J. Aust. Ceram. Soc., [39], 2, 2003, pages 81-87

IMMOBILISATION OF RADIOACTIVE ^{129}I IN A LEAD VANADATE MATRIX BY IN-CAN HOT ISOSTATIC PRESSING

D. S. PERERA*, B. D. BEGG, D. J. CASSIDY, R. L. TRAUTMAN and E. R. VANCE

Australian Nuclear Science and Technology Organisation,
Private Mail Bag 1, Menai, NSW 2234. Australia
email: dsp@ansto.gov.au

ABSTRACT

One method of capturing radioactive ^{129}I is to adsorb it from a gas stream heated to ~200^{0}C onto $AgNO_3$ - impregnated porous alumina or silica sorbents, with the I forming principally AgI. A lead vanadate matrix was selected to examine its suitability for encapsulating non-radioactive I-loaded sorbents by hot isostatic pressing (HIPing) in a stainless steel can at 700^{o}C. After HIPing, the AgI was shown to be contained within the sorbent by scanning electron microscopy and energy dispersive X-ray analysis. There was no observable reaction of the AgI or the alumina sorbent with the matrix. No elemental iodine was detected on the inside of the can or in the matrix, showing iodine had not volatilised. However, although limited aqueous durability tests showed good leach resistance for iodine, this was not so for the Ag and Pb and more work on this aspect is necessary.

KEYWORDS

Iodine-129, hot isostatic pressing, radioactive waste, AgI, lead vanadate.

J. Aust. Ceram. Soc., [39], 2, 2003, pages 88-91

AN EMPIRICAL RELATIONSHIP BETWEEN NITROGEN DEPOSITION PRESSURE AND HARDNESS OF MAGNETRON CO-SPUTTERED TERNARY NITRIDE COATINGS

R. WUHRER[1] and W. Y. YEUNG[2]

[1]*Microstructural Analysis Unit, University of Technology, Sydney, P.O. Box 123, Broadway, NSW 2007, Australia*
email: Richard.Wuhrer@uts.edu.au
[2]*Department of Chemistry, Materials and Forensic Sciences, University of Technology, Sydney, P.O. Box 123, Broadway, NSW 2007, Australia*
email: Wing.Yeung@uts.edu.au

ABSTRACT
An empirical equation of the hardness of ternary nitride coatings and the nitrogen deposition pressure was formulated in the present study. A linear relationship was established between the coating hardness and the reciprocal of the square root of nitrogen pressure. The primary sputter yield of the coating materials was found to contain a linear relationship with the minimum hardness value, H_o, of the empirical equation but showed no effect on the rate of hardness increase, m_H. With defined discharge conditions and sputter yields of the target materials, the values of m_H and H_o can be calculated and the hardness of a coating produced at a specified nitrogen deposition pressure can be theoretically determined.

KEYWORDS
Ternary nitride coatings, magnetron sputtering, nitrogen deposition pressure.

J. Aust. Ceram. Soc., [39], 2, 2003, pages 92-98

EFFECT OF SINTERING AND POLING CONDITIONS ON THE PROPERTIES OF 0.875Pb($Ti_{0.5}Zr_{0.5}$)O_3-0.125Pb($Mg_{1/3}Nb_{2/3}$)O_3 CERAMIC WITH PbO-BASED GLASS FRIT

C. H. WANG

Department of Electronic Engineering,
Nan-Jeon Institute of Technology, Tainan, Taiwan, 737, R.O.C
email: wch70982@ms41.hinet.net

ABSTRACT
The influence of sintering and poling conditions on the dielectric and piezoelectric properties of the 0.875Pb(Ti,Zr)O_3-0.125Pb($Mg_{1/3}Nb_{2/3}$)O_3 system with PbO-based glass frit was investigated. Specimens were prepared by the conventional mixed-oxide technique. If small amounts of 4PbO·B_2O_3 glass powder are added to the calcined 0.875PZT-0.125PMN ceramics, the liquid phase is formed during sintering. Hence, the piezoelectric and dielectric properties are enhanced and the sintering temperature can be reduced. Depending on the doping amount, the 4PbO·B_2O_3 appears not only to be a grain growth promoter within the solubility limit, but also to be a grain growth inhibitor above the solubility limit. For the poling process, poling efficiency is a main consideration. The optimum poling conditions were 3 kV/mm for 30 min at 90°C. The values of the k_p, K^T_{33} and Q_m are increased when small amounts of 4PbO·B_2O_3 dopants (i.e. 0.2 wt %) are added to the 0.875PZT-0.125PMN system. With more 4PbO·B_2O_3 doping (i.e. 1 wt %), the values of k_p and K^T_{33} are decreased due to the glassy phase segregation at the grain boundaries.

KEYWORDS
Dielectric and piezoelectric properties, domain reorientation, poling, sintering, pyrochlore.

J. Aust. Ceram. Soc., [39], 2, 2003, pages 103-107

CHARACTERISATION OF PHASE RELATIONS IN AIR-OXIDIZED TITANIUM SILICON CARBIDE (Ti_3SiC_2)

I. M. LOW* and E. WREN

Materials Research Group, Department of Applied Physics, Curtin University of Technology, GPO Box U1987, WA. 6845 Australia
email: j.low@curtin.edu.au

ABSTRACT
The nature and processes of oxidation of Ti_3SiC_2 in air from 25-1500°C have been characterised by differential thermal analysis, x-ray diffraction and neutron diffraction. Diffraction results show that rutile formed at ~750°C and a glassy phase formed at <1000°C which subsequently crystallized to cristobalite at ~1300°C. The oxides formed at the near-surface are layered and exhibit a duplex microstructure with an outer layer of TiO_2 and an inner layer consisting of SiO_2 and TiO_2.

KEYWORDS
Ti_3SiC_2, rutile, cristobalite, oxidation, x-ray diffraction, neutron diffraction.

J. Aust. Ceram. Soc., [39], 2, 2003, pages 108-113

TITANIUM ISOPROPOXIDE POST-TREATMENT OF TITANIUM DIOXIDE ELECTRODES FOR USE IN DYE-SENSITISED SOLAR CELLS

D. MENZIES[1], R. CERVINI[1], Y.-B. CHENG[1*], G. P.SIMON[1] and L. SPICCIA[2]

[1]*School of Physics and Materials Engineering, Monash University, VIC 3800, Australia*
[2]*School of Chemistry, Monash University, VIC 3800, Australia*
email: Yibing.Cheng@spme.monash.edu.au

ABSTRACT
Surface modification of titanium dioxide (TiO_2) electrodes for application in dye-sensitised solar cells (DSSCs) using 0.1M and 1M solutions and neat titanium isopropoxide (TIP) was performed. The modified electrodes were characterised by X-ray diffraction (XRD) and scanning electron microscopy (SEM) and DSSCs incorporating these electrodes were constructed and tested. The homogeneity and electrical connectivity of the TiO_2 layer appeared to improve in the case of the 0.1M TIP post-treatment, and the cell efficiency was found to increase from 0.8% to 1%. This rise in cell efficiency is proposed to be due to the increased necking in the semiconductor, which is critical to electron conduction. However, if TIP is used at a higher concentration (1M or neat) a monolithic sol-gel monolithic layer was formed on top of the TiO_2. This had a much greater effect on cell efficiencies resulting, in an increase from below 1% up to 3%.

KEYWORDS
Dye-sensitised solar cells, TiO_2 working electrodes, nanostructured TiO_2 network, electrode post-treatment.

J. Aust. Ceram. Soc., [39], 2, 2003, pages 114-118

OXIDATION BEHAVIOUR OF ZIRCONIUM DIBORIDE

A. K. KHANRA

Department of Metallurgical and Materials Engg,
Indian Institute of Technology, Khargapur, India-721302
email: asit_iitkgp@yahoo.com / asit_metal @metal.iitkgp.ernet.in

ABSTRACT
Oxidation behaviour of dense zirconium diboride (ZrB_2) was investigated over a temperature range of 873 to 1273K in static air. Pressureless sintering of fine powder at 2223K produced the dense ZrB_2 product. Both isothermal and non-isothermal studies were carried out. It has been seen that during oxidation two types of oxides (boron oxide and zirconia) were formed on the surface of the sample. Formation temperatures of both the boron oxide (B_2O_3) and zirconia (ZrO_2) were detected by Differential Thermal Analysis (DTA) technique. The activation energy for oxidation was estimated to be approximately 8.23 kJ/mol. A boron oxide layer was formed at lower temperatures. At higher temperatures B_2O_3 vaporized and only a crystalline ZrO_2 layer was observed on the surface of the sample.

KEYWORDS
Oxidation, Sintering, ZrB_2, Fracture Surface, Crystalline, Evaporation, XRD, SEM.

J. Aust. Ceram. Soc., [39], 2, 2003, pages 119-129

MICROWAVE HEATING OF CERAMICS – A REVIEW

D. H. TRINH*, O. C. STANDARD and C. C. SORRELL

School of Materials Science and Engineering, University of New South Wales,
Sydney, NSW 2052, Australia
email: eikkert@hotmail.com

ABSTRACT
A brief review of microwave heating of ceramics is presented. The basis of microwave heating of ceramics is explained and its advantages compared with conventional ceramic heating processes are discussed. A comprehensive tabulated summary of published microwave heating studies for which non-thermal heating effects leading to the enhancement of diffusion-based processes, such as densification, are either claimed or discounted is presented. The experimental limitations of microwave heating studies and their significance in the interpretation of microwave heating data also are considered.

KEYWORDS
Microwave heating, thermal gradients, sintering.

J. Aust. Ceram. Soc., [39], 2, 2003, pages 130-148

NEAR-EQUILIBRIUM PROCESSING OF CERAMICS FOR ACTINIDE DISPOSITION

M. W. A. STEWART[1*], E. R. VANCE[1], A. JOSTSONS[1] and B. B. EBBINGHAUS[2]

[1]*Australian Nuclear Science and Technology Organisation (ANSTO), PMB 1, Menai, NSW 2234, Australia*
[2]*Lawrence Livermore National Laboratory (LLNL), Livermore CA 94550, U.S.A.*
email mws@ansto.gov.au

ABSTRACT
A baseline pyrochlore-rich ceramic designed for Pu-immobilisation, nominally 95 wt% $Ca_{0.89}Gd_{0.22}Hf_{0.23}Pu_{0.22}U_{0.44}Ti_2O_7$ plus 5 wt% $Ti_{0.9}Hf_{0.1}O_2$, has been studied. The samples were prepared via by alkoxide-route to give samples having near-equilibrium mineralogy and via oxide-routes using wet or dry milling to give samples similar to those of production scale. Samples containing Pu and Th as a Pu analogue were studied. Samples were sintered in oxidizing, neutral (Ar) and reducing conditions (3.5% H_2 in Ar). Related ceramics were prepared based around "zirconolite-rich" and "brannerite-rich" formulations, plus a formulation originally designed to contain ~ 10 % perovskite (or "Ca-rich"). Pyrochlore was the main actinide host phase and brannerite and zirconolite were the secondary actinide-bearing phases found in the materials, with a small amount of perovskite forming in most of the samples sintered in hydrogenous atmospheres. The ceramics were found to be extremely flexible with respect to processing conditions and composition, with the composition changing slightly to accommodate variations in the valency of the U and Ti with sintering atmosphere.

KEYWORDS
Plutonium immobilisation, waste forms, pyrochlore, zirconolite.

J. Aust. Ceram. Soc., [39], 2, 2003, pages 149-153

CHEMICALLY-MIXED POWDERS FOR SOLID OXIDE FUEL CELLS

GEOFFREY A. CARTER[1*], ROBERT D. HART[2], NIGEL M. KIRBY[2], DARKO MILOSEVIC[3] and ALEXANDER N. TITKOV[4]

[1]Millennium Chemicals, 1 Ward Road, Rockingham, 6168, Western Australia, Australia
[2]Materials Research Group, Dept of Applied Physics, Curtin University, PO Box U1987, Perth, 6845, Western Australia, Australia
[3] Ceramic Fuel Cells Limited, 170 Browns Road, Noble Park, 3174, Victoria, Australia
[4]Millennium Chemicals, PO Box 245 Bunbury, 6231, Western Australia, Australia
email: geoff.carter@millenniumchem.com

ABSTRACT
Yttria-stabilised zirconia is commonly used as both the electrolyte and as an anode support structure in Solid Oxide Fuel Cell (SOFC) manufacture. To allow for ionic conduction, the zirconia and yttria must be in solid solution with a consistent distribution allowing control of the zirconia polymorphs. The addition of alumina to the stabilised zirconia facilitates the scavenging of any contaminant silica that may be present as well as allowing for the control of microstructure through grain pinning. This addition also acts as a sintering aid. For consistent performance, the three elements need to be intimately mixed with a homogenous distribution.
Mapping of the distribution of elements in 10 mol % yttria-stabilised zirconia doped with alumina by energy dispersive spectroscopy shows that the elements Y, Al and Zr are homogenously mixed at the nanometre scale. The sintered ceramic produced from the precursor has a homogenous mixture of yttria and zirconia. The alumina separates and forms deposits, some crystalline, through the ceramic matrix. Amorphous alumina tends to form in the grain boundaries and at triple points.
The 10 mol% yttria-stabilised zirconia doped with alumina was produced by Millennium Chemicals using a process that is of a proprietary nature.

KEYWORDS
Solid Oxide Fuel Cells (SOFC), Yttria-stabilised zirconia, SEM, TEM, EDS elemental mapping.

J. Aust. Ceram. Soc., [39], 2, 2003, pages 154-158

CAN COMPUTER-INTEGRATED DESIGN AND FINITE ELEMENT ANALYSIS BE APPLIED TO THE TRADITIONAL CERAMICS? AN INDUSTRIAL DESIGNER'S VIEW

O. ACOSTA PALACIOS*, A. H. CHOI, B. TEALE and B. BEN-NISSAN

Department of Chemistry, Materials, and Forensic Science, University of Technology, Sydney, P.O. Box 123, Broadway, N.S.W., 2007, Australia
email: oscar.acostapalacios@uts.edu.au

ABSTRACT
Integrated computer-aided design, finite element analysis, and manufacturing are currently applied in high-tech ceramic production areas. With the recent improvement of computer technology and the development of more powerful but compact and user-friendly programs, the cost of production can be further reduced. This technique can be applied to the traditional ceramics. This paper provides a short review of this integrated technology and gives an industrial designer's view on applying and improving the production quality of traditional ceramics and reducing extensive experimentation involved in the trial-and-error approach.