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Selected Abstracts of Thermal Spray Literature

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Applications

Automotive

Flame sprayed V-doped TiO_2 nanoparticles with enhanced photocatalytic activity under visible light irradiation. V-doped TiO_2 (V-TiO_2) nanoparticles were prepared by a simple one-step flame spray pyrolysis (FSP) technique. The obtained samples were characterized by x-ray diffraction (XRD), transmission electron microscopy (TEM), electron paramagnetic resonance (EPR) spectra, UV-vis absorption spectroscopy, and nitrogen adsorption-desorption methods. Benefiting from the short residence time and high quenching rate during the flame spray process, V^{4+} ions are successfully incorporated into the crystal lattice of TiO_2. It reveals that V doping favors the primary particle size growth as well as the increase of rutile content in the products. The photocatalytic activity of the V-TiO_2 samples under UV and visible light irradiation were evaluate by the photocatalytic degradation of methylene blue (MB) and 2,4-dichlorophenol (2,4-DCP), respectively. It was found that V doping enhances the photocalytic activity under both UV and visible light irradiation. Especially, under visible light irradiation, the degradation rate of 2,4-dichlorophenol over 1%V-TiO_2 is two times higher than that over undoped TiO_2. The photocatalytic mechanisms for V-TiO_2 samples under UV and visible light irradiation were tentatively discussed. © 2009 Elsevier B.V. All rights reserved.

B. Tian, C. Li, F. Gu, H. Jiang, Y. Hu, and J. Zhang, Key Laboratory for Ultrafine Materials, Ministry of Education, School of Materials Science and Engineering, Shanghai 200237, China. Cited: *Chem. Eng. J.,* 2009, Aug 15, **151**(1-3), p 220-227. ISSN 1385–8947.

Microstructural alterations within thermal spray coatings during highly loaded diesel engine tests. The good wear characteristics of thermal spray coatings are related to structural, productional, and topographical properties. Finally, the alteration of the microstructure in different contact zones is essential for mild wear conditions that will guarantee a long-life cycle because it reveals the ability of the material to adjust to the current load situation. Previous studies have shown that in diverse tribosystems an in situ formation of a nanocrystalline layer together with mechanical mixing maintains long-lasting, wear resistant surfaces with low wear rates. This investigation exemplifies results from a cylinder that was run in a road test motor. The relevant piston ring positions that fully describe the tribosystem have to be defined at the combustion chamber (CC), top dead centre (TDC), stroke and bottom dead centre (BDC). Transmission electron microscopy (TEM) and energy-filtered transmission electron microscopy (EFTEM) are used to analyze these contact zones in terms of microstructure and chemistry. Nanocrystalline surface layers up to a thickness of 100 nm occurred in all areas of contact whereas subsurface zones revealed differing microstructural changes. Thus the influence of thermal impact and different mechanical load conditions in a motor cylinder are evident. EFTEM elemental mappings verify the incorporation of elements that stem from lubrication or combustion residues. © 2009 Elsevier B.V. All rights reserved.

M. Hahn, R. Theissmann, B. Gleising, W. Dudzinski, and A. Fischer, Institute of Product Engineering, Material Science and Engineering, University of Duisburg, Essen, Germany. Cited: *Wear,* 2009, June 15, **267**(5-8), p 916-924. ISSN 0043-1648.

Oxygen-diffused titanium as a candidate brake rotor material. Titanium alloys are one of several candidate materials for the next generation of truck disk brake rotors. Despite their advantages of lightweight relative to cast iron and good strength and corrosion resistance, titanium alloys are unlikely to be satisfactory brake rotor materials unless their friction and wear behavior can be significantly improved. In this study, a surface engineering process—oxygen diffusion (OD)—was applied to titanium rotors and has shown very encouraging results. The oxygen-diffused Ti-6Al-4V (OD-Ti64) was tested on a sub-scale brake tester against a flat block of commercial brake lining material and benchmarked against several other Ti-based materials, including untreated Ti-6Al-4V (Ti64), Ti-based metal matrix composites (MMCs), and a thermal spray-coated Ti alloy. With respect to friction, the OD-Ti64 outperformed all other candidate materials under the imposed test conditions with the friction coefficient remaining within a desirable range of 0.35-0.50, even under the harshest conditions when the disk surface temperature reached nearly 600 °C. In addition, the OD-Ti64 showed significantly improved wear-resistance over the untreated Ti64 and was even better than the Ti-based composite materials. © 2009 Elsevier B.V.

J. Qu, P.J. Blau, and B.C. Jolly, Materials Science and Technology Division, Oak Ridge National Laboratory, Oak Ridge, TN 37831-6063. Cited: *Wear,* 2009, June 15, **267**(5-8), p 818-822. ISSN 0043-1648.

Biomaterials

A novel graded bioactive high adhesion implant coating. One method to increase the clinical success rate of metal implants is to increase their bone bonding properties, i.e. to develop a bone bioactive surface leading to reduced risks of interfacial problems. Much research has been devoted to modifying the surface of metals to make them become bioactive. Many of the proposed methods include depositing a coating on the implant. However, there is a risk of coating failure due to low substrate adhesion. This paper describes a method to obtain bioactivity combined with a high coating adhesion via a gradient structure of the coating. Gradient coatings were deposited on Ti (grade 5) using reactive magnetron sputtering with increasing oxygen content. To increase the grain size in the coating, all coatings were post annealed at 385 °C. The obtained coating exhibited a gradual transition over 70 nm from crystalline titanium oxide (anatase) at the surface to metallic Ti in the substrate, as shown using cross-section transmission electron microscopy and x-ray photoelectron spectroscopy depth profiling. Using scratch testing, it could be shown that the adhesion to the substrate was well above 1 GPa. The bioactivity of the coating was verified in vitro by the spontaneous formation of hydroxylapatite upon storage in phosphate buffer solution at 37 °C for 1 week. The described process can be applied to implants irrespective of bulk metal in the base and should introduce the possibility to create safer permanent implants like reconstructive devices, dental, or spinal implants. © 2009 Elsevier B.V. All rights reserved.

U. Brohede, S. Zhao, F. Lindberg, A. Mihranyan, J. Forsgren, M. Stromme, and H. Engqvist, Division for Nanotechnology and Functional Materials, Department of Engineering Sciences, The Angstrom Laboratory, 751 21 Uppsala, Sweden. Cited: *Appl. Surf. Sci.,* 2009, June 15, **255**(17), p 7723-7728. ISSN 0169-4332.

A novel nano-porous alumina biomaterial with potential for loading with bioactive materials. Nano-porous alumina, with the potential for being loaded with bioactive materials, has been proposed as a novel material for coating implants. In this study, the shear strength of the interface between such nano-porous anodic aluminium oxide (AAO) coatings and titanium substrates, their biocompatibility, and their potential for pore loading have been investigated. An interface shear strength in excess of 29 MPa was obtained which is comparable with that of conventional plasma sprayed hydroxyapatite implant coatings. The viability and differentiation of MG63 osteoblastic cells co-cultured on the coating was found to be broadly comparable to that of similar cells co-cultured on conventional bioinert implant materials such as titanium and fully dense alumina. Extensive pore loading with silica nanoparticles of different sizes and in different combinations was demonstrated throughout the thickness of AAO layers 1 μm and 60 ± μm thick. This work has demonstrated, that with suitable choice of pore filling materials, this novel coating might simultaneously combat infection, encourage bone regeneration, and secure fixation of the implant to bone. © 2008 Wiley Periodicals, Inc.

A.R. Walpole, Z. Xia, C.W. Wilson, J.T. Triffitt, and P.R. Wilshaw, Department of Materials, University of Oxford, Oxford, UK. Cited: *J. Biomed. Mater. Res. A,* 2009, July, **90**(1), p 46-54. ISSN 1549-3296.

Bone growth is enhanced by novel bioceramic coatings on Ti alloy implants. Calcium phosphate ceramics are widely used as coating materials to orthopedic implants and are found to enhance initial bony ingrowth by stimulating osseous apposition to the implant surface. In this study, two novel calcium orthophosphate materials were selected for coating onto the commonly used orthopedic implant material Ti-6Al-4V. One was calcium alkali orthophosphate with the crystalline phase $Ca_{10}[K/Na](PO_4)_7$ with a small addition of SiO_2 (AW-Si) and the other was calcium orthophosphate composed of 70 mol% fluorapatite, $Ca_{10}(PO_4)_6F_2$ and 30 mol% $CaZr_4(PO_4)_6$ (FA7Z). The coated implants were placed in cortical and cortico-cancellous bone of sheep femur for 6 weeks. Retrieved samples were tested for osseointegration and mechanical strength. It was found that both coatings produced enhanced bone/implant contact rate compared to the control when implanted in cortico-cancellous bone. This study demonstrates that the two coatings have the capability of encouraging bone growth, and hence the potential for being used as coating materials on Ti implants. © 2008 Wiley Periodicals, Inc.

C. Wang, G.A. Karlis, G.I. Anderson, C.R. Dunstan, A. Carbone, G. Berger, U. Ploska, and H. Zreiqat, Biomedical and Tissue Engineering Research Unit,

School of AMME, University of Sydney, Sydney, NSW 2006, Australia. Cited: *J. Biomed. Mater. Res. A,* 2009, Aug, **90**(2), p 419-428. ISSN 1549-3296.

Characterization and corrosion properties of novel hydroxyapatite niobium plasma sprayed coating. A novel hydroxyapatite niobium (HA-Nb) composite coating was deposited on 316L SS substrate to improve the corrosion properties and functional compatibility of 316L SS alloy. HA-Nb coatings were applied by air plasma spray under electrical current intensities of 400, 600 and 800 A. X-ray diffraction and scanning electron microscopy techniques were utilized to investigate the characteristics of coatings. Corrosion properties were evaluated by electrochemical polarization test in Ringer solution. Results indicated that optimum electrical current intensity for deposition of the HA-Nb composite coating on 316L SS substrate was 600 A. The composite coating improved corrosion resistance and exhibited good structural properties which in turn increased biocompatibility of 316L SS substrate. © 2009 Institute of Materials, Minerals and Mining.

M.H. Enayati, M.H. Fathi, and A. Zomorodian, Department of Materials Engineering, Isfahan University of Technology, Isfahan 84156 83111, Iran. Cited: *Surf. Eng.,* 2009, May, **25**(4), p 338-342. ISSN 0267-0844.

Characterization and fatigue damage of plasma sprayed HAp top coat with Ti and HAp/Ti bond coat layers on commercially pure titanium substrate. The surface of commercially pure Ti (cp-Ti) substrate was grit-blasted with Al_2O_3 powders and then wet-blasted with HAp/Ti mixed powders at room temperature. Then plasma spraying with Ti powders or HAp/Ti mixed powders on the blasted surface was carried out to form a bond coat layer, denoted as T50 and T100 bond coat for the former and HT100 bond coat for the later. The HAp top coat was subsequently sprayed with 100 μm thickness. The XRD patterns showed that the as-sprayed HT100 bond coat layer was mainly composed of HAp with minor components of Ti and TiO_2. EDS analysis also showed there co-existed HAp and Ti without reaction in the HT100 bond coat layer. Some cracks were observed in the bond coat and the top coat layers after compression-compression and tension-tension fatigue tests. The HT100 bond coat specimen produced less AE signal and a small amount of debonding and cracking in compression-compression fatigue test. The HT100 specimen could survive up to 10 million cycles at stress amplitude of 200 MPa, which is high enough compared to the maximum stress in bones: the order of 100 MPa. The degree of damage (debonding and cracking) in tension-tension fatigue test was more severe than that in compression-compression fatigue testing. © 2008 Elsevier Ltd. All rights reserved.

A. Raknagarm and Y. Mutoh, Department of System Safety, Nagaoka University of Technology, Nagaoka, Niigata 940-2188, Japan. Cited: *J. Mech. Behav. Biomed. Mater.,* 2009, Oct, **2**(5), p 444-453. ISSN 1751-6161.

Cladding of titanium/fluorapatite composites onto Ti_6Al_4V substrate and the in vitro behavior in the simulated body fluid. To improve the bioactivity of Ti6Al4V alloy, an innovative cladding method has been developed to bond a Ti/fluorapatite (FA) composite onto the alloy for load-bearing applications. With the aid of a silver interlayer and external pressure during sintering, a defect-free interface between the composite and the substrate was obtained. The fabricated materials were bioactive and could induce the nucleation and formation of bone-like carbonated apatite after immersed in the simulated body fluid (SBF). Functional ions, such as Ag^+ and F^-, were released from the materials during immersion, which could impart favorable activities for the implant. This work demonstrated that a simple and novel method could be applied to enhance functionalities of Ti alloys for load-bearing implant applications. Crown Copyright © 2009.

H. Ye, X.Y. Liu, and H.P. Hong, Faculty of Engineering, The University of Western Ontario, London, ON N6A 5B8, Canada. Cited: *Appl. Surf. Sci.,* 2009, June 30, **255**(18), p 8126-8134. ISSN 0169-4332.

Development of novel thermal sprayed antibacterial coating and evaluation of release properties of silver ions. Several studies have addressed the use of antibacterial coating to reduce implant-associated infections. In this study, novel silver (Ag)-containing calcium-phosphate (CP) coating technology based on the thermal spraying method was developed. The coating's physical and chemical properties, in vitro antibacterial activity, hydroxyapatite (HA)-forming ability, and release of Ag ions were evaluated. An amorphous structure of the coating was confirmed by x-ray diffraction, and Ag residue in the coating was determined by elementary analysis. The coating showed strong antibacterial activity to methicillin-resistant *Staphylococcus aureus* in fetal bovine serum (FBS) along with HA-forming ability in simulated body fluid. Therefore, it is expected that the coating would confer antibacterial and bone bonding abilities to the implant surface. Time course release testing of Ag ions from the coating on immersion in FBS showed pronounced Ag release for up to 24 h after immersion, with consistent strong antibacterial activity at the early postoperative stage. In repeated testing, the amount of released Ag ions was about 6500 parts per billion (ppb, μg/L) for the first release test, after which it gradually decreased. However, retention of significant release of Ag ions after a sixth repeat implies that Ag release from the coating is slow in FBS. © 2008 Wiley Periodicals, Inc.

I. Noda, F. Miyaji, Y. Ando, H. Miyamoto, T. Shimazaki, Y. Yonekura, M. Miyazaki, M. Mawatari, and T. Hotokebuchi, Research Department, Japan Medical Materials Corporation, Osaka 532-0003, Japan. Cited: *J. Biomed. Mater. Res. B,* 2009, May, **89**(2), p 456-465. ISSN 1552-4973.

Effect of surface roughness, porosity, and a resorbable calcium phosphate coating on osseointegration of titanium in a minipig model. The aim of this study was to compare the osseointegration of four different implant surfaces in the Gottingen minipig femur model. They were prepared by glasspearlblasting (A), sandblasting (B) and titanium- plasma spraying (C and D). Surface D received additionally an electrochemically deposited layer of a resorbable calcium phosphate (CaP) layer, made mainly of brushite. Sample size was n = 20 per group. Implants were placed in the intertrochanteric and intercondylar sites of both femora. After 12 weeks, implant anchorage was measured by the pull-out test and histomorphometry measurements were carried out at the bone-implant interface. Implant anchorage was 0.7 ± mn; 0.3 MPa for surface A, 3.2 ± mn; 0.6 MPa for surface B, 6.5 ± mn;1.5 MPa for surface C and 7.3 ± mn;1.9 MPa for surface D. The differences between surfaces were statistically significant, with exception of C and D. The stiffness of the bone-implant interface showed no statistically significant difference between surfaces. After pull-out, surface A and B showed nearly no bone spots, while on surfaces C and D bone remains were found. Bone- implant contact was 1.9 ± mn; 1.1% for surface A, 10.5 ± mn; 3.6% for surface B, 22.4 ±mn; 4.5% for surface C, and 48.8 ± mn; 4.5% for surface D. The differences were statistically significant. Implant location, intertrochanteric and intercondylar, did not affect the data. In this minipig model, rougher surfaces showed better osseointegration. After 12 weeks of healing, the resorbable CaP layer enhanced significantly the bone- implant contact but not the level of anchorage. The findings also suggest that the pull-out test should be critically evaluated to determine the shear strength between bone and porous surfaces. © 2008 Wiley Periodicals, Inc.

M.L.R. Schwarz, M. Kowarsch, S. Rose, K. Becker, T. Lenz, and L. Jani, Laboratory for Biomechanics and Experimental Orthopedics, University Hospital Mannheim, University of Heidelberg, Germany. Cited: *J. Biomed. Mater. Res. A,* 2009, June 1, **89**(3), p 667-678. ISSN 1549-3296.

Hydrothermal crystallization effect on the improvement of erosion resistance and reliability of plasma-sprayed hydroxyapatite coatings. The aim of present study is to investigate the crystallization effect of air and hydrothermal heat treatments on the erosion resistance, failure behaviors and reliability of plasma-sprayed HA coatings (HACs). Experimental results show that just 150 °C is required to see a significant increase in crystallinity and phase purity for hydrothermally-treated HACs compared with the high-temperature (600 °C) air heat treatment. The significantly improved bonding strength of hydrothermally-treated HACs can be recognized for the self-healing effect that resulted from the hydrothermal crystallization. Results of erosion test indicated that the erosion resistance decreases with increasing erosion impact angle. The maximum erosion rate occurred at 90°; impact angle for all the as-sprayed and heat-treated HACs. The erosion resistance of plasma-sprayed HACs is significantly improved through the crystallization of a coating after heat treatments. Furthermore, it should be worth noting that the erosion resistance for hydrothermally-treated HACs is much better than as-sprayed and air heat-treated HACs at any impact angle. The statistical analysis of Weibull model shows that plasma-sprayed coatings are generally reliable materials with a wear-out failure model (with a Weibull modulus $m > 3$) of increasing failure rate (IFR). The knowledge of the minimum strength and failure behavior will be very helpful for understanding the HA coating reliability for further biological applications. Crown Copyright © 2009.

C.-W. Yang, T.-S. Lui, and L.-H. Chen, Department of Materials Science and Engineering, National Cheng Kung University, Tainan 70101, Taiwan. Cited: *Thin Solid Films,* 2009, July 1, **517**(17), p 5380-5385. ISSN 0040-6090.

Investigation of boundary conditions for biomimetic HA deposition on titanium oxide surfaces. To improve the clinical outcome of metal implants, i.e. earlier loading and reduction of the incidence of revision surgery, better bone bonding ability is wanted. One method to achieve this is to change the surface chemistry to give a surface that facilitates bone bonding in vivo, i.e. a bioactive surface. Crystalline titanium oxide has recently been proven to be bioactive in vitro and is an interesting option to the more common hydroxylapatite (HA) coatings on implants. A materials possible in vitro bioactivity is tested through soaking in simulated body fluid and studies of possible HA formation on the surface. For bioactive materials, the formed HA layer can also be used as a coating. The aim of the current paper is to investigate some boundary conditions for HA formation on crystalline titanium oxide surfaces regarding influence from coating thickness, soaking time and soaking temperature. The influence from soaking time and temperature on the HA growth were investigated on oxidized Ti samples, (24 h at 800 °C) resulting in a rutile surface structure. The oxidized samples were tested at three temperatures (4, 37 and 65 °C) and four times (1 h, 1 day, 1 week and 4 weeks). The influence from titanium coating thickness on the HA growth was investigated via depositing thin films of crystalline titanium dioxide on Ti plates using a reactive magnetron sputtering process. Four different PVD runs with coating thicknesses between 19 and 74 nm were tested. The soaking temperature had an

effect on the HA formation and growth on both rutile surfaces and native oxide on Ti substrates. Higher temperatures lead to easier formation of HA. It was even possible, at 65 °C, to grow HA on native titanium oxide from soaking in PBS. The coating quality was better for HA formed at 65 °C compared to 37 °C. All PVD-coatings showed HA growth after 1 week in PBS at 37 °C, thus even very thin coatings of crystalline titanium oxide coatings are bioactive. © 2009 Springer Science+Business Media, LLC.

M. Lindgren, M. Astrand, U. Wiklund, and H. Engqvist, Department of Engineering Sciences, Materials Science, Uppsala University, Uppsala, Sweden. Cited: *J. Mater. Sci. Mater. Med.,* 2009, July, **20**(7), p 1401-1408. ISSN 0957-4530.

Microstructural and in vitro characterization of high-velocity suspension flame sprayed (HVSFS) bioactive glass coatings. The paper reports the first attempt at employing the innovative high-velocity suspension flame spraying (HVSFS) technique in order to deposit bioactive glass coatings. Fine (micrometric) glass particles having a composition similar to that of the A-W (apatite-wollastonite) bioactive glass-ceramic as proposed by Kokubo were dispersed into a 50% water + 50% isopropanol solvent mixture and the resulting suspension (containing 20 wt.% glass powder) was thermally sprayed onto Ti plates using a modified high velocity oxy-fuel torch. Each torch pass produces a dense coating layer, featuring strong cohesion between lamellae thanks to viscous flow sintering along the interlamellar boundary. However, some porosity exists between different layers deposited during successive torch passes. In vitro bioactivity tests indicate that the coatings interact remarkably with the simulated body fluid (SBF), developing a thick silica-rich layer containing hydroxyapatite crystals. © 2009 Elsevier Ltd. All rights reserved.

G. Bolelli, V. Cannillo, R. Gadow, A. Killinger, L. Lusvarghi, and J. Rauch, Department of Materials and Environmental Engineering, University of Modena and Reggio Emilia, I-41100 Modena, MO, Italy. Cited: *J. Eur. Ceram. Soc.,* 2009, Aug, **29**(11), p 2249-2257. ISSN 0955-2219.

On the effect of Ta on improved oxidation resistance of Ti-Al-Ta-N coatings. Formation of protective oxide scales is the main reason for the high oxidation resistance of TiAlN based coatings. Here the authors report on further improvement in the oxidation resistance of TiAlN by Ta alloying. An industrial-scale cathodic arc evaporation facility was used to deposit Ti-Al-Ta-N coatings from powder metallurgically produced Ti38 Al57 Ta5 targets. After oxidation in ambient air, a significantly reduced oxide layer thickness in comparison to unalloyed TiAlN reference material was observed. Energy-dispersive x-ray spectroscopy line scans and secondary ion mass spectroscopy depth profiling showed that the oxide scale consists of an Al-rich top layer without detectable amount of Ta and a Ti-Ta-rich sublayer. Transmission electron microscopy investigations revealed α-$A_{12}O_3$, rutile-type Ti O_2, and anatase-type Ti O_2 as the scale forming oxides. Furthermore, the Ti-Ta-rich sublayer consists of a porous layer at the oxide-nitride interface but appears dense toward the Al-rich top layer. The improved oxidation resistance is explained by doping the Ti O_2 lattice by replacing Ti4+ with Ta5+ in the rutile lattice, which decreases the oxygen mass transport. This leads to reduced oxidation of Ti under formation of Ti O_2 at the oxide-nitride interface and is the reason for the excellent oxidation behavior of Ti-Al-Ta-N coatings. © 2009 American Vacuum Society.

M. Pfeiler, C. Scheu, H. Hutter, J. Schnoller, C. Michotte, C. Mitterer, and M. Kathrein, Materials Center Leoben Forschung GmbH, A-8700 Leoben, Austria. Cited: *J. Vac. Sci. Technol. A,* 2009, **27**(3), p 554-560. ISSN 0734-2101.

TiO_2 thin films—Influence of annealing temperature on structural, optical and photocatalytic properties. Nanostructured TiO_2 thin films were deposited on glass substrates by sol-gel dip coating technique. The structural, morphological and optical characterizations of the as deposited and annealed films were carried out using x-ray diffraction (XRD), Raman spectroscopy, atomic force microscopy (AFM), and UV-vis transmittance spectroscopy. As-deposited films were amorphous, and the XRD studies showed that the formation of anatase phase was initiated at annealing temperature close to 400 °C. The grain size of the film annealed at 600 °C was about 20 nm. The lattice parameters for the films annealed at 600 °C were a = 3.7862 A and c = 9.5172 A, which is close to the reported values of anatase phase. Band gap of the as deposited film was estimated as 3.42 eV and was found to decrease with the annealing temperature. At 550 nm the refractive index of the films annealed at 600 °C was 2.11, which is low compared to a pore free anatase TiO_2. The room temperature electrical resistivity in the dark was of the order of 4.45×10^6 Ohm-cm. Photocatalytic activity of the TiO_2 films were studied by monitoring the degradation of aqueous methylene blue under UV light irradiation and was observed that films annealed above 400 °C had good photocatalytic activity which is explained as due to the structural and morphological properties of the films. © 2009 Elsevier Ltd. All rights reserved.

N.R. Mathews, E.R. Morales, M.A. Cortes-Jacome, and J.A. Toledo Antonio, Programa de Ingenieria Molecular, IMP, San Bartolo, Atepehuacan, Mexico, Mexico. Cited: *Solar Energy,* 2009, Sept, **83**(9), p 1499-1508. ISSN 0038-092X.

Photocatalytics

Flame sprayed V-doped TiO_2 nanoparticles with enhanced photocatalytic activity under visible light irradiation. V-doped TiO_2(V-TiO_2) nanoparticles were prepared by a simple one-step flame spray pyrolysis (FSP) technique. The obtained samples were characterized by x-ray diffraction (XRD), transmission electron microscopy (TEM), electron paramagnetic resonance (EPR) spectra, UV-vis absorption spectroscopy, and nitrogen adsorption-desorption methods. Benefiting from the short residence time and high quenching rate during the flame spray process, V^{4+} ions are successfully incorporated into the crystal lattice of TiO_2. It reveals that V doping favors the primary particle size growth as well as the increase of rutile content in the products. The photocatalytic activity of the V-TiO_2 samples under UV and visible light irradiation were evaluate by the photocatalytic degradation of methylene blue (MB) and 2,4-dichlorophenol (2,4-DCP), respectively. It was found that V doping enhances the photocalytic activity under both UV and visible light irradiation. Especially, under visible light irradiation, the degradation rate of 2,4-dichlorophenol over 1%V-TiO_2 is two times higher than that over undoped TiO_2. The photocatalytic mechanisms for V-TiO_2 samples under UV and visible light irradiation were tentatively discussed. © 2009 Elsevier B.V. All rights reserved.

B. Tian, C. Li, F. Gu, H. Jiang, Y. Hu, and J. Zhang, Key Laboratory for Ultrafine Materials, Ministry of Education, School of Materials Science and Engineering, Shanghai 200237, China. Cited: *Chem. Eng. J.,* 2009, Aug 15, **151**(1-3), p 220-227. ISSN 1385-8947.

Solid Oxide Fuel Cells

Air plasma spray processing and electrochemical characterization of Cu-SDC coatings for use in solid oxide fuel cell anodes. Air plasma spraying has been used to produce porous composite anodes based on $Ce_{0.8}Sm_{0.2}O_{1.9}$ (SDC) and Cu for use in solid oxide fuel cells (SOFCs). Preliminarily, a range of plasma conditions has been examined for the production of composite coatings from pre-mixed SDC and CuO powders. Plasma gas compositions were varied to obtain a range of plasma temperatures. After reduction in H_2, coatings were characterized for composition and microstructure using EDX and SEM. As a result of these tests, symmetrical sintered electrolyte-supported anode-anode cells were fabricated by air plasma spraying of the anodes, followed by in situ reduction of the CuO to Cu. Full cells deposited on SS430 porous substrates were then produced in one integrated process. Fine CuO and SDC powders have been used to produce homogeneously mixed anode coatings with higher surface area microstructures, resulting in area-specific polarization resistances of 4.8 ω; cm^2 in impedance tests in hydrogen at 712 °C. © 2009 Elsevier B.V. All rights reserved.

N. Benoved and O. Kesler, Department of Mechanical and Industrial Engineering, University of Toronto, Toronto, ON M5S 3G8, Canada. Cited: *J. Power Sources,* 2009, Sept 5, **93**(2), p 454-461. ISSN 0378-7753.

Fabrication, electrochemical characterization and thermal cycling of anode supported microtubular solid oxide fuel cells. This work describes the manufacture and electrochemical characterization of anode supported microtubular SOFC's (solid oxide fuel cells). The cells consist of a Ni-YSZ anode tube of 400 μm wall-thickness and 2.4 mm inner diameter, a YSZ electrolyte of 15-20 μm thickness and a LSM-YSZ cathode. The microtubular anode supporting tubes were prepared by cold isostatic pressing. The deposition of thin layers of electrolyte and cathode are made by spray coating and dip coating respectively. The cells were electrochemically characterized with polarization curves and complex impedance measurements using 5% H_2/95% Ar and 100% of H_2, humidified at 3% as reactant gas in the anodic compartment and air in the cathodic one at temperatures between 750 and 900 °C. The complex impedance measurements show an overall resistance from 1 to 0.42 ω; cm^2 at temperatures between 750 and 900 °C with polarization of 200 mA cm^{-2}. The I-V measurements show maximum power densities of 0.3-0.7 W cm^{-2} in the same temperature interval, using pure H_2 humidified at 3%. Deterioration in the cathode performance for thin cathodes and high sintering temperatures was observed. They were associated to manganese losses. The cell performance did not present considerable degradation at least after 20 fast shut-down and heating thermal cycles. © 2008 Elsevier B.V. All rights reserved.

R. Campana, R.I. Merino, A. Larrea, I. Villarreal, and V.M. Orera, Instituto de Ciencia de Materiales de Aragon, Universidad de Zaragoza-CSIC, E-50009, Zaragoza, Spain. Cited: *J. Power Sources,* 2009, July 1, **192**(1), p 120-125. ISSN 0378-7753.

Thermal Barrier Coatings

Adhesive strength of new thermal barrier coatings of rare earth zirconates. $La_2Zr_2O_7$ (LZ) and $La_2Zr_{0.7}(Ce_{0.3})_2O_7$ (LZ7C3) as novel candidate materials for thermal barrier coatings (TBCs) were prepared by electron beam-physical vapor deposition (EB-PVD). The adhesive strength of the as-deposited LZ and LZ7C3 coatings were evaluated by transverse scratch test.

Meanwhile, the factors affecting the critical load value were also investigated. The critical load value of LZ7C3 coating is larger than that of LZ coating, whereas both values of these two coatings are lower than that of the traditional coating material, i.e. 8 wt.% yttria stabilized zirconia (8YSZ). The micro-cracks formed in the scratch channel can partially release the stress in the coating and then enhance the adhesive strength of the coating. The width of the scratch channel and the surface spallation after transverse scratch test are effective factors to evaluate the adhesive strength of LZ and LZ7C3 coatings.

L. He, Z. Xu, X. Cao, X. Zhong, R. Mu, and S. He, Beijing Institute of Aeronautical Materials, Department 5, Beijing 100095, China. Cited: *Vacuum,* 2009, July 14, **83**(11), p 1388-1392. ISSN 0042-207X.

Analysis of anisotropic void system in electron-beam physical-vapor deposited (EB-PVD) thermal-barrier coatings. The study demonstrated processing-related morphological differences that produced three different electron-beam physical-vapor deposition (EB-PVD) partially yttria stabilized zirconium (PYSZ) coatings. The thermally activated changes of the coatings were analyzed by employing a matching-mixture immersion and in situ high-temperature small-angle neutron scattering (SANS) techniques. The total surface area, pore size, pore morphology, and anisotropic changes were determined and correlated with thermally induced deviations in the thermal conductivity. EB-PVD coatings were produced by employing 'von Ardenne' pilot-plant equipment with a maximum EB power of 150 kW. Evaporation was carried out from single source that had standard chemical composition with a diameter of 62.5 mm and a length of 150 mm. The vapor phase was deposited on plane substrates under three different rotating modes by mounting the substrate in a holder with its axis perpendicular to the evaporation surface. (Edited abstract).

B. Saruhan, R. Ochrombel, V. Ryukhtin, and A. Wiedenmann, German Aerospace Centre, Institute of Materials Research, D-51147, Cologne, Germany. Cited: *Adv. Eng. Mater.,* 2009, June, **11**(6), p 488-494. ISSN 1438-1656.

Characterization of alumina interfaces in TBC systems. Interfacial segregants in thermally grown α-Al_2O_3 scales formed during high temperature exposure of thermal barrier coating systems reflect the oxygen-active dopants present in the bond coating and substrate, such as Y and Hf. These dopants diffuse outward and segregate to the substrate-alumina interface and the alumina grain boundaries. Related studies suggest that these segregants affect the growth and mechanical properties of the alumina-scale; however, the characterization of segregation in alumina formed on coated superalloy systems has been limited. Segregation examples evaluated using analytical transmission electron microscopy are given from traditional Pt-modified aluminide coatings and newer Pt diffusion coatings. Model systems are used to illustrate that grain boundary segregants on the columnar alumina boundaries are not because of the reverse diffusion of cations from the Y_2O_3-stabilized ZrO_2 top coating, and that interstitial elements in the substrate likely affect the outward flux of cation dopants. The dynamic nature of this segregation and oxygen-potential gradient-driven diffusion is discussed in light of observations of substrate dopant and interstitial contents affecting coating performance.

B.A. Pint and K.L. More, Materials Science and Technology Division, Oak Ridge National Laboratory, Oak Ridge, TN 37831-6156. Cited: *J. Mater. Sci.,* 2009, Apr, **44**(7), p 1676-1686. ISSN 0022-2461.

Characterization of ceria-yttria stabilized zirconia plasma-sprayed coatings. Ceria-yttria stabilized zirconia (CYSZ) coatings were prepared by air plasma-sprayed on the nickel alloy. The as-sprayed CYSZ coatings and heat-treated CYSZ coatings were characterized by x-ray photoelectron spectroscopy (XPS) and x-ray diffraction (XRD). The XPS data indicated the coexistence of Ce^{3+}, Ce^{4+}, Y^{3+} and Zr^{4+} ions near the surface of the as-sprayed CYSZ coatings and the disappearance of Ce^{3+} ions in the CYSZ coatings after thermal treatment at 1000 °C for 15 h. From the XRD patterns, the solid solution of CeO_2-Y_2O_3-ZrO_2 formed in the CYSZ coatings because of the lack of any features from Y_2O_3 and ZrO_2 single phases. After thermal treatment, the main phases of all the samples were consistent with the characteristic peaks of cubic ZrO_2.

B. Ma, Y. Li, and K. Su, Center for Composite Materials, Harbin Institute of Technology, Harbin 150080, China. Cited: *Appl. Surf. Sci.,* 2009, May 30, p 7234-7237. ISSN 0169-4332.

Comparison of the coatings deposited using Ti and B_4C powder by reactive plasma spraying in air and low pressure. The coatings were deposited by reactive plasma spraying (RPS) in air and low-pressure plasma spraying (LPPS) based on the reaction between Ti and B_4C powder, respectively. The thermal spray powder of Ti and B_4C added with powder Cr (metallic binder) in air is compared with that without powder Cr addition in the low pressure. (Prior to deposition, the powder was screened and separated for RPS whereas spray drying, sintering and sieving were done for LPPS.) The phase composition and the microstructure of coatings were studied by x-ray diffractometer (XRD) and scanning electron microscopy (SEM). The anti-corrosion property of coatings was also investigated. It is found that the coating prepared by RPS, which is more densification, is composed of TiN, TiB_2, and a small phase fraction of titanium oxides. The composition of the coating deposited by reactive LPPS is TiB_2, Ti(C, N), Ti_4N_{3-x} and impurity phase of Ti_5Si_3. There is no appearance of titanium oxides in low pressure. The coatings have the typical lamellar structure and adhere to the bond coating well. The mean Vickers microhardness value of the coating deposited by RPS is higher than that of the coating deposited by LPPS. Furthermore, the corrosion resistance of the coating deposited by RPS is superior to that of the coating prepared by LPPS in near neutral 3.5 wt.% NaCl electrolyte.

Z. Mao, J. Ma, J. Wang, and B. Sun, State Key Laboratory of Metal Matrix Composites, Shanghai Jiaotong University, Shanghai 200240, China. Cited: *J. Mater. Sci.,* 2009, June, **44**(12), p 3265-3272. ISSN 0022-2461.

Failure mechanisms of thermal barrier coatings on MCrAlY-type bondcoats associated with the formation of the thermally grown oxide. The effect of the thermally grown oxide (TGO) formation on the lifetime of the thermal barrier coatings (TBC) with MCrAlY-bondcoats (BC) is reviewed. A number of factors affecting the TGO-formation and TBC-failure are discussed including the coating microstructure, geometrical (coating roughness and thickness) and processing parameters. Under given testing conditions for a specific EB-PVD-TBC-system forming a flat, uniform alumina TGO a critical TGO-thickness for TBC-failure can be defined. This TGO-morphology is, however, not necessarily optimum for obtaining long TBC-lifetime, which can be extended by formation of TGO's with an uneven TGO/BC interface. In contrast, APS-TBC-systems are prone to formation of intrinsically inhomogeneous TGO-morphologies. This is attributed to non-uniform depletion of Y and Al underneath rough MCrAlY-surfaces as well as due to the commonly observed repeated-cracking/re-growth of the TGO during temperature cycling. The latter phenomenon depends on the exposure temperature and the mechanical properties of the APS-TBC. In both types of TBC-systems the TGO-formation and TBC-lifetime appear to be very sensitive to the manufacturing parameters, such as vacuum quality during bondcoat spraying and temperature regime of the bondcoat vacuum heat-treatment.

D. Naumenko, V. Shemet, L. Singheiser, and W.J. Quadakkers, Forschungszentrum Julich GmbH, IEF-2, Juelich 52425, Germany. Cited: *J. Mater. Sci.,* 2009, Apr, **44**(7), p 1687-1703. ISSN 0022-2461.

High temperature oxidation of plasma and HVOF thermal sprayed CoNiCrAlY coatings in simulated gas turbine and furnace environments. CoNiCrAlY powders were thermal sprayed using plasma (atmospheric plasma spraying) and high velocity oxyfuel procedures onto AISI 310 austenitic stainless steel specimens in order to study the cyclic oxidation behavior of these coatings in air and in a simulated gas turbine environment (10% oxygen) at 800 and 1000 °C. The oxidation behavior and hardness evolution of both coatings were significantly different, and the observed weight gain for the plasma spray coating was always much greater due to the presence of substantial open interconnected porosity. In both cases, protective alumina (Al_2O_3) and spinel $CoAl_2O_4$ layers were created.

V. Higuero, F.J. Belzunce, and J. Riba, Department of Materials Science, University of Oviedo, 33203 Gijon, Spain. Cited: *Surf. Eng.,* 2009, May, **25**(4), p 319-325. ISSN 0267-0844.

Indentation properties of plasma sprayed Al_2O_3-13% TiO_2 nanocoatings. Young's modulus and hardness were determined by depth sensing indentation in plasma sprayed Al_2O_3-13% TiO_2 nanocoatings. Results were compared to conventional coatings and the relevance of the nanostructure was analyzed. An indentation size effect was observed. Data provided by indentation tests at different maximum loads were used to estimate size-independent hardness and elastic modulus. Enhanced properties were observed in the nanostructured coating compared to the conventional one. Partially melted zones in the nanocoating, which act as reinforcements in the ceramic matrix composite, are likely responsible for the enhancement.

J. Rodriguez, A. Rico, E. Otero, and W.M. Rainforth, Departamento de Ciencia e Ingenieria de Materiales, Universidad Rey Juan Carlos, 28933 Mostoles, Madrid, Spain. Cited: *Acta Mater.,* 2009, June, **57**(11), p 3148-3156. ISSN 1359-6454.

Microstructural characterization of porous thermal barrier coatings by laser flash technique. An inversion procedure has been developed to obtain microstructural parameters describing the porosity morphology of porous thermal barrier coatings (TBCs) from the thermal diffusivity measured in different environments by a laser flash technique. The model base for the inversion procedure combines the Knudsen effect (i.e. the thermal conductivity variation of gases within a pore as a function of pore size and shape) with the asymmetric Bruggeman model that describes the effect of porosity on the thermal conductivity of a porous medium in terms of pore shape, orientation and content. A simplified approach in the inversion procedure has been proposed, and the reliability has been checked by simulating different microstructures within the TBC. The inversion procedure has been also applied to

experimental thermal diffusivity values of a TBC which were obtained by filling pores with He, N_2Ar and in vacuo. © 2009 Acta Materialia Inc.

F. Cernuschi, P. Bison, and A. Moscatelli, CESI RICERCA, 20134 Milano, Italy. Cited: *Acta Mater.,* 2009, July, **57**(12), p 3460-3471. ISSN 1359-6454.

Microstructural evolution and failure characteristics of a NiCoCrAlY bond coat in ''hot spot'' cyclic oxidation. Microstructural evolution and the onset of failure in a NiCoCrAlY bond coat (BC) on a single-crystal superalloy substrate have been investigated in a newly developed ''hot spot'' apparatus that imposes a temperature gradient along the length of a coated, cylindrical specimen. Local spallation events were observed in the ''hottest spot'' of the coated specimens after 50-60 oxidation cycles with a peak temperature of 1050 °C. The thickness of the thermally grown oxide (TGO) was in the range of 2-3 μm when spalls were initiated. The failure surface contained a significant density of embedded oxides and the remnant TGO exhibited surface cracks indicative of a buckling delamination failure mode. The failed surface morphology and the cross-section microstructure of the BC have been characterized, including morphological imperfections in the TGO. The role of these microstructural features in the failure process is addressed. © 2009 Acta Materialia, Inc.

F. Cao, B. Tryon, C.J. Torbet, and T.M. Pollock, ExxonMobil Research and Engineering Company, Annandale, NJ 08801. Cited: *Acta Mater.,* 2009, Aug, **57**(13), p 3885-3894. ISSN 1359-6454.

Modeling of thermal barrier coating temperature due to transmissive radiative heating. Thermal barrier coatings are generally designed to possess very low thermal conductivity to reduce the conduction heat transfer from the coating surface to the metal turbine blade beneath the coating. In high-temperature power generation systems, however, a considerable amount of radiative heat is produced during the combustion of fuels. This radiative heat can propagate through the coating and heat up the metal blade, and thereby reduce the effectiveness of the coating in lowering the thermal load on the blade. Therefore, radiative properties are essential parameters to design radiative barrier coatings. This article presents a combined radiation and conduction heat transfer model for the steady-state temperature distribution in semitransparent yttria-stabilized zirconia (YSZ) coatings. The results of the model show a temperature reduction up to 45 K for YSZ of high reflectance (80%) compared to the YSZ of low reflectance (20%). The reflectivities of YSZ and metal blade affect the temperature distribution significantly. Additionally, the absorption and scattering coefficients of YSZ, the thickness of the coating, and the thermal conductivities of YSZ and metal blade affect the temperature distribution. © 2009 Springer Science+Business Media, LLC.

G. Lim and A. Kar, Department of Mechanical, Materials and Aerospace Engineering, College of Optics and Photonics, University of Central Florida, Orlando, FL 32816-2700. Cited: *J. Mater. Sci.,* 2009, July, **44**(13), p 3589-3599. ISSN 0022-2461.

Remove coatings from turbine components without damaging them and lower your costs. A significant technology for removing coatings from turbine components without damaging them and by lowering costs is discussed. A precision Abrasive Waterjet (AWJ) process is a high quality and cost effective process for coating removal compared to traditional acid stripping and grit blasting. AWJ is a repeatable and an environmentally friendly process that can remove coatings without damaging the turbine component while lowering total costs. A 5-axis computer numerically controlled (CNC) abrasive waterjet (AWJ) is used to remove the coating in iterative steps. The process offers material removal by controlling speeds, feeds, pressures, and material flow. The waterjet stream is controlled to a specific distance from the surface, while feed and speed are controlled by software that keep the offset normal over the entire form of a blade. This process is able to remove the thermal barrier coating and bond coat in one process. (Edited abstract).

B. Vernyi, Springfield Manufacturing LLC and Huffman Corp. Cited: *Weld. Des. Fabr.,* 2009, Feb 1, **82**(2). ISSN 0043-2253.

Study on structural evolution of nanostructured 3 mol% yttria stabilized zirconia coatings during low temperature aging. In the present work, the nanostructured 3 mol% yttria stabilized zirconia coatings were deposited by plasma spraying, and its structural evolution during the low temperature ageing in wet atmosphere was investigated by Raman spectroscopy. The results showed that the nanostructured 3 mol% yttria stabilized zirconia coatings had lower resistance to low temperature ageing, although the nanostructured coatings have a metastable tetragonal-prime (t prime) crystal structure. The degradation mechanism was explained in terms of the diffusion of oxygen vacancies and OH^- ion and the reactions between OH^- and Y'_{Zr} ion. The microstructure of as-sprayed coating, especially the microcracks, plays a very important role in the low temperature degradation. It can enhance and accelerate the low temperature degradation. It was also verified by wavelength dispersive spectrometer (WDS) analysis that an yttrium-rich surface was formed due to the reaction between OH^- and $Y'OH^-$ and Y'_{Zr} ion, which resulted in the transformation of t prime to monoclinic zirconia phase. © 2009 Elsevier Ltd. All rights reserved.

B. Liang, C. Ding, H. Liao, and C. Coddet, State Key Laboratory of Metastable Materials Science and Technology, Yanshan University, Qinhuangdao, Hebei 066004, China. Cited: *J. Eur. Ceram. Soc.,* 2009, Aug, **29**(11), p 2267-2273. ISSN 0955-2219.

The effect of start-up cycle in ceramic coating used as thermal barrier for a gas turbine bucket. The unsteady aerodynamic and aero-thermal performance of a first stage gas turbine bucket with thermal barrier coating (TBC) and internal cooling configuration were investigated by application of a three dimensional Navier-Stokes commercial turbo machinery oriented CFD-code. Convection and conduction were modeled for a super alloy blade with TBC. The CFD simulations were configured with a mesh domain including the nozzle and bucket interstage in order to accurately predict the fluid parameters at inlet and outlet of bucket. Comparisons to the gas turbine manufacturer data have permitted validation of the flow conditions at the inlet of the rotor. The effects of blade TBC surface temperature changes during a start-up cycle were simulated by means of an unsteady simulation, with unsteady inlet/outlet boundary conditions specified according to test data. The calculations include not only the fluid but also the solving of conduction within the blade, allowing for a correct modeling of the large difference of thermal inertia between the fluid and solid. The role of thermal barrier coatings (TBC) is, as their name suggests, to provide thermal insulation of the blade. A coating of about 100-400 μm can reduce the temperature by up to 200 °C. A TBC can be used either to reduce the need for blade cooling (by about 36%) increasing the turbine efficiency, while maintaining identical creep life of the substrate; or to increase considerably the creep life of the blade while maintaining level of blade cooling (and therefore allowing the blade to operate at a lower temperature for an identical turbine inlet temperature). © 2009 Elsevier Ltd. All rights reserved.

A.H. Rossette, Z.M. C.A. Demeulenaere, and J.A. Roque Lopez Hernandez, Electrical Research Institute, Col. Palmira, 62490 Cuernavaca Morelos, Mexico. Cited: *Appl. Therm. Eng.,* 2009, Oct, **29**(14-15), p 3056-3065. ISSN 1359-4311.

Thermal cyclic behavior of glass-ceramic bonded thermal barrier coating on nimonic alloy substrate. Thermal barrier coating system comprised of 8 wt.% yttria stabilized zirconia (YSZ) top coat, glass-ceramic bond coat and nimonic alloy (AE 435) substrate was subjected to thermal shock test from 1000 °C to room temperature for 100 cycles. Two types of thermal shock testing were performed. In one test, specimens held at 1000 °C for 5 min were forced air quenched while in the other test specimens were water quenched from the same conditions. Microstructural changes were investigated by scanning electron microscopy (SEM) and phase analysis was conducted by XRD and energy dispersive x-ray (EDX) analysis. In the case of forced air quenched specimens, no deterioration was observed in the top coats after 100 cycles while the top coats were damaged in the water quenched ones. In both forced air quenched and water quenched specimens, interfacial crack was not observed at the top coat-bond coat and bond coat-substrate interfaces after thermal cycling experiments and the top coat maintained its phase stability. © 2009 Elsevier Ltd and Techna Group S.r.l.

S. Das, S. Datta, D. Basu, and G.C. Das, Central Glass and Ceramic Research Institute, Kolkata 700032, India. Cited: *Ceram. Int.,* 2009, Aug, **35**(6), p 2123-2129. ISSN 0272-8842.

Thermal shock resistance and mechanical properties of $La_2Ce_2O_7$ thermal barrier coatings with segmented structure. $La_2Ce_2O_7$ (LCO) is a promising candidate material for thermal barrier coatings (TBCs) application because of its higher temperature capability and better thermal insulation property relative to yttria stabilized zirconia (YSZ). In this work, $La_2Ce_2O_7$ TBC with segmentation crack structure was produced by atmospheric plasma spray (APS). The mechanical properties of the sprayed coatings at room temperature including microhardness, Young's modulus, fracture toughness and tensile strength were evaluated. The Young's modulus and microhardness of the segmented coating were measured to be about 25 and 5 GPa, relatively higher than those of the non-segmented coating, respectively. The fracture toughness of the LCO coating is in a range of 1.3-1.5 MPa $m^{1/2}$, about 40% lower than that of the YSZ coating. The segmented TBC had a lifetime of more than 700 cycles, improving the lifetime by nearly two times as compared to the non-segmented TBC. The failure of the segmented coating occurred by chipping spallation and delamination cracking within the coating. © 2009 Elsevier Ltd and Techna Group S.r.l.

Y. Wang, H. Guo, and S. Gong, Beijing University of Aeronautics and Astronautics (BUAA), Department of Materials Science and Engineering, Beijing 100083, China. Cited: *Ceram. Int.,* 2009, Sept, **35**(7), p 2639-2644. ISSN 0272-8842.

Measurement Methods

Energy dissipation in depth-sensing indentation as a characteristic of the nanoscratch behavior of coatings. Wear behavior of coatings has usually been described in terms of mechanical properties such as hardness (H) and effective elastic modulus (E*). Alternatively, an energy approach appears as a promising analysis taking into account the influence of those

properties. In a nanoindentation test, the dissipated energy depends not only on the hardness and elastic modulus, but also on the elastic recovery (W_e). This work aims to establish a relation between plastic deformation energy (E_p) during depth-sensing indentation method and the grooving resistance of coatings in nanoscratch tests. An energy dissipation coefficient (K_d) was defined, calculated as the ratio of the plastic to the total deformation energy (E_p/E_t), which represents the energy dissipation of materials. Reactive depositions using titanium as the target and nitrogen and methane as reactive gases were obtained by triode magnetron sputtering, in order to assess wear and nanoindentation data. A topographical, chemical and microstructural characterization has been conducted using x-ray diffraction (XRD), x-ray photoelectron spectroscopy (XPS), wave dispersion spectroscopy (WDS), scanning electron (SEM) and atomic force microscopy (AFM) techniques. Nanoscratch results showed that the groove depth was well correlated to the energy dissipation coefficient of the coatings. On the other hand, a reduction in the coefficient was found when the elastic recovery was increased.

A.A.C. Recco, C.C. Viafara, A. Sinatora, and A.P. Tschiptschin, Surface Phenomena Laboratory, Mechanical Engineering Department, Polytechnic School, 05508-970 Sao Paulo, Brazil. Cited: *Wear,* 2009, June 15, **267**(5-8), p 1146-1152. ISSN 0043-1648.

Instrumented indentation microscope applied to the elastoplastic indentation contact mechanics of coating/substrate composites. In instrumented indentation tests for a thin film coated on a substrate (film/substrate composite), it is well known that the substrate-affected contact area estimated through conventional approximations includes significant uncertainties, leading to a crucial difficulty in determining the elastic modulus and the contact hardness. To overcome this difficulty, an instrumented indentation microscope that enables researchers to make an in situ determination of the contact area is applied to an elastoplastic film on substrates having various values of their elastic moduli. Using the indentation microscope, the substrate-affected indentation contact parameters including contact hardness of the film/substrate composites are determined directly as well as quantitatively without any undesirable assumptions and approximations associated with the contact area estimate. The effect of a stiffer substrate on the contact profile of impression is significant, switching the profile from sinking in to piling up during penetration, and resulting in the substrate-affected contact hardness being highly enhanced at deeper penetrations. Through the present experimental study, it is demonstrated that the instrumented indentation microscopy is highly efficient in determining the substrate-affected elastoplastic contact parameters of film/substrate composite systems.

N. Hakiri, A. Matsuda, and M. Sakai, Department of Materials Science, Toyohashi University of Technology, Toyohashi 441-8580, Japan. Cited: *J. Mater. Res.,* 2009, June, **24**(6), p 1950-1959. ISSN 0884-2914.

Physico/chemical characterization and in vivo evaluation of nanothickness bioceramic depositions on alumina-blasted/acid-etched Ti-6Al-4V implant surfaces. The objective of this study was to physico/chemically characterize and evaluate the in vivo performance of two nano-thickness ion beam assisted depositions (IBAD) of bioceramic coatings on implants in a beagle model. Alumina blasted/acid-etched (AB/AE) Ti-6Al-4V implants were subjected to two different IBAD depositions (IBAD I and IBAD II), which were physico/chemically characterized by SEM, EDS, XPS, XPS + ion-beam milling (depth profiling), XRD, AFM, and ToF-SIMS. A beagle dog tibia model was utilized for histomorphometric and biomechanical (torque) comparison between AB/AE, IBAD I, IBAD II, and plasma-sprayed hydroxyapatite (PSHA) coated implants that remained in vivo for 3 and 5 weeks. The coatings were characterized as amorphous Ca-P with high Ca/P stoichiometries with thicknesses of an order of magnitude difference (IBAD I = 530-50 nm and IBAD II = 5300-500 nm). The histomorphometric and biomechanical testing results showed that the 300-500 nm thickness deposition (IBAD II) and PSHA positively modulated bone healing at early implantation times.

P.G. Coelho and J.E. Lemons, Department of Biomaterials and Biomimetics, New York University, New York, NY 10010. Cited: *J. Biomed. Mater. Res. A,* 2009, Aug, **90**(2), p 351-361. ISSN 1549-3296.

Microstructure

Characterization of detonation gun sprayed Cr_3C_2-25NiCr coatings on Ni and Fe based superalloys. Cr_3C_2-25NiCr coatings are essential to provide protection against both wear and corrosion of superalloys particularly in the temperature range up to 900-1000 °C. The Cr_3C_2-25NiCr coatings were deposited on the Fe and Ni based superalloys by D gun spray technique and subsequently investigated for their microstructural characteristics such as coating thickness, porosity, phase formation, microhardness, surface and cross-sectional morphologies. The coatings showed a dense microstructure with porosity contents less than 0.69%. The carbide grains of different size are uniformly cladded with the metallic binder and located around the splat boundaries as observed in the coatings. Lower carbide dissolution and its uniform distribution ensured a better binder protection in the coatings. High cohesive strength of the individual splats and high volume fraction of carbides contributed for the higher microhardness values of the coatings (775-1200 HV).

S. Kamal, R. Jayaganthan, and S. Prakash, Department of Metallurgical and Materials Engineering, Indian Institute of Technology, Roorkee 247667, India. Cited: *Surf. Eng.,* 2009, May, **25**(4), p 287-294. ISSN 0267-0844.

Evaluation of hillock-like deposition behavior of HVOF thermal spray coatings using rotary shutter procedure. Evaluation of hillock-like deposition behavior of WC/Co coatings was performed using a rotary shutter procedure coupled with 100 passes of high velocity oxy fuel thermal spraying. During the spraying procedure, a DPV 2000 in situ diagnostic instrument was used to monitor the temperature and velocity of in-flight particles. The microstructure of the coatings was analyzed using an optical microscope to monitor the porosity and thickness distributions at various positions of the hillock-like coatings. A 7.1% porosity was observed at the centre of the hillock-like coatings, and a 10% porosity was observed at the edge, each at a spraying distance of 200 mm. The centre area of hillock-like coatings exhibited almost a 30% decrease in porosity compared to the edge area. The results indicate a higher quality structure at the centre area of the hillock-like coatings.

W.T. Hsiao, W.H. Liao, C.Y. Su, and M.S. Leu, Graduate Institute of Manufacturing Technology, National Taipei University of Technology, Taipei 106, Taiwan. Cited: *Surf. Eng.,* 2009, May, **25**(4), p 313-318. ISSN 0267-0844.

Influence of substrate temperature on intersplat bonding and properties of plasma-sprayed yttria-stabilized zirconia coatings. A method has been developed to control the microstructure or the bonding ratio between the lamellae in plasma sprayed yttria-stabilized zirconia (YSZ) coatings through controlling the coating surface temperature during the spraying process. Fused and crushed 8 mol% Y_2O_3-ZrO_2 (8YSZ) powder was used as the feedstock. The 8YSZ was deposited by a commercial plasma spray system. The plasma torch was operated at 38.5 kW, and the flow rate of Ar and H_2 was 33 1/min and 2 1/min. The measurement of the through-thickness ionic conductivity of YSZ coatings was performed using a electrochemical interface. The examination of fractured YSZ splats bonded to a YSZ substrate reveals that effective bonding between the splat and the substrate is not formed when the substrate surface temperature is below a temperature that ranges from 460 °C to 600 °C. YSZ coatings deposited at room temperature exhibit a distinct lamellar structure with numerous bonded interface areas. (Edited abstract)

Y.-Z. Xing, Chang'an University, Xi'an, Shaanxi, China. Cited: *Adv. Mater. Processes,* 2009, May, **167**(5), p 76-77. ISSN 0882-7958.

Maximizing the glass fraction in iron-based high velocity oxy-fuel coatings. Developing iron-based coatings, from glass forming alloys such as SAM2X5, which exhibit outstanding corrosion performance superior to nickel-based alloys, results in particular challenges. This is because the resulting corrosion performance of the coating depends on a complex inter-relationship between the intrinsic properties including coating chemistry with its resulting protective oxide layer, the extrinsic properties related to the macrostructure with its defects resulting from the spray process, and the microstructure where one key factor is the total level of microstructural refinement achieved. As the microstructural scale is reduced, it becomes increasingly difficult for the electrochemical system to initiate electrochemical attack. Metallic glasses, which can be considered "angstrom" scaled materials, represent the ultimate in microstructural uniformity. In this article, the influence of the feedstock powder structure on the resulting glass content in the coating will be explored, because maximizing the glass percentage is one key factor in improving corrosion performance.

D.J. Branagan, W.D. Swank, and B.E. Meacham, The NanoSteel Company, Idaho Falls, ID 83402. Cited: *Metall. Mater. Trans. A,* **40**(6), p 1306-1313. ISSN 1073-5623.

Mechanical and microstructural characterizations of nicrcoalyta coatings on superalloys deposited by detonation gun technique. The microstructure and mechanical properties of detonation gun sprayed NiCoCrAlYTa alloy coatings on the selected superalloys were investigated. The coatings were characterized in relation to thickness, porosity, microhardness, microstructure, compositions, and phases across by using the techniques such as optical microscopy, x-ray diffraction, field emission scanning electron microscopy/energy dispersive analysis and x-ray mapping. The formation of spherical or elliptical shaped dendritic splats was observed in the as sprayed coatings on the superalloys. The splat morphology of the coatings is due to the deposition and re-solidification of successive molten or semimolten powder particles. The coatings showed a bond strength of 50 MPa and the surface roughness (arithmetic average height) of the coatings was found to be in the range of 6.25-7.48 μm. The porosity and microhardness of the coatings were less than 0.48% and 385-748 Hv, respectively. The XRD analysis of the

coatings showed the phases ν-Ni or ν-Ni_3Al and β-NiAl inter metallic as the minor phase. © 2009 Institute of Materials, Minerals and Mining.

S. Kamal, R. Jayaganthan, and S. Prakash, Department of Metallurgical and Materials Engineering, Indian Institute of Technology, Roorkee, Roorkee 247667, India. Cited: *Surf. Eng.,* 2009, May, **25**(4), p 303-312. ISSN 0267-0844.

Microstructure and oxidation resistance of Mo-Si and Mo-Si-Al alloy coatings prepared by electro-thermal explosion ultrahigh speed spraying. Mo-Si and Mo-Si-Al alloy coatings were synthesized on the surface of nickel-based superalloy substrate using electro-thermal explosion ultrahigh speed spraying technology. The coatings have dense microstructure with submicrometer size grains. The microhardness of the coatings is in the range of 1100-1350 HV. The weight loss of Mo-Si alloy coatings is found to be 2 mg/cm^2 on exposure at 500 °C for 840 h and 20 mg/cm^2 on holding at 900 °C for 360 h, respectively. However, Al alloyed in Mo-Si coatings obviously slows down the oxidation at high temperature. The weight loss of Mo-Si-Al alloy coatings is only 0.5 mg/cm^2 at 500 °C for 840 h and 7 mg/cm^2 at 900 °C for 360 h, respectively. The weight loss ratio of Mo-Si-Al alloy coatings decreases about 70% comparing to that of Mo-Si alloy coatings. The pest disintegration of the $MoSi_2$ can be suppressed by electro-thermal explosion ultrahigh speed spraying technology and alloying Al. © 2009 Elsevier B.V. All rights reserved.

S.-X. Hou, Z.-D. Liu, D.-Y. Liu, B.-R. Li, and N.-Q. Zhang, Key Laboratory of Condition Monitoring and Control for Power Plant Equipment, Ministry of Education, North China Electric Power University, Beijing 102206, China. Cited: *Mater. Sci. Eng. A,* 2009, Aug 25, **518**(1-2), p 108-117. ISSN 0921-5093.

Microstructure and properties of AC-HVAF sprayed Ni60/WC composite coating. A Ni60/WC coating was deposited on 0Cr13Ni5Mo stainless steel substrate by the actived combustion-high velocity air fuel (AC-HVAF) technique. The structure and morphologies of the Ni60/WC coating were characterized by x-ray diffraction (XRD) and scanning electron microscopy (SEM), and the wear resistance and corrosion resistance were studied. The results showed that the AC-HVAF spraying was seen as the pre-eminent process for the deposition of Ni60/WC coating. Due to low particle heating and high particle velocity in the HVAF process, WC phase remain almost unchanged after spraying. The tribological behaviors were evaluated by using a HT-600 wear test rig. Under the same conditions, the worn volume of 0Cr13Ni5Mo stainless steel was 10.43 times more than that of the coating. The wear mechanism was mainly fatigue wear. A series of the electrochemical tests was carried out in a 3.5 wt.% NaCl solution in order to examine the corrosion behavior. Mechanisms for corrosion resistance were discussed. Crown Copyright © 2009.

S.L. Liu and X.P. Zheng, School of Materials Science and Engineering, Chang'an University, Xi'an 710061, China. Cited: *J. Alloys Compd.,* 2009, July 8, **480**(2), p 254-258. ISSN 0925-8388.

Microstructure and properties of arc sprayed coatings containing Fe based amorphous phase and nanocrystallites. An Fe based cored wire was used to deposit wear resistant coatings containing Fe based amorphous phase and nanocrystallites on Q235 steel substrate by arc spraying. The microstructure of the coatings was investigated by scanning electron microscopy and transmission electron microscopy. Electron probe microanalyser and x-ray diffraction analysis were used to study the chemical compositions and phase compositions in the coatings. The microhardness of the coating was determined. The wear behavior of the coatings was evaluated. The results showed that the coatings contained Fe based amorphous phase and other crystallites such as Fe_2B, Cr_2B, $M_{23}C,B)_6$, Fe_3O_4 and α-(Fe,Cr). Some of the crystallites show grain sizes of less than or equal 30 nm. The coatings were hard. Compared with the reference sample of commercial 3Cr13 coating, the coatings showed a much higher wear resistance; the relative wear resistance of the amorphous coating was 8 times higher than that of commercial 3Cr13 coating. © 2009 Institute of Materials, Minerals and Mining.

B.Y. Fu, D.Y. He, L.D. Zhao, J.M. Jiang, and X.Y. Li, College of Materials Science and Engineering, Beijing University of Technology, Beijing 100124, China. Cited: *Surf. Eng.,* 2009, May, **25**(4), p 333-337. ISSN 0267-0844.

Nanomechanical behavior of plasma sprayed PZT coatings. Nanomechanical properties of the plasma sprayed lead zirconate titanate (PZT) coating have been investigated using nanoindentation technique. PZT coating processed at higher plasma power of 32 kW exhibited lower elastic modulus E of 98 GPa compared with the modulus (113 GPa) of the coating processed at plasma power of 20 kW. The variation in the elastic modulus is attributed to the fine porosity of the PZT coating, which is formed during plasma spraying. Porosity increases by evaporation of PbO phase during plasma spraying. Overall effective elastic modulus of both coatings is computed using micromechanics models and compared with the experimentally obtained values. Hashin-Shtrikman and rule of mixtures models predict values that closely match with nanoindentation values. © 2009 Institute of Materials.

A.K. Keshri, S.R. Bakshi, Y. Chen, T. Laha, X. Li, C. Levy, and A. Agarwal, Department of Mechanical and Materials Engineering, Florida International University, Miami, FL 33174. Cited: *Surf. Eng.,* 2009, May, **25**(4), p 270-275. ISSN 0267-0844.

Preparation of barium hexaferrite coatings using atmospheric plasma spraying. Thick coatings of barium hexaferrite with the compositions $BaFe_{12}O_{19}$ and $BaCoTiFe_{10}O_{19}$ were prepared using atmospheric plasma spraying (APS) technology. The coatings were prepared from pre-reacted powders of the desired composition. The as-deposited coatings were poorly crystallized, but their crystallinity was improved with a subsequent annealing. The crystallization mechanism of the sprayed hexaferrites was studied during annealing up to 1300 °C, using x-ray powder diffraction combined with thermal analysis and with electron microscopy including microanalysis. Single-phase coatings were obtained after annealing treatments at 1100-1300 °C. Their magnetic properties showed that they would be suitable for absorbers at microwave and mm-wave frequencies, depending on the coating phase's composition, the crystallinity and the thicknesses. © 2009 Elsevier Ltd. All rights reserved.

D. Lisjak, K. Bobzin, K. Richardt, M. Begard, G. Bolelli, L. Lusvarghi, A. Hujanen, P. Lintunen, M. Pasquale, E. Olivetti, M. Drofenik, and T. Schlafer, Jozef Stefan Institute, Department for Materials Synthesis, Ljubljana, Slovenia. Cited: *J. Eur. Ceram. Soc.,* 2009, Aug, **29**(11), p 2333-2341. ISSN 0955-2219.

Reactive detonation spraying of in situ synthesised TiC reinforced Fe36Ni based composite coatings via sucrose as carbonaceous precursor. A kind of Ti-Fe-Ni-C compound powder was obtained by heating a mixture of FeTi, Ni and sucrose to pyrolyse sucrose. The sucrose is the source of carbon that is a reactive constituent as well as a binder in the compound powders. These powders were employed to in situ synthesize TiC-Fe36Ni cermet coatings by reactive detonation spraying. The cermet coatings are mainly composed of different reinforcement areas where the round fine TiC particles homogeneously distribute within the metallic matrix. The surface hardness and average microhardness of the cermet coatings are about 94+2 (HR15 N) and 1752 HV(0.2), respectively. Finally, the TiC-Fe36Ni cermet coatings have good wear resistance performance and bonding strength. © 2009 Institute of Materials, Minerals and Mining.

H.T. Wang, S.Q. Zhang, J.H. Huang, J.L. Zha, and H. Zhang, School of Materials Science and Engineering, University of Science and Technology, Beijing, Beijing 100083, China. Cited: *Surf. Eng.,* 2009, May, **25**(4), p 295-302. ISSN 0267-0844.

Structure and mechanical properties of nanoscale multilayered CrN/ZrSiN coatings. Nanocrystalline/amorphous CrN/ZrSiN multilayer coatings with a bilayer thickness ranging from 11 to 153 nm were prepared by reactive magnetron sputtering technique. The microstructure and mechanical properties of these thin films were characterized by x-ray diffraction (XRD), scanning electron microscopy, transmission electron microscopy (TEM), Fourier transform infrared spectroscopy (FTIR), and nanoindentation. The formation of nanocrystalline CrN and nanocomposite ZiSiN in the single layer coatings was identified by XRD and FTIR. The periodic structure of the as-deposited multilayer coatings was confirmed by TEM observation. Nanoindentation tests showed that both the values of hardness (H) and reduced elastic modulus (E_r) of CrN/ZrSiN multilayers remained almost constant despite varying the bilayer thickness. The multilayer coatings exhibited higher H of 30 GPa and higher resistance to plastic deformation when compared to the single layer CrN and ZrSiN coatings. © 2009 American Vacuum Society.

Z.G. Zhang, O. Rapaud, N. Allain, M. Baraket, C. Dong, and C. Coddet, State Key Laboratory of Materials Modification, Dalian University of Technology, Dalian 116024, China. Cited: *J. Vac. Sci. Technol. A,* 2009, **27**(4), p 672-680. ISSN 0734-2101.

Postprocessing

Development of alternative method of blasting and ultra-high adhesive strength thermal spray coatings by vacuum arc treatment. There are some problems for the environment and for the human body in a conventional blasting process when it is used for the pre-treatment of thermal spray. They are, for example, generation of noise and dust. One possible method to overcome these problems is a vacuum arc cleaning (VAC) process. It is possible for this technology to both surface cleaning and roughen surface. The VAC process is good for the environment as well as the human body, because this process takes place inside a chamber. In this study, the first aim is to establish the VAC process as the alternative of blasting, and the second aim is to develop ultra-high adhesive strength plasma spray coatings by employing blasting and the VAC process as the pre-treatment of plasma spray. The adhesive strength higher than 50 N/mm^2 is achieved only by applying the VAC process as pre-treatment and higher than 90 N/mm^2 is achieved by employing the VAC process after blasting. © 2009 Japan Thermal Spraying Society.

Y. Noda, A. Sato, S. Tobe, M. Hara, and T. Inaba, Department of Mechanical Engineering, Ashikaga Institute of Technology, Asikaga 326-8558, Japan. Cited: *Mater. Trans.,* 2009, Apr, **50**(4), p 825-831. ISSN 1345-9678.

Femtosecond laser machining of cooling holes in thermal barrier coated CMSX4 superalloy. Machining of cooling holes on thermal barrier coated

superalloy components using a nanosecond (ns) laser generates considerable collateral damage such as recast layer, spatter and delamination of the ceramic coating. However, recent studies have suggested that these damages can be virtually eliminated by machining with femtosecond (fs) lasers. A detailed study on the microstructural characteristics of fs laser machined holes with diameters of 300 μm and 600 μm, generated on thermal barrier coated superalloy CMSX4 under various processing conditions has been conducted. Features examined include the shape, size and the surface finish of the hole wall. Femtosecond laser machined holes with a surface roughness of less than 2 μm and no major collateral damage could be generated in coated samples up to a thickness of 1.5 mm. The machining was found to cause minor ablative material removal from the top ceramic layer within 100 μm of the outer edge of the hole. The presence of machined holes did not affect the thermal cycling life at 1100 °C of the coated samples.

D.K. Das and T.M. Pollock, Defense Metallurgical Research Laboratory, Kanchanbagh, Hyderabad 500058, India. Cited: *J. Mater. Process. Technol.,* 2009, Aug 1, **209**(15-16), p 5661-5668. ISSN 0924-0136.

Heat treatment induced intermetallic phase transition of arc-sprayed coating prepared by the wires combination of aluminum-cathode and steel-anode. A method to prepare intermetallic composite coatings employing the cost-efficient electric arc spraying twin wires assistant with suitable heat treatment was developed. In this study, a Fe-Al composite coating was produced by spraying twin wires, i.e. a carbon steel wire as the anode and an aluminum wire as the cathode. The inter-deposited Fe-Al coating was transformed in situ to Fe-Al intermetallic composite coating after a post annealing treatment. The effect of annealing treatment conditions on phase composition, microstructure and mechanical properties of the coating was investigated by using XRD, SEM, EDS and OM as well as microhardness tester. The results show that the desirable intermetallic phases such as Fe_2Al_5, FeAl and Fe_3Al are obtained under the annealing condition. The main oxide in the coating is FeO which can partially transform to Fe_3O_4 up to the annealing condition.

Y. Chen, X. Liang, S. Wei, Y. Liu, and B. Xu, National Key Laboratory for Remanufacturing, Academy of Armored Forces Engineering, Beijing 100072, China. Cited: *Appl. Surf. Sci.,* 2009, July 15, **255**(19), p 8299-8304. ISSN 0169-4332.

Improvement in tribological properties of atmospheric plasma-sprayed WC-Co coating followed by Cu electrochemical impregnation. The WC-Co coating obtained by atmospheric plasma spraying (APS) was modified by Cu electrochemical impregnation. The copper has infiltrated into and filled up the pores in WC-Co coating. The tribological properties of the coating against the stainless steel ball as sliding pairs were investigated with a ball-on-disc (BOD) configuration in air at room temperature. The as-prepared samples were characterized by means of optical microscope, scanning electron microscope and x-ray diffraction. It was found that the frictional behavior of the WC-Co coating followed by Cu electrochemical impregnation was superior to that of WC-Co coating. The wear mechanism of the WC-Co coating followed by Cu electrochemical impregnation was microcutting, whilst that of a WC-Co coating was the fatigue wear. The improvement in tribological properties of the WC-Co coating followed by Cu electrochemical impregnation was attributed to the formation of self-lubricating Cu film on the wear surface which induces the transformation of wear mechanism.

J. Yuan, Y. Zhu, X. Zheng, Q. Ruan, and H. Ji, Key Laboratory of Inorganic Coating Materials, Shanghai Institute of Ceramics (SIC), Chinese Academy of Sciences (CAS), Changning, Shanghai 200050, China. Cited: *Appl. Surf. Sci.,* 2009, June 30, **255**(18), p 7959-7965. ISSN 0169-4332.

Interaction in the $MoSi_2$-W system at 1500 to 1800 °C. The paper studies the kinetics of the diffusion redistribution of phases in the $MoSi_2$-W system when tungsten samples with molybdenum silicide coatings are heated in air at 1500-1800 °C. It is established that the $(Mo_x,W_{y5}Si_3$ phase, which represents a molecular solid solution of lower molybdenum and tungsten silicides, forms in an exchange reaction between molybdenum and tungsten at the $MoSi_2$-W_5Si_3 interface. The $MoSi_2$-W system is much more stable than the WSi_2-W and $MoSi_2$-Mo systems.

P.I. Glushko, V.I. Zmii, N.A. Semenov, A.A. Sushchaya, V.I. Sheremet, and B.M. Shirokov, National Scientific Center, Kharkov Physics and Technology Institute, Kharkov, Ukraine. Cited: *Powder Metall. Met. Ceram.,* 2009, Jan, **48**(1-2), p 88-92. ISSN 1068-1302.

Processing

A new method for thermal spraying of Zn-Al coatings. This paper presents the development of the thermal spraying system built on the principles of the high velocity air flame (HVAF) process. HVAF sprayed coatings showed considerably higher bond strength than coatings obtained by the conventional methods, indicating the advantage of this method in areas where the adhesion strength is critically important. The highly dense structure of the coating obtained with HVAF eliminates a need for a top paint coat, which is typically applied on metal sprayed coatings to extend service life. The thermal sprayed coatings were characterized by the standard techniques, such as light microscopy, scanning electron microscopy with energy-dispersive spectroscopy, x-ray diffraction, salt spray and bond strength tests. The results show that thermal sprayed coatings have a dense structure, low presence of oxides and high resistance to corrosion. High spray rate and good coating quality make the HVAF thermal spray method a viable alternative to the conventional thermal spraying technologies, such as Wire Flame and Twin-Wire Arc.

I.A. Gorlach, Nelson Mandela Metropolitan University, Port Elizabeth, 6031, South Africa. Cited: *Thin Solid Films,* 2009, July 1, **517**(17), p 5270-5273. ISSN 0040-6090.

Controlling graphite content in plasma sprayed cast iron coatings via in-flight particle diagnostic. Graphite formation and degradation in thermally sprayed cast iron coatings is a technological barrier for achieving superior wear resistant coatings. Therefore, there is a need to understand the in-flight particle behavior of cast iron powder and introduce new approaches to control the graphite content. In this study, it has been demonstrated that the graphite content can be controlled by means of in-flight particle diagnostic. For this purpose, cast iron coatings were plasma sprayed under a variety of spray conditions and characterized by using an optical microscope, x-ray diffractometer and electron probe micro-analyzer. As a result, a significant amount of graphite with respect to a wide range of in-flight particle temperature and velocity was preserved in cast iron coatings.

C. Tekmen, K. Iwata, Y. Tsunekawa, and M. Okumiya, Toyota Technological Institute, Materials Processing Laboratory, Tempaku 468-8511, Nagoya, Japan. Cited: *J. Mater. Process. Technol.,* 2009, July 19, **209**(14), p 5417-5422. ISSN 0924-0136.

Laminar premixed spray flame analysis with thermally sensitive intermediate kinetics. A new thermo-diffusive analysis of one-dimensional laminar lean or rich off-stoichiometric premixed spray flames has been performed using a chain branching/chain breaking chemical kinetic scheme and under the assumption that the fuel droplets evaporate in a sharp front. The sensitivity of the flame structure, speed and the location of the evaporation front to the initial droplet load have been demonstrated. A linear stability analysis reveals the way in which the spray's presence modifies the neutral stability curves.

J.B. Greenberg, A. Zinoviev, and J.W. Dold, Faculty of Aerospace Engineering, Technion-Israel Institute of Technology, Haifa, Israel. Cited: *Combust. Theory Modell.,* **13**(2), p 365-388. ISSN 1364-7830.

Liquid feedstock thermal spray. The field of thermal spray is witnessing advancements with respect to layered coatings from liquid feedstocks. Thermal spray deposition coatings, containing nanostructured phases, can be achieved using agglomerated nanocrystals and improvements can be done in the performance of tribocoatings, thermal barriers, and corrosion resistant layers, bio-compatible and poly-catalytic coatings. Two feedstock thermal spray techniques that have been developed are Suspension Plasma Spray (SPS) and Solution Precursor Thermal Spray (SPTS). The homogeneity of powder suspensions in water or organic solvents can be improved by the use of dispersing and deflocculating agents and stabilizing suspensions either electrostatically or sterically. Thermal barrier coatings, coatings for high performance SOFCs such as lanthanum-strontium perovskites and yttria stabilized zirconia are considered as most promising applications of STS and SPTS. (Edited abstract).

C. Bartuli, Department of Chemical Engineering Materials Environment, Sapienza University of Rome, INSTM Reference Laboratory for Engineering of Surface Treatments. Cited: *Surf. Eng.,* 2009, July, **25**(5), p 343-345. ISSN 0267-0844.

Mechanisms of the formation of silica particles from precursors with different volatilities by flame spray pyrolysis. The flame spray pyrolysis (FSP) synthesis of silica particles from two different precursors, tetraethylorthosilicate (TEOS) and silicic acid which have significantly different volatilities, was investigated. The size and morphology of the particles produced using various concentrations of precursors and flame temperatures were examined. Significantly different volatilities of the precursors affected the particle formation mechanism. Two different particle formation mechanisms, vapor phase reaction (VPR) and intradroplet reaction (IDR), are proposed based on the relative time scale for the evaporation of sprayed precursor droplets and for particle formation at the same process conditions. VPR resulted in silica agglomerates with small primary particles of around 10 nm sizes. IDR resulted in isolated and spherical silica particles with the sizes of around 650 nm from silicic acid.

K. Cho, H. Chang, D.S. Kil, J. Park, H.D. Jang, and H.Y. Sohn, Industrial Materials Research Department, Korea Institute of Geoscience and Mineral Resources, Yuseong-gu, Daejeon 305-350, South Korea. Cited: *Aerosol Sci. Technol.,* 2009, Sept, **43**(9), p 911-920. ISSN 0278-6826.

Modeling and experimental verification of tubular product formation during spray forming. A mathematical model is formulated to predict the

shape evolution and the final geometry of a tubular product prepared by spray forming. The effects of several important processing parameters on the shape evolution of the tube are investigated. The model is validated against experiments of spray formed large diameter tubes. The experimental and the modeling results show that there are three distinct regions in the preform, i.e., the left transition region, the middle uniform diameter region and the right transition region. The results show that the atomization parameters a_s and b_s, traversing speed v of the substrate, the outer diameter D_0 of the substrate, and the initial deposition distance d_0 play important roles in the contour and the wall thickness of the spray formed tube. But the angular velocity ω; of the substrate has little effect on the buildup of the deposit. After a certain time from the beginning of the process, the deposit will come into a steady growth state. In addition, an equation is provided to estimate the wall thickness of the deposit under the steady growth state based on the mass conservation. © 2009 The Nonferrous Metals Society of China.

D.-M. Liu, J.-Z. Zhao, and M.-S. Li, Key Laboratory of Liquid Structure and Heredity of Materials, Ministry of Education, Shandong University, Ji'nan 250061, China. Cited: *Trans. Nonferr. Met. Soc. China (Engl. Edn.),* 2009, June, **19**(3), p 661-667. ISSN 1003-6326.

Parameter optimization for spray coating. The aim of planning path-oriented spray-coating processes is to find a time-dependent continuous sequence of spray gun configurations so that a coating of desired thickness is achieved when executing the sequence. A novel approach to solving the planning task, called "geometry-last", is outlined which leads to a more general gun configuration cover problem. The gun configuration cover problem is to find a finite set of spray gun configurations, which minimizes the error between a target coating and the coating induced by simultaneously activating those configurations. A suitable objective function for gun configuration covers is defined, and algorithmic solutions for the optimization problem are presented, including speed-up by hierarchization and use of graphics hardware. An experimental evaluation shows that good approximations of the desired coatings can be achieved within reasonable computing times. In contrast to other approaches, geometry-last gains additional flexibility required to find complex paths for free-form workpieces. © 2009 Elsevier Ltd. All rights reserved.

A. Kout and H. Muller, Dortmund University of Technology, D-44227 Dortmund, Germany. Cited: *Adv. Eng. Software,* 2009, Oct, **40**(10), p 1078-1086. ISSN 0965-9978.

Some aspects on 3D numerical modeling of high velocity impact of particles in cold spraying by explicit finite element analysis. Three-dimensional modeling of particle impacting behavior in cold spraying by using ABAQUS/Explicit was conducted for copper and other materials. Various combinations of calculation settings concerning material damage, Arbitrary Lagrangian Eulerian adaptive meshing, distortion control and contact interaction were examined. The effects of meshing size and particle size on the impact behavior were analyzed compared to the previous results. The results show that the simulations with material damage cope well with the element excessive distortion and the resultant output is more reasonable than that obtained without material damage. In addition, the meshing size has less effect on the output with the material damage than without material damage. Although particle size has little effect on the morphologies of the deformed particles, it has some effect on the failure of elements at contact interfaces. The critical velocity for particle deposition could be estimated given the appropriate material properties. © 2009 Elsevier B.V. All rights reserved.

W.-Y. Li and W. Gao, Shaanxi Key Laboratory of Friction Welding Technologies, School of Materials Science and Engineering, Northwestern Polytechnical University, Xi'an, Shaanxi 710072, China. Cited: *Appl. Surf. Sci.,* 2009, June 30, **255**(18), p 7878-7892. ISSN 0169-4332.

Synthesis of $BaMgAl_{10}O_{17}:Eu^{2+}$ blue phosphor by electro-spray aerosol flame deposition. Spherical and nano-sized $BaMgAl_{10}O_{17}:Eu^2$ (BAM) phosphor particles for plasma display panel (PDP) application were synthesized by Aerosol Flame Deposition (AFD) and subsequent heat treatment at 1250 °C for 4 h under reducing atmosphere. The effects of various atomization methods, precursor solution and various deposition position along flame axis were investigated in order to control the morphology and size of the phosphor. Characteristics of BAM phosphor were investigated for products prepared under various condition and they were compared with those of the commercial BAM. It was found that electro-spray gas-assisted atomization produce the most fine particle, while the optimum particle size for real application in phosphor devices (200-400 nm) was produced by the gas-blast atomizer. © 2009 American Scientific Publishers All rights reserved.

D. Shin and S. Ko, Division of Materials Science and Engineering, Hanyang University, 17 Haengdang-dong, Seongdong-gu, Seoul 133-791, South Korea. Cited: *J. Nanosci. Nanotechnol.,* 2009, Feb, **9**(2), p 853-856. ISSN 1533-4880.

Synthesis of nanocrystalline NiCrC alloy feedstock powders for thermal spraying by cryogenic ball milling. Nanocrystalline NiCrC alloy powders with a qualified particle size distribution for thermal spraying were synthesized using the cryogenic ball milling (cryomilling) method. The morphology, microstructure, size distribution, and phase transformation of the powders were characterized by scanning electron microscopy (SEM), laser scattering for particle size analysis, x-ray diffraction (XRD), and transmission electron microscopy (TEM). After cryomilling for 20 h, the average grain size of the as-milled powders approached a constant value of 30 nm by XRD measurement. The average particle size slightly increased from 17.5 to 20.3 μm during the 20-h milling. About 90 vol.% of the powders satisfied the requirement for thermal spraying with the particle dimension of 10-50 μm, and most of the powders exhibited spherical morphology, which were expected to have good fluidity during thermal spraying. The Cr_2O_3 phase formed during the cryomilling process as revealed in the XRD spectra, which was expected to enhance the thermal stability of the as-milled powders during the followed thermal spraying or other heat treatment. © 2009 University of Science and Technology Beijing.

K. Tao, X.-L. Zhou, H. Cui, H.-B. Chen, Y.-B. Li, and J.-S. Zhang, State Key Laboratory for Advanced Metals and Materials, University of Science and Technology Beijing, Beijing 100083, China. Cited: *Int. J. Miner. Metall. Mater.,* 2009, Feb, **16**(1), p 77-83. ISSN 1674-4799.

Thin films by metal-organic precursor plasma spray. While most plasma spray routes to coatings utilize solids as the precursor feedstock, metal-organic precursor plasma spray (MOPPS) is an area that the authors have investigated recently as a novel route to thin film materials. Very thin films are possible via MOPPS and the technology offers the possibility of forming graded structures by metering the liquid feed. The current work employs metal-organic compounds that are liquids at standard temperature-pressure conditions. In addition, these complexes contain chemical functionality that allows straightforward thermolytic transformation to targeted phases of interest. Toward that end, aluminum 3,5-heptanedionate (Al $(hd)_3$), triethylsilane ($HSi(C_2H_5)_3$ or HSi Et_3), and titanium tetrakisdiethylamide ($Ti(N(C_2H_5)_2)_4$ or Ti $(Net_2)_4$) were employed as precursors to aluminum oxide, silicon carbide, and titanium nitride, respectively. In all instances, the liquids contain metal-heteroatom bonds envisioned to provide atomic concentrations of the appropriate reagents at the film growth surface, thus promoting phase formation (e.g., Si-C bond in triethylsilane, Ti-N bond in titanium amide, etc.). Films were deposited using a Sulzer Metco TriplexPro-200 plasma spray system under various experimental conditions using design of experiment principles. Film compositions were analyzed by glazing incidence x-ray diffraction and elemental determination by x-ray spectroscopy. MOPPS films from HSi Et_3 showed the formation of SiC phase but Al $(hd)_3$-derived films were amorphous. The Ti $(Net_2)_4$ precursor gave MOPPS films that appear to consist of nano-sized splats of TiOCN with spheres of Ti O_2 anatase. While all films in this study suffered from poor adhesion, it is anticipated that the use of heated substrates will aid in the formation of dense, adherent films. © 2009 American Vacuum Society.

D.L. Schulz, R.A. Sailer, S. Payne, J. Leach, and R.J. Molz, North Dakota State University, Fargo, ND 58108-6050. Cited: *J. Vac. Sci. Technol. A,* 2009, **27**(4), p 962-969. ISSN 0734-2101.

Twin-fluid atomization and novel lifted swirl-stabilized spray flames. The effects of swirl configuration and airflow distribution on the structure of swirl-stabilized spray flames are investigated in a combustor featuring a twin-fluid fuel atomization nozzle, coannular airstreams, and helical-vane swirl assemblies. The flames investigated are similar to those employed in gas turbine combustion engines. A novel lifted swirl-stabilized spray flame, obtained with a particular set of experimental conditions, is described. Three-dimensional particle image velocimetry data are used to analyze the structure of the airflow associated with the lifted flame. The lifting effect is shown to result from an interaction between the atomization airstream and the recirculation zone in the flow, which creates two distinct recirculation regions. Only the larger far-field recirculation zone is able to stabilize combustion effectively, and the structure of the airflow is found to determine the regions of heat release associated with the flame. Detailed information on the structure and characteristics of the fuel spray, obtained using phase-Doppler particle analysis, is also presented. The twin-fluid atomization approach is shown to provide effective atomization over a wide range of operating conditions, while simultaneously allowing a great degree of control over the flame structure.

M.B. Linck and A.K. Gupta, University of Maryland, College Park, MD 20742. Cited: *J. Propul. Power,* 2009, Mar-Apr, **25**(2), p 344-357. ISSN 0748-4658.

Use of aqueous suspensions in plasma spraying of alumina coatings. The paper examines and compares the properties of Al_2O_3 coatings sprayed using two methods: arc plasma spraying (APS) of micron powders (average particle size is 45 μm) and suspension plasma spraying (SPS) (average particle size is 2.9 μm). A system for feeding suspension into plasma spray is developed and fabricated. It is established that SPS coatings contain finer structural components than APS. This improves their mechanical characteristics such as microhardness and indentation fracture toughness. © 2009 Springer Science+Business Media, Inc.

V.E. Oliker, A.E. Terent'ev, L.K. Shvedova, and I.S. Martsenyuk, Frantsevich Institute for Problems of Materials Science, National Academy of Sciences of Ukraine, Kiev, Ukraine. Cited: *Powder Metall. Met. Ceram.,* 2009, Jan, **48**(1-2), p 115-120. ISSN 1068-1302.

Yttria-stabilized zirconia in-flight particle characteristics under vacuum plasma spray conditions. This paper deals with the diagnostic yttria-stabilized zirconia (YSZ) in-flight particles in Vacuum Plasma Spray (VPS) process using an optical measurement device. Particle velocity, temperature and diameter were correlated to spray distance under a fixed chamber pressure of about 14 kPa. Experiments were carried out with a two-color pyrometer. Results show that correlations can be satisfactory described with linear relationships. Particle velocity and temperature decrease when increasing spray distance whereas particle diameter exhibits a linear increase with the spray distance.

Z. Salhi, S. Guessasma, and N. Feninechе, INRA–BIA, 44316, Nantes, France. Cited: *Vacuum,* 2009, July 14, **83**(11), p 1382-1387. ISSN 0042-207X.

Properties

Mechanical

Bonding strength of fluoridated hydroxyapatite coatings: A comparative study on pull-out and scratch analysis. In this study, fluoridated hydroxyapatite coatings are prepared on Ti6Al4V alloy substrate through sol-gel method. The bonding strength is evaluated through two different methods: pull-out method and scanning scratch method. Both results show F incorporation could effectively increase the bonding between coating and substrate. It is found that the pull-out results are actually compounds of adhesion failure, cohesive failure and glue failure; while the critical loads in scanning scratch show only the coating-matrix adhesion strength. It is suggested that scanning scratch test is more suitable to evaluate the bonding strength of bioactive ceramic coatings.

K. Cheng, C. Ren, W. Weng, P. Du, G. Shen, G. Han, and S. Zhang, Department of Materials Science and Engineering, Zhejiang University, Hangzhou 310027, China. Cited: *Thin Solid Films,* 2009, July 1, **517**(17), p 5361-5364. ISSN 0040-6090.

Characterization of plasma sprayed hydroxyapatite/ZrO_2 graded coating. Hydroxyapatite/ZrO_2 graded coating was deposited onto Ti-6Al-4V substrate by atmospheric plasma spraying. The adhesive strength of the graded coating was tested and the bioactivity was evaluated in vitro by incubation test in the simulated body fluid (SBF). The results indicated that the graded coating has improved bonding strength and the crystallinity of hydroxyapatite can be improved using a post heat treatment. The bioactivity of the hydroxyapatite/ZrO_2 graded coating was also confirmed.

H. Li, Z.X. Li, H. Li, Y.Z. Wu, and Q. Wei, College of Materials Science and Engineering, Beijing University of Technology, Beijing 100124, China. Cited: *Mater. Des.,* 2009, Oct, **30**(9), p 3920-3924. ISSN 0261-3069.

Dry sliding up to 7.5 m/s and 800 °C of thermally sprayed coatings of the TiO_2-Cr_2O_3 system and (Ti,Mo)(C,N)-Ni(Co). Since the term 'lubricious oxides' was introduced to tribology in order to describe expected low coefficients of friction (COF) and high wear resistances in unlubricated (dry) sliding conditions numerous studies have been carried out on bulk materials and thermal spray coatings of the Ti-O system. Recently, studies were performed on the binary TiO_2-Cr_2O_3 system, as well as with (Ti,Mo)(C,N)-NiMo cermets or TiC-based thermally sprayed hardmetal coatings, which might form beneficial titanium suboxides as a result of tribo-oxidative and/or high-temperature reactions. In this paper, we shortly summarize the characteristics and dry sliding wear resistance of thermally sprayed oxide coatings of the Ti-O and TiO_2-Cr_2O_3 systems, as well as of (Ti,Mo)(C,N)-Ni(Co) hardmetal coatings. The prediction of solid lubrication properties of titanium suboxides was inspired from the planar oxygen defects present in the Magneli-phases of titania, e.g., so-called crystallographic shear planes. While such structures with some limitations can be realised in coatings, the significant disadvantage is that TiO_x tends to re-oxidize in air above [similar to] 380 °C. The isostructural phases in the TiO_2-Cr_2O_3 phase diagram can be prepared in air and have stable oxygen content. However, as can be concluded from the phase diagram, during thermal spraying phase transformations occur as well. In this paper, the wear resistance of alumina dry sliding against APS-sprayed coatings of three compositions in the TiO_2-Cr_2O_3 systems (compositions $75Cr_2O_3/25TiO_2$, $27Cr_2O_3/73TiO_2$ and $23.5Cr_2O_3/76.5TiO_2$) is studied from room temperature up to 800 °C and sliding speeds in the range of 0.1-7.5 m/s. The results are compared with those of a chromia and a titania suboxide coatings, as well as with (Ti,Mo)(C,N)-Ni(Co) coatings and bulk (Ti,Mo)(C,N)-NiMo cermets as self-mated couples.

L.M. Berger, C.C. Stahr, S. Saaro, S. Thiele, M. Woydt, and N. Kelling, Federal Institute for Materials Research and Testing, BAM, Berlin, Germany. Cited: *Wear,* 2009, June 15, **267**(5-8), p 954-964. ISSN 0043-1648.

Dynamic stability analysis of an elastic composite material having a negative-stiffness phase. The rigorous classical bounds of elastic composite materials theory provide limits on the achievable composite stiffnesses in terms of the properties and arrangements of the composite's constituents. These bounds result from the assumption, presumably made for stability reasons, that each constituent material must have positive-definite elastic moduli. If this assumption is relaxed, recently published elasticity analyses and experimental measurements show these bounds can be greatly exceeded, resulting in new materials of enormous potential. The key question is whether a composite material having a non-positive-definite constituent can be stable overall in the practically useful situation of applied traction boundary conditions. Drugan [2007. Elastic composite materials having a negative-stiffness phase can be stable. Phys. Rev. Lett. 98(5), article no. 055502] first proved the answer is yes, by applying the energy criterion of elastic stability to the basic two- and three-dimensional composites consisting of a cylinder or sphere having non-positive-definite (but strongly elliptic) moduli with a thin positive-definite coating and proving overall stability provided the coating is sufficiently stiff. Here, we perform a complete and direct dynamic stability analysis of the plane strain fundamental elastic composite consisting of a circular cylinder of non-positive-definite material firmly bonded to a positive-definite concentric coating, for the full range of coating thicknesses (i.e., volume fractions). We determine quantitatively the full permissible range of inclusion and coating moduli, as a function of coating thickness, for which the overall composite is stable under dead traction boundary conditions. Among the results, we show that in the thin-coating case, the present dynamic stability analysis leads to precisely the same analytical stability requirements as those derived via the energy criterion by Drugan [2007. Elastic composite materials having a negative-stiffness phase can be stable. Phys. Rev. Lett. 98(5), article no. 055502], and we derive new analytical stability requirements that are valid for a wider range of coating thickness. At the other extreme, we show that in the case of very thick coatings (corresponding to the dilute case of a matrix-inclusion composite), even an inclusion with merely strongly elliptic moduli can be stabilized by a positive-definite matrix satisfying weak requirements, for which we derive analytical expressions. Overall, our results show that surprisingly weak restrictions on the moduli and thickness of the positive-definite coating are sufficient to stabilize a non-positive-definite inclusion, even one whose moduli are merely strongly elliptic. These results legitimize expanding the search for novel materials with extreme properties to those incorporating a non-positive-definite constituent, and they provide quantitative restrictions on the constituent materials' moduli and volume fractions, for the geometry examined here, that ensure overall stability of such composite materials.

D.M. Kochmann and W.J. Drugan, Ruhr-Universitat Bochum, 44780, Bochum, Germany. Cited: *J. Mechan. Phys. Solids,* 2009, July, **57**(7), p 1122-1138. ISSN 0022-5096.

Effect of carbon nanotube and aluminum oxide addition on plasma-sprayed hydroxyapatite coating's mechanical properties and biocompatibility. This study reports on the synthesis of novel bioceramic composite coating of hydroxyapatite (HA) reinforced with carbon nanotubes (CNTs) and aluminum oxide (Al_2O_3) using plasma spray technique. Fracture toughness of HA-20 wt.% Al_2O_3 improved by 158% as compared to HA coating whereas HA-18.4 wt.% Al_2O_3-1.6 wt.% CNT showed an improvement of 300%. Carbon nanotubes provided reinforcement via rebar mechanism. Human fiber osteoblast cell-growth studies showed that biocompatibility of the coating remained unaltered, as Al_2O_3 retained its bio-inertness and CNT, its bioactivity, within the composite coatings. Composite coating showed lower attachment, but higher proliferation rate, for the osteoblast cells, which has been attributed to the surface roughness. An optimized relation between coating composition, its biocompatibility and mechanical properties was established to predict the most suited coating material for orthopedic implants. HA-Al_2O_3-CNT composite coating displayed most improved mechanical properties while retaining its biocompatibility.

J.E. Tercero, S. Namin, D. Lahiri, K. Balani, N. Tsoukias, and A. Agarwal, Plasma Forming Laboratory, Mechanical and Materials Engineering, Florida International University, Miami, FL 33174. Cited: *Mater. Sci. Eng. C,* 2009, Aug 31, **29**(7), p 2195-2202. ISSN 0928-4931.

Effect of La_2O_3 addition on the microstructure, hardness and abrasive wear behavior of flame sprayed Ni based coatings. This paper describes the effect of rare earth elements (La_2O_3) on the microstructure; hardness and abrasive wear behavior of Ni based flame sprayed coatings. The mechanical and tribological properties of the coatings can be significantly improved by refinement of grain structure of the coatings. A commercially available Ni based powder was modified with the addition of La_2O_3 (0.4-2 wt.%) to refine the grain structure of coatings. Unmodified and La-modified coatings were investigated in respect of microstructure, hardness and abrasive wear behavior. It has been observed that an optimal addition of La_2O_3 (1.2 wt.%) refines the grain size, improves hardness and abrasive wear resistance of the coatings. The XRD of the unmodified and La-modified coating with optimum addition of La_2O_3(1.2 wt.%) was also carried out to identify the various phases present in the coating.

S.P. Sharma, D.K. Dwivedi, and P.K. Jain, Department of Mechanical and Industrial Engineering, IIT Roorkee, Roorkee 247667, Uttaranchal, India. Cited: *Wear,* 2009, June 15, **267**(5-8), p 853-859. ISSN 0043-1648.

HVOF-sprayed WC-CoCr coatings on Al alloy: Effect of the coating thickness on the tribological properties. The microstructure, the micromechanical properties, the wear behaviour and the impact resistance of WC-CoCr cermet coatings, deposited onto an aluminium alloy substrate by High Velocity Oxygen-Fuel (HVOF) flame-spraying, were examined as a function of the coating thickness, which was varied between 50 μm and 150 μm by performing different numbers of scans of the HVOF torch in front of the substrate. The coatings became denser and significantly harder as the number of torch scans increased: the analysis of single WC-CoCr splats by combined SEM and Focused Ion Beam (FIB) techniques enabled the interpretation of the mechanisms underlying this phenomenon. In accordance to such densification, the sliding wear resistance increased with the number of torch scans, as abrasive grooving and brittle failure mechanisms were progressively suppressed. The resistance to cyclic impact was also enhanced. In comparison to anodized films, the WC-CoCr coatings appeared much more resistant against wear and cyclic impact; specifically, three torch scans seem enough to produce a coating having suitable characteristics.

G. Bolelli, L. Lusvarghi, and M. Barletta, Department of Mechanical Engineering, University of Roma Tor Vergata, I-00133 Roma, Italy. Cited: *Wear,* 2009, June 15, **267**(5-8), p 944-953. ISSN 0043-1648.

Investigation of stress field and failure mode of plasma sprayed Al_2O_3-13%TiO_2 coatings under thermal shock. The stress field and failure mode of plasma sprayed Al_2O_3-13%TiO_2 coatings under thermal shock were analyzed by experimental and numerical investigations in this paper. Two kinds of nanostructured coatings were derived from reconstituted nanostructured feedstocks and one kind of conventional coating was deposited with commercial fused and crushed feedstock. Testing results showed that the nanostructured coatings exhibited improved thermal shock resistance than the conventional coating. The failure modes of coatings predicted by numerical analysis had a good consistency with the experimental results. The effects of interface morphology and coating defects on thermal stresses were also discussed in this paper. The improved thermal shock resistance of nanostructured coatings was related to their pre-existing spherical pores, reduced cracks and microstructures.

Y. Wang, W. Tian, Y. Yang, C.G. Li, and L. Wang, Nano surface engineering laboratory, Department of Materials Science, Harbin Institute of Technology, Harbin 150001, China. Cited: *Mater. Sci. Eng. A,* 2009, Aug 15, **516**(1-2), p 103-110. ISSN 0921-5093.

Microstructure characterization and wear properties of arc sprayed NiB containing amorphous coatings. Two kinds of cored wires were used to deposit coatings containing amorphous phase and nanocrystalline grains by arc spraying. The microstructure characteristics of the coatings were conducted by scanning electron microscopy (SEM), transmission electron microscopy (TEM), electron probe micro-analyzer (EPMA) and x-ray diffraction (XRD). The microstructures of the both coatings had lamellar morphologies. Both coatings consisted of Fe rich matrix and several kinds of borides. The Fe rich matrix had a majority amorphous phase regions with a fraction of nanocrystalline grains. The coatings' microhardness values for NiB coating is 950 HV(100 g) and for NiB-Cr_3C_2 coating is 1090 HV(100 g). Compared with the reference sample of Q235 steel, the coatings showed a much higher wear resistance, and the relative wear resistance of the NiB coating is 10 times while the NiB-Cr_3C_2 coating is 13.3 times higher than that of Q235 steel.

B.Y. Fu, D.Y. He, L.D. Zhao, and X.Y. Li, College of Materials Science and Engineering, Beijing University of Technology, Beijing 100124, China. Cited: *Surf. Eng.,* 2009, May, **25**(4), p 326-332. ISSN 0267-0844.

Nanomechanical properties and microstructure of $ZrO_2Al_2O_3$ plasma sprayed coatings. Nanocomposite coatings were prepared by atmospheric plasma spraying process using the yttria-stabilized zirconia (YSZ) power mixed 5 wt.% nano-Al_2O_3. The mechanical properties of the nanocomposite coatings were studied by nanoindentation and the microstructures were studied by SEM and TEM. Compared to the microcomposite coatings prepared with YSZ powers without nano-Al_2O_3, the nanocomposite coatings can better tolerate applied loads and has higher hardness and elastic modulus values, better elastic recovery, and excellent microstructure. Associated with the investigation of the microstructure, the nano-Al_2O_3 is shown to play a major role in the grain refinement, densification, and microcrack formation, and be beneficial for better mechanical properties of the coatings.

H. Lv, W. Zhao, Q. An, P. Nie, J. Wang, and P.K. Chu, Department of Physics and Materials Science, City University of Hong Kong, Kowloon, Hongkong, Hong Kong. Cited: *Mater. Sci. Eng. A,* 2009, Aug 25, **518**(1-2), p 185-189. ISSN 0921-5093.

Self-lubricating W-S-C nanocomposite coatings. This paper is aimed on a perspective low-friction coatings, the W-S-C system deposited by magnetron sputtering, which exhibits extremely low-friction coefficient together with highload-bearing capacity. Special attention has been paid to the analysis of the frictional and wear mechanisms under different operating conditions, such as the contact pressure, the air humidity, and the temperature. The formation of a thin self-lubricating WS2 tribolayer, which was observed regardless on the sliding conditions, is the driving force for the promising frictional properties of the coatings. A figure is presented.

T. Polcar, M. Evaristo, and A. Cavaleiro, Faculty of Electrical Engineering, Department of Control Engineering, Czech Technical University in Prague, Prague 6, Czech Republic. Cited: *Plasma Process. Polym.,* 2009, July 18, **6**(6-7), p 417-424. ISSN 1612-8850.

Slurry and cavitation erosion resistance of thermal spray coatings. The slurry and cavitation erosion resistance of six thermal spray coatings were studied in laboratory and compared to that of an uncoated martensitic stainless steel. Nickel, chromium oxide and tungsten carbide coatings were applied by oxy fuel powder (OFP) process and chromium and tungsten carbide coatings were obtained by high velocity oxy fuel (HVOF) process. The microstructure of the coatings was analyzed by light optical microscopy (LOM) and scanning electron microscopy (SEM), as well as by x-ray diffraction (XRD). The cavitation erosion resistance of the coatings was measured in a vibratory apparatus according to ASTM G32 standard and the slurry erosion tests were carried out in a modified centrifugal pump in which the samples were conveniently placed to guarantee grazing incidence conditions, as well as in a high velocity jet erosion testing machine. The results showed that the slurry erosion resistance of the steel can be improved up to 16 times by the application of the thermally sprayed coatings. On the other hand, none of the coated specimens showed better cavitation resistance than the uncoated steel in the experiments. The main mass removal mechanisms observed in all the coatings submitted to slurry erosion were micro-cutting and micro-ploughing as well as detachment of hard particles. In cavitation erosion, OFP coatings showed brittle fracture and microcracking, and in nickel-based coatings some ductile deformation was also observed. In HVOF coatings, detachment of small particles led to coalescence of pores in WC/Co coatings while in CrC coatings the main wear mechanism was brittle fracture of particles.

J.F. Santa, L.A. Espitia, J.A. Blanco, S.A. Romo, and A. Toro, Tribology and Surfaces Group, National University of Colombia, Medellin, Colombia. Cited: *Wear,* 2009, June 15, **267**(1-4), p 160-167. ISSN 0043-1648.

Slurry erosion properties of detonation sprayed and plasma sprayed coatings for materials used in mining environments. Mining industries extensively use pumps for disposing water mixed with slurry. The pump impellers often get eroded while draining the mixture containing solid particles and water. The impeller shafts are commonly made of stainless steels. Though several types of other thermal sprayed coatings are well known, the attention has been focused on plasma and detonation sprayed coatings in the present investigation. An experimental investigation was made involving variations in parameters such as surface velocity, time of erosion and slurry composition using a pot erosion tester. It is observed that mass loss increases with increase in surface velocity and duration of exposure in such conditions. Increase in slurry composition reveals the initial increase in mass loss. However, this trend cannot be overestimated. Surface characterization studies were made using XRD and SEM. The observations indicate that the SEM morphology for detonation spray coated material reflects better adhesion leading to negligible wear when compared with the plasma sprayed coatings.

S. Natarajan and Z.E. Kennedy, Metallurgical and Materials Engineering Department, National Institute of Technology, Tiruchirappalli, India. Cited: *Surf. Eng.,* 2009, Aug, **25**(6), p 476-481. ISSN 0267-0844.

Structure, hardness and corrosion behavior of a gradient CrN_x thick coating applied to turbine blades. In order to protect turbine blades from solid particle erosion, a gradient CrN_x coating was deposited on 10% Cr heat-resistant steel by ion plating; the thickness of the coating was about 40 μm. The chemical composition, microstructure and nano-hardness of gradient CrN_x coating were analyzed. The bonding force was determined using scratch test. The potentiodynamic polarization and high-temperature oxidation tests were respectively conducted to investigate the corrosion behavior. The results indicate that gradient variation of phase structure, chemical composition and nano-hardness in the coating is found, and the bonding force with substrate is excellent. The microstructure obtained can enhance the corrosion performance of the substrate. The corrosion resistance improvement is not only attributed to the increase of coating in thickness, but also to internal microstructure and chemical composition of coating. Based on SEM and TEM observations, the cross-sectional fracture of the coating shows nanocrystalline and fine columnar crystalline structures. There are no penetrable pinholes, which could validly reduce the electrolyte transferring to inner substrate. In addition, the corrosion resistance of coating is further improved by the formation of nitrogen and chromium rich transition layers.

Z.-Y. Chen, Z.-Q. Li and X.-H. Meng, College of Materials Science and Chemical Engineering, Harbin Engineering University, Harbin 150001, China. Cited: *Appl. Surf. Sci.,* 2009, May 30, **255**(16), p 7408-7413. ISSN 0169-4332.

Study on adhesion and wear resistance of multi-element (AlCrTaTiZr)N coatings. Multi-element (AlCrTaTiZr)N films were deposited on cemented carbide and M2 steel substrates by reactive RF magnetron sputtering. Prior to nitride film deposition, an interlayer between the film and the substrate was introduced to improve adhesion property. The influence of interlayer materials (Ti, Cr, and AlCrTaTiZr alloy) and interlayer thickness (0-400 nm) on the adhesion and tribological properties of films was investigated. In this study, the nitride film deposited at R_N = 20% exhibited the highest hardness (35.2 GPa) and the lowest residual compressive stress (−1.52 GPa), and was prepared as the top layer for further testing. The interlayer materials can effectively improved the film adhesion onto the cemented carbide substrates, and the adhesive failure was not observed even under the normal load of 100 N. For M2 steel substrates, only the Cr interlayer can slightly improve the film adhesion, and the cohesive and adhesive failure can be found at relatively lower applied load. The optimal interlayer thickness was 100-200 nm for the 1 μm-thick (AlCrTaTiZr)N film and can be related to the stress evolution. The friction coefficient and wear rate for the (AlCrTaTiZr)N film were 0.82 and 4.9×10^{-6} mm^3 Nm, respectively, and almost kept constant under different interlayer materials and thickness. The worn-through event of the nitride film during tribological test occurred easily owing to its poor adhesion behavior, and can be improved by interlayer additions. © 2009 Elsevier B.V. All rights reserved.

K.-H. Cheng, C.-H. Weng, C.-H. Lai, and S.-J. Lin, Department of Materials Science and Engineering, National Tsing Hua University, Hsinchu 300, Taiwan. Cited: *Thin Solid Films,* 2009, July 1, p 4989-4993. ISSN 0040-6090.

Thermal spray coating of abradable Ni based composite. Abradable clearance control coatings of compressor and turbine casing of aircraft engines are designed to wear in performance to the opposing blade tip or other moving parts. In the present work the mild steel surface has been coated with KNA (boron nitride, nickel, silicon and carbon) using thermal spray coating technique. The feed rate of the coating material has been optimized or the required hardness of 15 to 25 kg mm^2. The coating has been characterized for porosity, coating thickness, adhesion strength, deposit efficiency and hardness in order to analyze the performance of the coating. Scanning electron microscopy has been carried out to observe the microstructure of the coating and distribution of boron nitride particles. © 2009 Institute of Materials.

U. Batra, Department of Metallurgical Engineering, Punjab Engineering College, Chandigarh, India. Cited: *Surf. Eng.,* 2009, May, **25**(4), p 284-286. ISSN 0267-0844.

Time-dependent creep deformation of the coating-based system under in-plane bending moment. The aim of this paper was to investigate the creep deformation of coating-based system under in-plane bending moment. An analytical model was proposed to predict the creep strain and stress within the coating-based system through extending the classic beam theory. Once the material properties and thicknesses of the coating and substrate were identified, the implementation of the model was fairly straightforward. A basic understanding of the time-dependent behavior of the coating-based systems was achieved by using this model, which can be used to guide their design and fabrication. Specific results were calculated for the time-dependent curvatures of the NiCrAlY coating/IN718 substrate systems, and the stresses as well as strains in them. The effects of the exposure time, coating thickness, and creep-law parameter of the coating on the stress and curvature of the coating-based systems were discussed. © 2009 Elsevier Ltd. All rights reserved.

X.C. Zhang, F.Z. Xuan, Z.D. Wang, Y.K. Zhang, and S.T. Tu, Key Laboratory of Safety Science of Pressurized System, Ministry of Education, East China University of Science and Technology, Shanghai 200237, China. Cited: *Mater. Des.,* 2009, Dec, **30**(10), p 4543-4547. ISSN 0261-3069.

Tribological behavior of thermally sprayed Ti-Cr-Si coatings. Quasicrystal coatings are potential candidates for many industrial applications, e.g., high hardness, low friction coefficient, low surface energy and high thermo-electric power. An attempt to produce a quasicrystal by plasma and flame spraying $Ti_{60}Cr_{32}Si_8$ (at.%) alloy powder has been reported in a previous paper. This paper focuses on the tribological properties of atmospheric plasma sprayed $Ti_{60}Cr_{32}Si_8$ (at.%) alloy coatings produced using two sets of spraying parameters. First coating contains a large amount of oxide (APSO) and the other coating has the metallic phases retained (APSM). For this purpose a reciprocating ball on block tribometer has been used. The test has been conducted using various speeds and loads, while the sliding distance has been kept constant. The worn surfaces have been studied using scanning electron microscope. A correlation of microstructural features, process parameters, tribotest parameters and wear mechanism has been conducted. The wear behavior of each coating has been found to depend strongly on both its phase content and tribotest parameters. In general, the coating with higher oxide content has been found to be more wear resistant. Such coatings are potential candidates for paper and printing industry. © 2009 Elsevier B.V. All rights reserved.

M. Hadad, P.P. Bandyopadhyay, J. Michler, and J. Lesage, Materials Technology, EMPA Thun, Thun, 3602, Switzerland. Cited: *Wear,* 2009, June 15, **267**(5-8), p 1002-1008. ISSN 0043-1648.

Wear behavior of nanostructured alumina-titania coatings deposited by atmospheric plasma spray. Dry sliding wear performance of Al_2O_3-13% TiO_2 nanostructured and conventional coatings has been experimentally analyzed. An enhanced behavior of the nanostructured material can be reported with substantially minor wear rates under all experimental conditions. Additionally, a transition from mild to severe wear can be established in both materials. However, the critical pressure at which the transition occurs is higher for the nanocoating. The main wear mechanisms controlling the mild and the severe regimes are related to brittle propagation of cracks. The hierarchical structure showed by the nanomaterial seems to control the improvements mentioned before. Crack deflection processes leading to a toughening effect can be identified, although, the microstructural feature which deflects the cracks changes depending on the wear regime. © 2009 Elsevier B.V.

A. Rico, J. Rodriguez, E. Otero, P. Zeng, and W.M. Rainforth, Departamento de Ciencia e Ingenieria de Materiales, Rey Juan Carlos University, 28933 Mostoles, Madrid, Spain. Cited: *Wear,* 2009, June 15, **267**(5-8), p 1191-1197. ISSN 0043-1648.

Wear behavior of plasma sprayed composite coatings with in situ formed Al_2O_3. In the present study, the wear behavior of in situ formed Al_2O_3 reinforced hypereutectic Al-18Si matrix composite coatings have been investigated. These coatings were successfully fabricated with mechanically alloyed Al-12Si and SiO_2 powder deposited on aluminum substrates by atmospheric plasma spraying (APS). The produced samples were characterized by means of microscopic examinations, hardness measurements and wear tests. The obtained results pointed out that the amount of in situ formed Al_2O_3 particles increased with increasing spray distance and decreasing in-flight particle velocity and temperature, which was accompanied by an improvement in hardness and wear resistance. © 2009 Elsevier Ltd. All rights reserved.

H. Mindivan, C. Tekmen, B. Dikici, Y. Tsunekawa, and M. Gavgali, Ataturk University, Department of Metallurgy Engineering, 25240, Erzurum, Turkey. Cited: *Mater. Des.,* 2009, Dec, **30**(10), p 4516-4520. ISSN 0261-3069.

Oxidation

Cyclic oxidation behavior and microstructure evolution of aluminized, Pt-aluminized high velocity oxygen fuel sprayed CoNiCrAlY coatings. In this study, the Hastelloy-X superalloy samples were firstly overlaid by a CoNiCrAlY bond coating utilizing a high pressure, high velocity oxygen fuel (HVOF) spray process. Then platinum thin film approximately 7.5 μm thick was introduced to selected test samples of CoNiCrAlY coatings by a magnetron sputtering deposition process. Then the HVOF sprayed superalloy coupons, with and without Pt coating were pack aluminized for 4 h at 850 °C to produce (Co,Ni)Al and $PtAl_2$ aluminide phases on their surfaces, respectively. All specimens were subjected to a thermal cycling test at 1100 °C. Then the aluminizing and Pt-aluminizing effects relative to cyclical oxidation behavior and microstructure evolutions of the coatings were evaluated. Scanning electron microscopy (SEM), x-ray diffractometry (XRD) and electron probe microanalyzer (EPMA) were used to identify crystalline phases and microstructures of each coating. Results clearly indicated that the surface roughness of the HVOF sprayed CoNiCrAlY coatings were unchanged after aluminizing or the Pt-aluminizing process. The oxide scales spalled after 50 h and 100 h cyclic oxidation for the HVOF sprayed sample and aluminized sample respectively, while the oxide scale attached successfully to the substrate for the Pt-aluminized sample after testing for 150 h. It is obvious that the Pt-aluminizing process significantly improves the oxidation resistance of HVOF sprayed coatings, while the isolated aluminizing process demonstrated negligible effect. © 2009 Elsevier B.V. All rights reserved.

J.-H. Lee, P.-C. Tsai, and J.-W. Lee, Department of Materials Science and Engineering, National Formosa University, Huwei, Yunlin, Taiwan. Cited: *Thin Solid Films,* 2009, July 1, **517**(17), p 5253-5258. ISSN 0040-6090.

Thermal

Comparative studies on the thermal stability and corrosion resistance of CrN, CrSiN, and CrSiN/AlN coatings. In this work, three kinds of Cr-based nitride coatings such as monolithic CrN, CrSiN coatings, and multilayered CrSiN/AlN coating with bilayer period of 3.0 nm were deposited on both Si (100) wafer and AISI H13 steel substrates by unbalanced magnetron sputtering. Thermal stability of these coatings was evaluated by annealing the coatings at temperatures between 600 and 1000 °C for 30 min in air. In addition, the corrosion behaviors of these coatings were investigated by potentiodynamic polarization tests in a deaerated 3.5 wt.% NaCl solution at 40 °C. Results from annealing test show the monolithic CrN and CrSiN coatings were completely oxidized after annealed at 800 and 900 °C, and their cross sectional images and atomic force microscopy showed a loose and very porous morphology due to the oxidation. Also, the hardness values of the monolithic CrN and CrSiN coatings were decreased significantly from 22 and 27 GPa to 8 and 14 GPa, respectively. However, the multilayered CrSiN/AlN coating still exhibited a dense microstructure without visible change after annealed at 1000 °C, and moreover, the relatively high hardness of 25 GPa was maintained. The superior thermal stability of the CrSiN/AlN multilayer

coating could be attributed to the formation of the dense and stable oxidation barrier consisted of the Al_2O_3, Cr_2O_3, and amorphous SiO_2 phases near the surface region, which retard the diffusion of oxygen into the coating. In the potentiodynamic polarization test results, it was found that the significantly improved corrosion resistance of the multilayered CrSiN/AlN coating was observed in comparison with those from the monolithic CrN and CrSiN coatings, and its corrosion current density (i_{corr}) and protective efficiency were measured to be approximately 4.21 $\mu A/cm^2$ and 95%, respectively. © 2009 American Vacuum Society.

G.S. Kim, S.M. Kim, S.Y. Lee, and B.Y. Lee, Department of Materials Engineering, NRL for Cracking Control and Management, Korea Aerospace University, KoYang-Si, KyungKi-Do 412-791, South Korea. Cited: *J. Vac. Sci. Technol. A,* 2009, **27**(4), p 873-879. ISSN 0734-2101.

Review

Applications in the nuclear industry for thermal spray amorphous metal and ceramic coatings. Amorphous metal and ceramic thermal spray coatings have been developed with excellent corrosion resistance and neutron absorption. These coatings, with further development, could be cost-effective options to enhance the corrosion resistance of drip shields and waste packages, and limit nuclear criticality in canisters for the transportation, aging, and disposal of spent nuclear fuel. Iron-based amorphous metal formulations with chromium, molybdenum, and tungsten have shown the corrosion resistance believed to be necessary for such applications. Rare earth additions enable very low critical cooling rates to be achieved. The boron content of these materials and their stability at high neutron doses enable them to serve as high efficiency neutron absorbers for criticality control. Ceramic coatings may provide even greater corrosion resistance for waste package and drip shield applications, although the boron-containing amorphous metals are still favored for criticality control applications. These amorphous metal and ceramic materials have been produced as gas-atomized powders and applied as near full density, nonporous coatings with the high-velocity oxy-fuel process. This article summarizes the performance of these coatings as corrosion-resistant barriers and as neutron absorbers. This article also presents a simple cost model to quantify the economic benefits possible with these new materials. © The Author(s) 2009.

J. Blink, J. Farmer, J. Choi, and C. Saw, Lawrence Livermore National Laboratory, Livermore, CA 94550. Cited: *Metall. Mater. Trans. A,* **40**(6), p 1344-1354. ISSN 1073-5623.

Chameleon coatings: Adaptive surfaces to reduce friction and wear in extreme environments. Adaptive nanocomposite coating materials that automatically and reversibly adjust their surface composition and morphology via multiple mechanisms are a promising development for the reduction of friction and wear over broad ranges of ambient conditions encountered in aerospace applications, such as cycling of temperature and atmospheric composition. Materials selection for these composites is based on extensive study of interactions occurring between solid lubricants and their surroundings, especially with novel in situ surface characterization techniques used to identify adaptive behavior on size scales ranging from 10^{-10} to 10^{-4} m. Recent insights on operative solid-lubricant mechanisms and their dependency upon the ambient environment are reviewed as a basis for a discussion of the state of the art in solid. © 2009 by Annual Reviews. All rights reserved.

C. Muratore and A.A. Voevodin, Thermal Science and Materials Branch, Air Force Research Laboratory, Wright-Patterson Air Force Base, OH 45433. Cited: *Annu. Rev. Mater. Res.,* 2009, Aug, **39**, p 297-324. ISSN 1531-7331.

Manufacturing of nanocomposite structural ceramic materials and coatings. So far research on ceramic nanocomposites was focussed on materials science aspects neglecting the development of suitable manufacturing technologies. The high performance properties of nanocomposites make final machining unaffordable. Near-net-shape manufacturing is mandatory to accomplish cost targets. Feedstocks with tailored micro-nano architecture can fulfill these requirements, using homogeneously dispersed nanosized powders in a matrix of sub-micron sized grains. Nanoceramic coatings deposited by thermokinetic deposition processes open new prospects and applications in surface technology. The novel HVSFS-process permits direct spraying of liquid nanodispersions in a HVOF torch yielding ultradense and thin oxide and cermet coatings for automotive, aerospace and mechanical engineering. © 2009 Inderscience Enterprises Ltd.

R. Gadow, F. Kern, and A. Killinger, Institute for Manufacturing Technologies of Ceramic Components and Composites, IMTCCC, Universitat Stuttgart, D-70569, Stuttgart, Allmandring 7b. Cited: *Int. J. Mater. Product Technol.,* 2009, May, **35**(3-4), p 334-345. ISSN 0268-1900.

Nanotechnology and concrete: Research opportunities. Synopsis: Nanotechnology is one of the most active research areas that encompasses a number of disciplines including civil engineering and construction materials. The most active fields are electronics, biomechanics, and coatings. Interest in nanotechnology concept for portland-cement composites is steadily growing. Currently, the most active research areas dealing with cement and concrete are: understanding of the hydration of cement particles and the use of nano-size ingredients such as alumina and silica particles. There are also a limited number of investigations dealing with the manufacture of nanocement. If cement with nano-size particles can be manufactured and processed, it will open up a large number of opportunities in the fields of ceramics, high-strength composites, and electronic applications. This will elevate the status of portland cement to a high-tech material in addition to its current status of the most widely used construction material. Very few inorganic cementing materials can match the capabilities of portland cement in terms of cost and availability. The main objective of this paper is to outline promising research areas. Basic background information on nanotechnology research, state of the art on use of this technology in concrete, opportunities, and challenges are discussed.

P. Balaguru and K. Chong, Department of Civil and Environmental Engineering, Rutgers the State University, NJ. Cited: *American Concrete Institute, ACI Special Publication* (Conf. Proc.) Nov 8, 2006 (Denver, CO), Vol. Ed., American Concrete Institute, 2008.

Polymer films: Just spray it. Spray-coating of multilayer films on fiber mats produce conformal coatings, opening up new possibilities for the fabrication of protective clothing and reactive membranes. Paula Hammond and colleagues have demonstrated that at low flow rates of spray through porous structures, conformal layer-by-layer (LbL) coating of mats of cylindrical fibers is possible. The flow rate of the spray through the electrospun mat can be controlled by varying the extent of the vacuum on the rear side of an electrospun fiber membrane, to give a conformal polycation/TiO_2, nanoparticle coating on the exterior of the fibers. Hammond and co-workers perform spraycoating in the absence of vacuum-induced convective flow on a mat that has already been coated with a polyelectrolyte/TiO_2 film. They construct highly catalytic mats for chloroethyl ethyl sulphide (CEES) photodegradation that still allow permeation of water vapor by selecting polyelectrolytes in which water is highly soluble and CEES is sparingly soluble. (Edited abstract).

M. Bruening and D. Dotzauer, Department of Chemistry, Michigan State University, East Lansing, MI 48824. Cited: *Nat. Mater.,* 2009, June, **8**(6), p 449-450. ISSN 1476-1122.

Thermal sprayed ceramic coatings: Fundamental issues and application considerations. This paper reviews progress in science and applications of thermal sprayed ceramic coatings. Examples of processing, microstructure and unique properties is provided through a description of thermal barrier coatings. Synthesis of dense ceramic coatings for wear and dielectric applications is also presented along with discussion of functional films produced both via traditional powder spray or suspension/precursor methods. Thermal spray will be continue to play an important role in ceramic coatings due to its cost advantages, flexibility and ubiquitous availability. Future expansion into functional coatings will require concerted, integrated, fundamental research in process and materials science, representing the next logical step in technology evolution. © 2009 Inderscience Enterprises Ltd.

S. Sampath, Center for Thermal, Spray Research, State University of New York, Stony Brook, NY 11784-2275. Cited: *Int. J. Mater. Product Technol.,* 2009, May, **35**(3-4), p 425-448. ISSN 0268-1900.