based on the energy balance approach, a temperature-dependent first matrix cracking stress model, which considered the effects of fibre debonding and residual thermal stress, was established. The model predictions were compared with the available experimental results, which showed good agreement between the theoretical predictions and experimental results. The quantitative effects of fibre volume fraction, interfacial debonded energy and interfacial frictional shear stress on the first matrix cracking stress and fibre debonding length were analysed at different temperatures. This work not only helped to understand the matrix cracking behaviour of fibre-reinforced ceramic matrix composites with general interfacial properties at high temperatures, but also provides guidance for material design. 39 refs.

Particle reinforced ceramic matrix composites

See also Abstract(s): 203609 203611 203625 203631 203662

203708

GRADIENT HfB2-SiC MULTILAYER OXIDATION RESISTANT COATING FOR C/C COMPOSITES

Wang P; Tong M; Wang H; Li H; Jia Y; Li B; Zhang Y; Zhao Z - *Xian,Northwestern Polytechnical University*

Ceram.Int. 44,No.17,2019,p.20968-20973

A gradient HfB2 modified SiC coating was prepared on the surface of SiC-coated C/C composites by in-situ synthesis and the anti-oxidation behaviour of the coated C/C samples at 1773, 1873 and 1973 K were investigated. Results showed that the gradient coatings had excellent oxidation resistance, which could protect C/C substrates from oxidation for 800, 305 and 100 h at 1773, 1873 and 1973 K, respectively. As the oxidation temperature increased, the evaporation of the Hf-Si-O glass layer and the active oxidation of SiC were accelerated, which resulted in the worst oxidation resistance of the sample at 1973 K. 34 refs.

203709

FABRICATION AND MECHANICAL PROPERTIES OF SiC/SiC COMPOSITES PREPARED BY SLS COMBINED WITH PIP

Jin L; Zhang K; Xu T; Zeng T; Cheng S - *Harbin,University of Science & Technology*

Ceram.Int. 44,No.17,2019,p.20992-20999

A new manufacturing process, combining selective laser sintering (SLS), cold isostatic pressing (CIP) and polymer infiltration pyrolysis (PIP), was developed to manufacture complex silicon carbide parts and improve their mechanical properties. The density and porosity of SiC/SiC composites were investigated and the mechanical properties of the specimens with and without cold isostatic pressing were compared. The bending strength of specimens with cold isostatic pressing was 201 MPa and their elastic modulus was 1.27 GPa, whereas the bending strength of specimens without cold isostatic pressing was 142 MPa and their elastic modulus was 0.88 GPa. Increasing the density of the SiC/SiC composites enhanced their mechanical properties. 39 refs.

203710

EFFECTS OF B4C PARTICLE SIZE ON THE MICROSTRUCTURES AND MECHANICAL PROPERTIES OF HOT-PRESSED B4C-TiB2 COMPOSITES

Liu Z; Deng X; Li J; Sun Y; Ran S - *Anhui,University of Technology*

Ceram.Int. 44,No.17,2019,p.21415-21420

Fully dense B4C-30 vol% TiB2 composites were prepared by hot pressing at 2000 C under 35 MPa from four different B4C starting powders with the medium particle size ranging from 0.5 to 35.8 micron. The effects of B4C particle size on the microstructures and mechanical properties of composites were investigated. Results indicated that the B4C and TiB2 grains grew during the sintering process, and each type of grain had a pinning effect on the grain growth of the other. Using coarse B4C powders as raw materials, the TiB2 grains in the B4C-TiB2 composites tended to grow with the [001] zone axis parallel to the applied pressure direction, which could reinforce the composites. When the particle size of the B4C starting powder was 7.09 micron, the B4C-TiB2 composite had the optimum mechanical properties including a flexural strength of 754 MPa, a Vickers hardness of 30.01 GPa and a fracture toughness of 5.23 MPa.m1/2, respectively, due to its homogenous and fine microstructure. 30 refs.

203711

TOWARD EXCELLENT PERFORMANCE OF Al2O3-ZrO2 RETICULATED POROUS CERAMICS: NEW INSIGHTS BASED ON RESIDUAL STRESS

Chen R; Jia W; Hei D; Wang Y - *Nanjing,University of Aeronautics & Astronautics*

Ceram.Int. 44,No.17,2019,p.21478-21485

To improve the properties of reticulated porous ceramics (RPCs) prepared by the polymer sponge replication technique, a vacuum infiltration process (VI process) was used to fabricate Al2O3-ZrO2 RPCs with multi-layered struts. The effect of additives on the rheological properties of a Al2O3-ZrO2 slurry was investigated and the influence of the ratio of Al2O3:ZrO2 in the slurries on the properties of Al2O3-ZrO2 RPCs were determined. The residual stress within the Al2O3-ZrO2 multi-layered struts was systematically assessed. Results showed that the Al2O3-ZrO2 slurry with 0.2 wt% FS20, 0.3 wt% polyvinyl alcohol (PVA) and 0.6 wt% carboxymethyl cellulose (CMC) had excellent rheological behaviour. Based on finite element results and experiments, for RPCs with a large amount of Al2O3 in the outer layer a compressive residual stress (tangential direction) existed in the outer layer and reduced the thermal stress concentration near the surface and the edge of struts, which improved the properties of RPCs. 36 refs.

203712

SPARK PLASMA SINTERING OF B4C-TiB2-SiC COMPOSITE CERAMICS USING B4C, Ti3SiC2 AND Si AS STARTING MATERIALS

Yin S-P; Zhang Z-H; Cheng X-W; Su T-J; Hu Z-Y; Song Q; Wang H - *Beijing,Institute of Technology; Beijing,National Key Lab.of Sci.& Technol.on Materials under Shock & Impact*

Ceram.Int. 44,No.17,2019,p.21626-21632

Almost fully dense B4C-TiB2-SiC composites, with high flexural strength and good fracture toughness, were fabricated by an in-situ reaction between B4C, Ti3SiC2 and Si using spark plasma sintering at a relatively low temperature of 1650 C. The intergranular and intragranular structure containing nanoparticles with different phases were introduced into the composites. The nano and micro particles in the microstructure formed a multi-scale particle-reinforced structure. The refined matrix grains and the multi-scale reinforcing particles had a synergetic effect on improving the mechanical properties of the composites. As a result, the B4C-TiB2-SiC composite with 30 wt% (TiB2 + SiC) had a low density and optimum mechanical properties with a high flexural strength of 531.2 MPa, good fracture toughness of 5.77 MPa.m1/2 and moderate microhardness of 28.6 GPa. 31 refs.

Metal matrix composites

Fibre and whisker reinforced metal matrix composites

See also Abstract(s): 203606

Particle reinforced metal matrix composites

See also Abstract(s): 203717

203713

SPARK PLASMA SINTERING OF TiAl-Ti3AlC2 COMPOSITE

Akhlaghi M; Tayebifard S A; Salahi E; Asl M S - *Karaj,Materials & Energy Research Centre; Ardebil,University of Mohaghegh Ardebili*

Ceram.Int. 44,No.17,2019,p.21759-21764

TiAl-15 wt% Ti3AlC2 composites were fabricated by spark plasma sintering (SPS) using as-purchased Ti and Al powders and as-synthesised Ti3AlC2 MAX phase. Ti3AlC2 was synthesised by the mechanically-activated self-propagating high-temperature synthesis of Ti, Al, and C powders in a tubular furnace. The mixture of Ti, Al and Ti3AlC2 was ball-milled and spark plasma sintered at 1000 C for a dwell time of 15 min under an external pressure of 40 MPa in a vacuum. The microstructure, phase evolution and mechanical properties of the as-sintered composite were studied. A relative density of about 95%, a Vickers hardness of around 4.5 GPa, a fracture toughness of 11.9 MPa.m1/2 and a flexural strength of 336 MPa were obtained by this low-temperature SPS route. 23 refs.

PROCESSING AND TREATMENT (INCLUDING MACHINERY)

Preliminary processes: mining, winning, purification, milling, comminution

See also Abstract(s): 203553

Extrusion

203714

EXTRUSION SYSTEMS FROM ECT-KEMA FOR CERAMIC LABORATORIES

ECT-KEMA GmbH

Ceram.Forum Int./Ber.DKG. 95,No.11/12,2018,p.E36-E38

The range of extrusion systems developed by the German company ECT-KEMA GmbH for use in the laboratories of R&D institutes and universities and production laboratories within ceramics companies is described. De-airing units are supplied if de-airing of the ceramic body is required and four types of feeding system can be offered.

Moulding

See also Abstract(s): 203593 203594

Sheet forming including tape casting

203715

TAPE CASTING OF UV-CURABLE ALUMINIUM NITRIDE-BASED SLURRIES

Ozog P; Kata D; Graule T - *EMPA; Krakow,University of Science & Technology*

Ceram.Int. 44,No.18,2018,p.22800-22807

AlN is used for the preparation of substrates for electronic circuits which can be prepared by tape casting. Only non-aqueous and aqueous tape casting has previously been developed and studied for AlN. An attempt was made to develop AlN-based slurries using a UV-curable binder as the dispersing medium for tape casting, including the use of photopolymerisable binder. Two different dispersing agents, BYK-W 9010 and glycerol trioleate, were used to stabilise and homogenise AlN dispersions. A pre-treatment step, where the powder was first mixed with the dispersing agent in an azeotropic solvent mixture, followed by the evaporation of the solvents and the redispersing of the pre-conditioned powder into the reactive binder, was used to modify the powder surface. The effective concentration of the dispersants, the impact of the solids loading on the viscosity and slurry behaviour and the effect of the powder pre-conditioning were studied by rheological measurements. Green tapes were optimised by evaluating the effect of the casting gap and the photo- and co-initiator concentrations. FTIR was used to estimate the polymer

conversion degree as a function of exposure time for the green tapes. 20 refs.

Other shaping processes

See also Abstract(s): 203630 203655 203674 203676 203678 203711

203716

3D GEL-PRINTING OF Sr FERRITE PARTS

Yang F; Zhang X; Guo Z; Volinsky A A - *Beijing,University of Science & Technology; South Florida,University*

Ceram.Int. 44,No.18,2018,p.22370-22377

3D gel-printing (3DGP) enables complex-shaped Sr ferrite parts for magnetic applications to be fabricated. A novel 3DGP process based on the hydroxyethyl methacrylate gelation system was used to prepare complex-shaped Sr ferrite samples. The Sr ferrite powder was modified by 1 wt% silane coupling agent and 2.5 vol% polymer Silok7050S was introduced into the ceramic slurry as a dispersant in order to obtain highly loaded pseudo-plastic slurries. Good dimensional accuracy and surface quality were achieved in the printed samples with a relatively low surface roughness of 5 micron. After sintering, the Sr ferrite ceramics had good surface quality and the surface roughness was 3.2 micron. A homogeneous microstructure was seen. The bending strength of the sintered samples with a relative density of 97% was 83 MPa. The corresponding coercivity, remanence, and maximum magnetic energy product values were 271.2 kA/m, 0.383 T, and 26.34 kJ/m3, respectively. 33 refs.

203717

REVIEW ON LASER DEPOSITION-ADDITIVE MANUFACTURING OF CERAMICS AND CERAMIC REINFORCED METAL MATRIX COMPOSITES

Hu Y; Cong W - *Texas,Tech University*

Ceram.Int. 44,No.17,2019,p.20599-20612

The direct additive manufacturing (AM) of ceramics and ceramic-reinforced metal matrix composites (MMCs), using a high-power-density laser beam as a heat source, has been developed. Compared with other direct AM processes, the laser deposition-additive manufacturing (LD-AM) process excels in several aspects, including lower labour costs, higher fabrication efficiency and the capability of parts remanufacturing and functionally gradient composite material fabrication. However, the problems of poor bonding, cracking, lowered toughness, etc. still exist in LD-AM fabricated parts. This paper reviews developments in LD-AM of ceramics and ceramic-reinforced MMCs in both bulk parts fabrication and cladding. The main issues to be solved, corresponding solutions and developments are summarised and discussed. 108 refs.

Sol-gel processing

See also Abstract(s): 203597 203628 203650 203652 203719

Coating and impregnating

See also Abstract(s): 203599 203602 203632 203664 203706

Machining, finishing and surface treatment

See also Abstract(s): 203557 203602 203621

Drying

See also Abstract(s): 203555

203718

FINDINGS FROM THE NEW HYBRID DRYER PROJECT

Marks H - *Marks Consult*

ZI Int. 71,No.6,2018,p.29-35

In English; German - TCKI, the Dutch Centre for Ceramic Building Materials Industry, has developed a new type of chamber dryer for the brick and tile industry. This hybrid drying system combines aerothermal and semi-steam drying and results in lower CO2 emissions and energy saving. Specific heat consumption can be reduced from 4000 kJ/kg evaporated water to 3000 kJ/kg. Results of a demonstration project at Vandersanden in Belgium are discussed.

Heat treatment: firing, sintering, furnaces and kilns

203719

MICROWAVE SINTERING OF COMPLEX SHAPES: FROM MULTIPHYSICS SIMULATION TO IMPROVEMENTS OF PROCESS SCALABILITY

Maniere C; Chan S; Olevsky E A - *San Diego,State University; California,University at San Diego*

J.Am.Ceram.Soc. 102,No.2,2019,p.611-620

The microwave sintering homogeneity of large and complex shape specimens was analysed. A new approach enabling the fabrication of complex shaped ceramics via 3D printing and microwave sintering is presented. The use of a dental microwave cavity enabled a substantial level of densification of complex shape components while restricting the grain growth. The homogeneity of the processed samples during microwave sintering was studied by an electromagnetic-thermal-mechanical simulation. The realistic densification behaviour that phenomenologically takes into account the microwave effect, was included in the modelling framework. The simulation showed the sharp correlation between the microwave field distribution in the cavity, the temperature profile, and the specimen's shape distortion. 26 refs.

203720

ENERGY EFFICIENT SPARK PLASMA SINTERING: BREAKING THE THRESHOLD OF LARGE DIMENSION TOOLING ENERGY CONSUMPTION

Maniere C; Lee G; McKittrick J; Olevsky E A - *San Diego,State University; California,University at San Diego*

J.Am.Ceram.Soc. 102,No.2,2019,p.706-716

An energy efficient spark plasma sintering (SPS) method enabling the densification of large size samples assisted by very low electric current levels is presented. In this method, the electric current is concentrated in the graphite foils around the sample. High-energy dissipation is then achieved in this area enabling the heating and full densification of large alumina parts (phi 40 mm) at relatively low currents (800 A). An electrothermal mechanical simulation revealed that the electric current needed to heat the large samples is 70% lower in the energy efficient configuration compared to the traditional configuration. The presence of thermal and densification gradients is also revealed for the larger sized samples. Potential solutions for this problem are discussed. The experiments confirm the possibility of full densification (96-99%) of large alumina samples. This approach allows the use of small and low cost SPS devices (generally limited to 10-15 mm samples) for large-size samples (40-50 mm). The developed technique also has an optimised energy consumption for large-scale SPS systems. 47 refs.

203721

STRAIN RATE DEPENDENCE OF THE CONTRIBUTION OF SURFACE DIFFUSION TO BULK SINTERING VISCOSITY

Delannay F; Brassart L - *Louvain,Universite Catholique; Monash,University*

J.Am.Ceram.Soc. 102,No.2,2019,p.736-747

Modelling of bulk sintering viscosity usually neglects the contribution of pore surface diffusion with respect to grain-boundary diffusion. This approximation is questionable at the high densification rates used in advanced fast sintering techniques. A two-dimensional analysis of the problem shows that the influence of surface diffusion on bulk viscosity at high strain rate can be decomposed as the sum of two terms: a term linked to the change in pore surface curvature and a term linked to the change in grain-boundary size. The computational procedure relies on the partition of pore profile evolution into a transient component accounting for non-densifying phenomena and an asymptotic component accounting for strain-rate-controlled phenomena. The largest impact of surface diffusion is found to arise from the change in grain-boundary size. It follows a transition from Newtonian viscosity at low strain rate to non-Newtonian viscosity which, during densification, increases nearly linearly with strain rate. In some conditions, viscosity can then reach more than twice the value estimated when neglecting pore surface diffusion. Reversely, expansion is accompanied by a decrease in grain-boundary size which causes a decrease in viscosity and can lead to grain separation at high strain rate. 22 refs.

203722

STRESS-INDUCED ANISOTROPY DURING SINTERING OF HIERARCHICAL POROSITY CERAMICS

Shang H; Olevsky E A; Bordia R K - *Washington,University; San Diego,State University; Clemson,University*

J.Am.Ceram.Soc. 102,No.2,2019,p.768-777

There is significant interest in the design and processing of porous ceramics due to their use in a variety of applications, such as energy storage, catalysis, adsorption, separation, and life science applications. A hierarchical porous structure in which there is a distinct difference between sizes of pores is desirable. A previous study showed that the microstructure and properties of porous materials become anisotropic after sinter-forging. In particular, the small interparticle pores (intrinsic pores) orient parallel to the applied compressive stress, in contrast to large pores from pore formers (extrinsic), which orient perpendicular to the applied stress. However, the pore size, for transition from extrinsic to intrinsic behaviour (transient pore size) has not been quantified. Here the effect of applied stresses during sinter-forging on the morphology (shape and size) of pores of different size is reported, focussing on a cathode material for solid oxide fuel cells. Based on these results, a two-step approach is proposed to predict transient pore size for hierarchically porous ceramics. The approach was used to quantify the effect of applied stresses on the transient pore size. The stress dependence of the transient pore size may be related to sintering stress - a fundamental quantity in continuum models of sintering. In addition, it can be used to calculate the effective surface energy of complex sintering systems. 47 refs.

203723

EXPERIMENTAL INVESTIGATION OF A RADIATIVE HEAT PIPE FOR WASTE HEAT RECOVERY IN A CERAMICS KILN

Delpech B; Axcell B; Jouhara H - *Brunel University*

Energy. 170,2019,p.636-651

The ceramics industry is still one of the major energy consuming manufacturing processes in Europe, and so energy-saving solutions have been investigated in order to decrease energy use in the manufacturing process. The main energy-consuming process is firing, using > 50% of all of the energy required for the process. The energy used during firing is then released during cooling. In order to improve the heat recovered during the cooling stage, a radiative heat pipe ceiling was investigated. The heat recovered during cooling is then sent to the drying stage. The proposed system is composed of a radiative heat pipe, a kiln and a ceramics heater. The radiative heat pipe is made of 10 parallel pipes of 28 mm diameter and a wall thickness of 2 mm. The tubes are connected at the bottom by a 28 mm pipe and a condenser section of 50 mm. The condenser is a shell and tube system with 9 pipes of 10 mm. The system is cooled by water. The radiative heat pipe has been tested at different flow rates and heater temperatures. Experimental results showed that the radiative heat pipe could recover heat using radiation and natural convection in an enclosed kiln. The system was able to recover up to 4 kW. This innovative solution for recovering heat from the cooling stage of an earth roller kiln for ceramic tile manufacture, transforming it into hot clean air for the drying stage of the ceramics manufacturing process, is described. 20 refs.

203724

ELECTRIC CURRENT EFFECT DURING THE EARLY STAGES OF FIELD-ASSISTED SINTERING

Biesuz M; Rizzi D; Sglavo V M - *Trento,University*

J.Am.Ceram.Soc. 102,No.2,2019,p.813-822

The linear shrinkage during isothermal treatment in the early stages of conventional and field-assisted sintering of 8YSZ was analysed. The results showed that the application of a moderate electric current caused a remarkable acceleration in the self-diffusion kinetics, resulting in enhanced densification. In addition, when an electric current was applied, two different field-assisted sintering regimes were identified. The first one, observed at low currents (i.e. 5 mA/mm2), was associated to sintering shrinkage which followed the conventional trend (epsilon alpha t 1/3), although the densification was accelerated. The second regime occurred when larger currents were applied (J > 10 mA/mm2) and is described by a different sintering law (epsilon alpha t 1/7). The electric current caused the activation of alternative densification mechanisms when it exceeded a

certain threshold value. 41 refs.

203725

FLASH SINTERING WITH CURRENT RATE: A DIFFERENT APPROACH

Punith Kumar M K; Yadav D; Lebrun J-M; Raj R - *Colorado,University at Boulder; Indian Institute of Technology; Saint-Gobain Northboro R&D Center*

J.Am.Ceram.Soc. 102,No.2,2019,p.823-835

The original flash sintering experiment was carried out by applying an electric field, and switching to current control at the onset of the flash, signalled by a rise in conductivity. Here experiments controlled from the very start were carried out on 3 mol% yttria-stabilised zirconia using injecting current, which was increased at a constant rate. The current rates were varied from 50 mA/min to 5000 mA/min. The experiment was continued until the current density reached 100 mA/mm2. The total duration of the experiment ranged from approximately 7 to 700 seconds. The following comparisons to the earlier voltage-to-current experiments were noted: (a) in both instances, the onset of the flash was signalled by an unusual rise in conductivity. However, since the power supply remained in the current control mode, the increase in conductivity was manifested by a drop in the voltage generated across the specimen; (b) the blackbody radiation model was modified to include the energy absorbed in specific heat, in order to determine the time-dependent change in temperature as the current was increased (which was particularly significant at the very high current rates); (c) sintering occurred continuously, reaching full density when the current density reached about 100 mA/mm2; and (d) these early experiments suggest that the current-rate experiments yielded fine-grained microstructures across the entire gauge section of the dog-bone specimen, presumably because the highly transient conditions of voltage-to-current flash experiments were sidestepped. 29 refs.

Lasers/laser treatment

See also Abstract(s): 203608 203621 203640 203709 203717

PROPERTIES AND TESTING

Toxicity

See also Abstract(s): 203585 203586

Colloid properties, properties of slips

See also Abstract(s): 203627 203715 203726

Rheological properties

See also Abstract(s): 203571 203578 203590 203630 203711 203715

203726

OVERVIEW OF THE RHEOLOGICAL BEHAVIOUR OF CERAMIC SLURRIES

Vitali S; Giorgini L - *Keser Italia Srl; Bologna,University*

FME Trans. 47,No.1,2019,p.42-47

Ceramic slurries are extensively used in industrial manufacturing techniques. The rheological behaviour has a significant impact on the processing of ceramics, defining crucial parameters such as the solid-to-water ratio, deflocculation level, and type and amount of chemical additives to be used. The importance of essential aspects of rheology in ceramic slurries is presented, to provide an overview of the chemical, physical and practical influences on the manufacture of tiles from both industrial and scientific points of view. 29 refs.

Morphological properties: pore size, powder packing, grain growth, porosity, particle size

203727

STRATEGIES AND PRACTICES FOR SUPPRESSING ABNORMAL GRAIN GROWTH DURING LIQUID PHASE SINTERING

Fisher J G; Kang S-J L - *Chonnam,National University; Korea,Advanced Institute of Science & Technology*

J.Am.Ceram.Soc. 102,No.2,2019,p.717-735

Abnormal grain growth (AGG), where a small number of grains grow to sizes much larger than the neighbouring matrix grains, is a frequent occurrence in liquid phase sintering of ceramics and cermets, and can be detrimental to the material properties. The mixed control theory of grain growth and the principle of microstructural evolution that have been developed by Kang and co-workers over the last two decades are discussed. The theory and the principle, which are based on theories of crystal growth from a liquid, state that grain growth behaviour is controlled by the nature of the solid-liquid interfaces, either atomically rough (macroscopically rounded) or smooth (macroscopically faceted). For grains with atomically rough solid-liquid interfaces, growth is controlled by diffusion of the solute through the liquid phase and normal grain growth always occurs. For grains with faceted solid-liquid interfaces (or a mixture of rough and faceted interfaces), growth is interface reaction-controlled and diffusion-controlled below and above a critical driving force for growth, respectively. Depending on the relative values of the critical driving force for growth (Delta gc) and the maximum driving force for the largest grain in the system (Delta gmax), pseudo-normal, abnormal, and stagnant grain growth can take place. Based on this theory and principle, strategies are presented for suppressing AGG by adjusting Delta gc and Delta gmax to avoid AGG, and examples of the successful use of these strategies are shown. 115 refs.

203728

REVIEW OF GRAIN BOUNDARY COMPLEXION ENGINEERING: KNOW YOUR BOUNDARIES

Krause A R; Cantwell P R; Marvel C J; Compson C; Rickman J M; Harmer M P - *Lehigh,University; GrainBound, LLC; ROSE-HULMAN INSTITUTE OF TECHNOLOGY; Almatis Inc.*

J.Am.Ceram.Soc. 102,No.2,2019,p.778-800

Grain boundary structure-property relationships influence bulk performance and, therefore, are an important criterion in materials design. Materials scientists can generate different grain boundary structures by changes in temperature, pressure, and chemical potential because interfaces attain their own equilibrium states, known as complexions. Complexions undergo first-order transitions by changes in thermodynamic variables, which results in discontinuous changes in properties. Grain boundary complexion engineering is introduced as a method for controlling complexion transitions to improve material performance. The tools for grain boundary complexion engineering are complexion equilibrium and time-temperature-transformation (TTT) diagrams. These tools can be implemented in processing design to tailor grain boundary properties, including grain boundary mobility. While impactful, these diagrams are often limited in scope because they are currently empirically derived. Measurement techniques can be combined with data analytical methods to build mechanistically derived complexion equilibrium and TTT diagrams. 165 refs.

Phase relations

See also Abstract(s): 203637

BASIC SCIENCE AND MATHEMATICAL ANALYSIS

203729

THERMODYNAMICALLY CONSISTENT PHASE-FIELD MODEL FOR VISCOUS SINTERING

Yang Q; Kirshtein A; Ji Y; Liu C; Shen J; Chen L-Q - *Pennsylvania,State University; Illinois,Institute of Technology; Purdue University*

J.Am.Ceram.Soc. 102,No.2,2019,p.674-685

A thermodynamically consistent phase-field model for viscous sintering is proposed, based on an energetic variational formulation that allows the governing equations to be analytically derived from a defined energy law. The conservation of mass is satisfied through the incompressibility assumption and the assumption that mass density is uniform initially within the particle compact while the balance of linear momentum is formulated from an energy dissipation law. The morphological changes of particles are described by the temporal and spatial evolution of a phase-field variable governed by a modified Cahn-Hilliard equation, and the motion of viscous mass flow is controlled by the Stokes equation incorporating the surface tension effect. The application of the phase-field model is illustrated by examining the effect of particle shape, initial contact angle and rearrangement effects on viscous sintering. 51 refs.