

**ON THE MICROSTRUCTURE AND PROPERTY DEVELOPMENT
OF D.C. MAGNETRON CO-SPUTTERED TERNARY TITANIUM
ALUMINIUM NITRIDE COATINGS:
EFFECT OF NITROGEN DEPOSITION PRESSURE**

R. WUHRER¹ and W. Y. YEUNG^{2*}

¹*Microstructural Analysis Unit, University of Technology, Sydney, P.O. Box 123, Broadway,
NSW 2007, Australia*

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

Advanced ternary (Ti,Al)N coatings were produced by reactive magnetron co-sputtering with a 30° magnetron configuration. The results reflected the significance and complexity of the nitrogen pressure effect on the coating development. As the nitrogen pressure increased above 0.4 mTorr, a transition of the coating structure from densified, fine columnar grains to porous faceted grains occurred, resulting in an abrupt decrease of the coating hardness. It is believed that an increase of the nitrogen pressure to high values may cause serious collision and scattering of the depositing atoms and poisoning of the targets, thus resulting in significantly fewer atoms/molecules arriving at the substrate with much lower energies. The adatom mobility and the nucleation rate in the coatings are therefore greatly reduced, resulting in development of a coarse grained structure.

KEYWORDS

Ternary nitride coatings, magnetron sputtering, nitrogen deposition pressure.

THERMAL GRADIENTS IN ZIRCONIA DURING MICROWAVE HEATING AND MICROWAVE HYBRID HEATING

O. C. STANDARD*, X. Q. ZHENG, and C. C. SORRELL

School of Materials Science and Engineering, University of New South Wales, SYDNEY, NSW 2052, Australia

**email: o.standard@unsw.edu.au*

ABSTRACT

Thermal gradients in presintered zirconia samples were measured during normal microwave and microwave hybrid heating as a function of heating rate. Thermal gradients were normal at low temperatures but changed to inverse at ~300°-400°C due to increasing microwave absorption. Above ~800°C, the surface became hotter than the interior, which was attributed to concentration of microwaves towards the surface, reduced emissivity of zirconia giving decreased radiant heat loss, and increased radiant heat from the susceptor (where used). The temperature distribution during microwave heating was controlled by the heat transfer modes (microwave absorption, radiant heat loss, and heat conduction), which, in turn, were dependent on temperature, heating rate, and heat application method. The present work demonstrates that temperature distributions may vary by >100°C and that correct temperature measurements through the entire sample are essential to permit understanding of heating, densification, and reactions of ceramics.

KEYWORDS

Microwave heating, thermal gradient, zirconia.

Si₃N₄-RICH PHASES IN THE Si-La-Y-O-N SYSTEM

D. S. PERERA* and D. R. G. MITCHELL

*Materials and Engineering Science
Australian Nuclear Science and Technology Organisation
PMB 1, Menai, NSW 2234, Australia
email: dsp@ansto.gov.au

ABSTRACT

Compositions in the Si₃N₄ corner of the right triangular prism (Jänecke prism) comprising the Si₃N₄-3SiO₂-2La₂O₃-4LaN-4YN-2Y₂O₃ diagram were made primarily from Si₃N₄, La₂O₃ and Y₂O₃ mixtures. They were sintered or sinter/hot isostatically pressed at 1500-1750°C in nitrogen atmospheres. The phase formation of the sintered materials was studied by X-ray diffraction. Selected materials were also examined by electron microscopy and energy dispersive X-ray analysis. The phases observed were Si₃N₄ and vitreous and crystalline Si-La-Y nitrides and oxynitrides. An oxynitride phase with approximate atomic ratios of La:Y:Si of 1:1:5 was characterised. It was not possible to prepare this phase in a pure state because it was sensitive to kinetic constraints. A nitrogen apatite phase consisting of La and Y of variable composition was also observed. The phase relationships and their compositions are discussed with respect to their microstructure.

KEYWORDS:

Si₃N₄, Si-La-Y nitrides, Si-La-Y oxynitrides, N-phase, nitrogen melilite, nitrogen apatite, TEM.

ALUMINA AND ZIRCONIA BIOCERAMICS IN ORTHOPAEDIC APPLICATIONS

R. CORDINGLEY^{1,2*}, L. KOHAN^{1,2}, B. BEN-NISSAN¹ and G. PEZZOTTI²

¹*Department of Chemistry, Materials and Forensic Science, University of Technology, Sydney,
PO BOX 123 Broadway, 2007 NSW Australia*

²*Orthomed, 99 Spring Street, Level 2, Bondi Junction, 2026, Sydney NSW, Australia*

³*Department of Materials, Kyoto Institute of Technology, Sakyo-Ku, Matsugasaki, Kyoto,
606-8585, Japan*

**email: Rebecca.Cordingley@uts.edu.au*

ABSTRACT

Interest in ceramics for biomedical applications has increased over the last thirty years. The ceramics that are used in implantation and clinical purposes include alumina, partially stabilised zirconia (PSZ) (both yttria [Y-TZP] and magnesia stabilised [Mg-PSZ]), bioglass®, glass-ceramics, calcium phosphates (hydroxyapatite and β -tricalcium phosphate) and crystalline or glassy forms of carbon and its compounds.

An improved understanding of currently used bioceramics in implants and in bone replacement materials could contribute significantly to the design of new generation prostheses. Overall, the benefits of advanced ceramic materials in biomedical applications have been universally accepted, specifically, in terms of their strength, biocompatibility and wear resistance. However, the amount of supporting data is not large and the continuous development of new methods is pertinent for better understanding of the microstructure-properties relationship and, in general, for obtaining new directives for their further improvement. This paper gives an overview and re-examines key-issues which concern both processing and applications of alumina and zirconia (PSZ and Y-TZP) ceramics as orthopaedic biomaterials.

INTERCONNECTED PORE NETWORKS FROM SINTERED SALT PARTICLES FOR SCAFFOLDS IN TISSUE ENGINEERING APPLICATIONS

K. A. GROSS*, L. M. RODRÍGUEZ-LORENZO

*School of Physics and Materials Engineering, Building 69, Monash University,
Victoria 3800, Australia*

**email: karlis.gross@spme.monash.edu.au*

ABSTRACT

This paper describes a new approach of producing interconnected pore networks in a carbonated fluorapatite composite scaffold for tissue engineering applications. Salt particles were sintered at 720, 750 and 780 °C for different times. The highest temperature produced the best interconnectivity with a neck size varying between several tens of microns to millimeter sized zones, depending on the contact between the salt particles. This interconnected salt template was infiltrated with an apatite suspension in a solvent with dissolved PLLA, and the interconnecting salt scaffold dissolved to produce an apatite composite scaffold. After drying, a rigid scaffold was produced of sufficient strength for handling.

KEYWORDS

Porous ceramics, porous scaffolds, tissue engineering, salt template.

EARLY APATITE DEPOSITION ON TITANIUM TREATED BY HYDROGEN PEROXIDE

JIN-MING WU^{1,2*}, SATOSHI HAYAKAWA¹, KANJI TSURU¹ and AKIYOSHI OSAKA¹

¹*Biomaterials Laboratory, Faculty of Engineering, Okayama University, Tsushima, Okayama 700-8530, Japan*

²*Department of Materials Science and Engineering, Zhejiang University, Hangzhou 310027, P. R. China*

**email: msewjw@zju.edu.cn*

ABSTRACT

Early apatite deposition is preferable for commercially pure titanium (cpTi) to be used as hard tissue replacements. The highly apatite inductive surface can be obtained by soaking cpTi in hydrogen peroxide solutions containing tantalum chloride, followed by heat treatments. The present study focused on clarifying the effects of the concentration of Ti(IV) in the treating solution through controlling both the soaking solution volume (V) and the ratio (S/V) of nominal surface area of cpTi to solution volume. It is found that the Ti(IV) ion concentration in the solution decreases with the increasing V and decreasing S/V , which in turn results in a titania gel with decreased thickness on the cpTi surface. The apatite deposition ability of the gel, which crystallized to anatase after heat treatments, was assessed by immersing in the Kokubo simulated body fluid. The results illustrate that anatase layer with medium film thickness induces a thin layer of apatite deposition in a much shorter duration than with thin or thick film thickness.

KEYWORDS

Titanium, hydrogen peroxide, apatite, bioactivity.

SYNTHESIS OF SiC POWDERS FROM BASIC AND ULTRABASIC ROCKS

P. MAJEWSKI ^{1,2*}, I. SCHUELLI ², I. VOSS ²

¹*Ian Wark Research Institute, University of South Australia, Adelaide, Australia*

²*Max-Planck-Institut fuer Metallforschung, Stuttgart, Germany*

**email: peter.majewski@unisa.edu.au*

ABSTRACT

Two different rocks (Harzburgit and Lherzolit) containing mainly SiO₂, Fe₂O₃ and MgO were powdered, mixed with graphite and heat treated at 1250°C in reducing Ar/H₂-atmosphere. The resulting powders consist of β-SiC and minor amounts of Fe₃Si besides graphite, which was added in excess. The results show that β-SiC can be synthesized from natural rocks other than quartz at significantly lower temperatures compared to the Acheson process.

KEYWORDS

Synthesis, SiC, powder.

SYNTHESIS OF SiC + α -AL₂O₃ POWDERS FROM NATURAL ALUMINIUM SILICATES

P. MAJEWSKI ^{1,2*}, I. SCHUELLI ², I. VOSS ²

¹*Ian Wark Research Institute, University of South Australia, Adelaide, Australia*

²*Max-Planck-Institut fuer Metallforschung, Stuttgart, Germany*

**email: peter.majewski@unisa.edu.au*

ABSTRACT

Powders of an alkali feldspar [KAlSi₃O₈] and different natural aluminum silicates were mixed with graphite and heat treated at 1250 °C in reducing Ar/H₂-atmosphere. Samples with alkali feldspar and mullite [Al₆Si₂O₁₃] having a significant excess of graphite result in powders consisting of β -SiC and α -Al₂O₃ besides graphite. The annealing of a mixture of graphite and kaolin [Al₂Si₂O₅(OH)₄] and pyrophyllite [Al₂Si₄O₁₀(OH)₂], respectively, result in a mixture of mullite beside β -SiC. However, prolonged annealing of a mixture of kaolin with higher graphite content yields β -SiC and α -Al₂O₃ powder. The results show that powders of β -SiC beside α -Al₂O₃ can be synthesized from natural aluminum rich minerals at significantly lower temperatures compared to the Archeson process.

KEYWORDS

Synthesis, SiC, powder.

SLICK BRICKS – AN INNOVATIVE NEW MASONRY SYSTEM

CATHY INGLIS

*Austral Bricks,
P.O. Box 6550 Wetherill Park, NSW, 1851, Australia
email: cathy@australbrick.com.au*

ABSTRACT

Over recent decades everything to do with construction has been improved to enable the builder to increase the speed of construction, that is, everything except bricklaying. Conventional masonry construction is labour intensive and although construction of brick walls on site has many advantages, at the same time this can prove to be the weakness of the masonry building system. Mortar constitutes only a relatively small proportion of the masonry, but the quality and workmanship can seriously affect the overall performance of the masonry.

A new system, namely **Slick Bricks®**, has been developed using precision, diamond ground clay bricks with an interlocking key that eliminates the vertical joint and utilises thin-bed jointing technology. This paper discusses the development and evaluation of the Slick Brick System, which makes bricklaying easier, quicker and stronger, resulting in productivity gains, improved on-site quality and cost savings.

EFFECT OF POLING CONDITIONS ON THE PROPERTIES OF $\text{Pb}_{0.96}\text{Sr}_{0.04}(\text{Zr}_{0.49}\text{Ti}_{0.51})_{0.74}(\text{Mg}_{1/3}\text{Nb}_{2/3})_{0.20}(\text{Zn}_{1/3}\text{Nb}_{2/3})_{0.06}\text{O}_3$ CERAMIC

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 poling conditions on dielectric and piezoelectric properties of the $\text{Pb}_{0.96}\text{Sr}_{0.04}[(\text{Zr}_{0.49}\text{Ti}_{0.51})_{0.74}(\text{Mg}_{1/3}\text{Nb}_{2/3})_{0.20}(\text{Zn}_{1/3}\text{Nb}_{2/3})_{0.06}]\text{O}_3$ system was investigated. Specimens were prepared by the conventional mixed-oxide technique. For the poling process, poling efficiency is a main consideration. The optimum poling conditions were 3 kV/mm for 20 min at 100°C. Under these conditions, faster and easier domain alignment occurred. To gain insight into the behavior of ferroelectric ceramics is the investigation of the biasing field dependence of the dielectric constant. The reversal of 180° domain and the rotation of 90° domain play their respective parts in changing the physical constants under the biasing field. The dielectric constant increases at the beginning because of the 180° domain reorientation and then decreases due to the anisotropic property of 90° domains as the poling field increases. Increasing the poling temperature can promote the poling effectiveness by introducing the domain orientation. This behavior makes K_{33}^T , k_p and dielectric loss increase. If the poling temperature is too high, K_{33}^T , k_p and Q_m decrease.

KEYWORDS

Piezoceramics, dielectric and piezoelectric properties, domain reorientation, poling.