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Electron Paring Mediated by Nanodisturbances in High- T_c Superconductors

I.A. Ovid'ko

A special mechanism of electron paring in superconducting cuprates is suggested. The mechanism is based on the electron-electron interaction mediated by quasistable nanodisturbances, planar nanoscopic areas of local shear with tiny shear vectors. Structural factors are discussed which enhance formation of nanodisturbances in superconducting cuprates. (Rev.Adv.Mater.Sci. (RAMS) No 1/2, Vol. 19, 2009, pages 114-120)

Transition from Plastic Shear into Rotation Deformation Mode in Nanocrystalline Metals and Ceramics

S.V. Bobylev, A.K. Mukherjee and I.A. Ovid'ko

A theoretical model is suggested which describes transition from plastic shear into rotation deformation mode - deformation accompanied by crystal lattice rotations - in nanocrystalline metals and ceramics. Within the model, the shear deformation occurs through either grain boundary sliding or lattice dislocation slip and results in formation of pile-ups of either grain boundary or lattice dislocations, respectively. The dislocation pile-ups create stress fields initiating the rotation deformation (occurring through formation of immobile disclinations whose strengths gradually increase during the formation process) in neighboring nanograins. These processes provide transition from plastic shear into rotation deformation mode in nanocrystalline metals and ceramics, including single-phase nanocrystalline materials with narrow and bimodal grain size distributions as well as nanocomposites consisting of microscale grains and nanoparticles. The conditions are calculated at which the transition is energetically favorable in nanocrystalline Ni and α - Al_2O_3 (corundum). (Rev.Adv.Mater.Sci. (RAMS) No 1/2, Vol. 19, 2009, pages 103-113)

Morphological Stability Analysis of Polycrystalline Interconnects under the Influence of Electromigration

K.E. Aifantis and S.A. Hackney

Failure due to electromigration is one of the limiting factors encountered in reliability of integrated circuits. The key to fully understanding the morphological changes in metal interconnect lines in the presence of an electric field is to account

for the variations of the electromigration flux as a function of the underlying factors, such as the microstructure. Although there is significant experimental and numerical simulation evidence documenting that grain structure is related to electromigration damage, a general analytical treatment that can explicitly account for such microstructure is lacking. In the present study the perturbation method is employed for the first time to the electromigration process in order to develop a general analysis of how morphological stability is correlated to microstructure induced spatial variations in the effective diffusivity. (Rev. Adv. Mater. Sci. (RAMS) No 1/2, Vol. 19, 2009, pages 98-102)

On Solution Non-Uniqueness in the Nonlinear Elasticity Theory

A.G. Kulikovskii and A.P. Chugainova

The simultaneous effects of dissipation and dispersion on nonlinear wave behavior in elastic media are considered when the effects are small and manifested only in narrow high-gradient regions. If one constructs solutions of self-similar problems in "hyperbolic" approximation using Riemann's waves and admissible discontinuities (i.e., discontinuities with structures) one obtains many solutions the number of which unlimitedly grows with growing the relative influence of dispersion (as compared to dissipation) in discontinuity structures. The numerical analysis (based on PDE with dispersion and dissipation) of nonself-similar problems with self-similar asymptotics is performed to determine which of self-similar solutions is an asymptotic form for the nonself-similar solution. (Rev. Adv. Mater. Sci. (RAMS) No 1/2, Vol. 19, 2009, pages 93-97)

Microstructural Modeling of Nanoindentation of Polycrystalline Gold with Random High Angle Grain-Boundaries

Jeong Beom Ma and M.A. Zikry

A hierarchical computational scheme that links molecular dynamic (MD) simulations to specialized finite-element (FE) microstructurally-based techniques has been used to predict how nanoindentation affects behavior in crystalline gold polycrystals aggregates with random high angle GBs. Displacement profiles from MD simulations of nanoindentation were used to obtain scaling relations, which are based on indented depths, grain-sizes and grain aggregate distributions. These scaling relations are then used in a microstructurally based finite-element (FE) formulation that accounts for dislocation-density evolution, plastic strains, crystalline structures, grain-sizes and grain-boundary (GB) Effects. This

computational methodology can be used to ascertain inelastic effects pertaining to nanoindentation, such as shear-slip distribution, pressure accumulation and dislocation-density and slip-rate activation and evolution. (Rev. Adv. Mater. Sci. (RAMS) No 1/2, Vol. 19, 2009, pages 78-92)

Generation and Convergence of Nanocracks in Nanocrystalline Materials Deformed by Grain Boundary Sliding

N.F. Morozov, I.A. Ovid'ko, Yu.V. Petrov and A.G. Sheinerman

A theoretical model is suggested which describes the generation of nanocracks at grain boundaries and their convergence into a catastrophic macrocrack in nanocrystalline materials deformed by grain boundary sliding. The criterion for the convergence is revealed and the fracture strength of a nanocrystalline material is calculated which characterizes the formation of a catastrophic macrocrack due to the convergence. Also, we estimated strain-to-failure controlled by grain boundary sliding, generation of nanocracks and their convergence. It is shown that both the fracture strength and strain-to-failure of a nanocrystalline material deformed through grain boundary sliding are highly sensitive to the misorientation angles of grain boundaries that dominate in the material. (Rev. Adv. Mater. Sci. (RAMS) No 1/2, Vol. 19, 2009, pages 63-72)

Dislocation Mechanics Aspects of Energetic Material Composites

R.W. Armstrong

The dislocation mechanics based properties of solid energetic materials, particularly, of high explosives, are of particular interest in connection with issues of intrinsic chemical stability and with their fast chemical decomposition when employed as propellants or in explosive formulations. The ballistic impact and shock-associated plasticity responses of such materials present great experimental and model challenges for establishment of predictable performances. As demonstrated in the present report, much has been learned through direct investigation with a full range of scientific tools of the individual crystal and composite material properties and also, through their comparison with relevant inert ionic and metallic material behaviors. Thus, in relation to other solid material structures, energetic crystals are elastically compliant, plastically strong and fracture prone. Somewhat surprisingly perhaps for such materials, individual dislocation self-energies are indicated to be relatively large while the intrinsic

crystal-determined dislocation mobility is restricted because of the complicated and rather dense molecular packing of awkwardly-shaped molecules that are self-organized within the exhibited lower-symmetry crystal structures. Because crack surface energies are low, cleavage is able to be initiated by relatively small dislocation pile-ups and with the restricted dislocation mobility, there is little additional plastic work requirement associated with cleavage crack propagation. Nevertheless, when compared with indentation fracture mechanics prediction, crack propagation appears to be controlled by the behavior of very limited dislocation activity at the crack tip. Adiabatic heating associated with dislocation pile-up avalanches provides an important mechanism for the thermal hot spot model of explaining the initiation of rapid chemical decompositions and relates directly to predicted influence of crystal (or particle) sizes. On such basis, desired characteristics of greater mechanical insensitivity to initiation but afterwards greater power dissipation are predicted to occur for energetic composite formulations comprising smaller particle-sized ingredients. (Rev.Adv.Mater.Sci. (RAMS) No 1/2, Vol. 19, 2009, pages 13-40)

The Mechanical Properties of Ultrafine-grained Metals at Elevated Temperatures

Roberto B. Figueiredo, Megumi Kawasaki and Terence G. Langdon

Ultrafine-grained materials, having grain sizes in the submicrometer or nanometer range, may be readily produced by processing bulk solids through the application of severe plastic deformation (SPD) and this leads to the possibility of revealing different flow mechanisms when these materials are tested at elevated temperatures. Experiments show the two-phase Zn-22% Al alloy and various magnesium alloys exhibit excellent superplastic properties after processing by SPD whereas it is not possible to reveal different creep mechanisms in high-purity aluminum because the ultrafine grains are unstable at high temperatures. (Rev.Adv.Mater.Sci. (RAMS) No 1/2, Vol. 19, 2009, pages 1-12)

Physical and Mathematical Simulation of Heat and Mass-Transfer in Micro-Plasma and Spark Processes with Various Ambience

Alexander A. Kouleshoff, Vladislav V. Nelayev and Natalia M. Chigrinova

This work is devoted to physical and mathematical simulation of micro-plasma and spark processes in conditions of various ambiances. Here we present results

illustrated possibilities of developed mathematical approach (in the frame of response surface methodology) for description and optimization of advanced materials covering technology, in particularly growth of oxide-ceramic films. Physical modeling of the process with taking into account main mechanisms is a subject of further studies. (Rev.Adv.Mater.Sci. (RAMS) No 2, Vol. 20, 2009, pages 196-202)

Discrete Crack Propagation and Composites Delamination

Ihar A. Miklashevich

In the present work crack growth (crack tip movement) is interpreted as indentation of the influence zone into undisturbed material under the action of an end load. At the investigation, we should differentiate between two stages of fracture. The first one is the stage of the elementary cell fracture with characteristic time t_{char} and the second one is the fracture propagation between elementary cells with characteristic time $t_* \neq t_{\text{char}}$. The delamination follows the loss of stability of the influence zone. Stability of the influence zone by indentation is investigated. From mathematical reason we approximate the shape of the influence zone not as a wedge, but as a thin equivalent plate. We can investigate the loss of stability of a rod which clutched between elastic thick foundations under the effect of end load $P(X,t)$ and additional "noise of fracture". According to definition, the additional perturbation (fracture of an elementary cell) is a shock one. The principal difference of the considered processes is in the fact that the shock acts not along the beam axis and the system loses its stability not as a result of a shock load but as a result of a quasi-static load under conditions of parametrical perturbation. The non-homogeneity is represented by additional terms (change of fracture noise parameters). The full analytical solution of the problem is received in the form of composition of exponents and generalized hypergeometric functions. The possibility of resonance modes is shown. (Rev.Adv.Mater.Sci. (RAMS) No 2, Vol. 20, 2009, pages 190-195)

Non-monotonic Changes of Silicon Microhardness Radiation-induced with Low-flux of Electrons

Alexander A. Dmitrievskiy, Nadezhda Yu. Suchkova, Vladimir M. Vasyukov and Maxim Yu. Tolotaev

The multistage process of silicon radiation defects (RD) modification (accompanied by non-monotonic change of mechanical properties) in conditions

of irradiation with low-flux ($I = 10^5 \text{ cm}^{-2}\text{s}^{-1}$) is discussed. A qualitative model of quasi-chemical reactions which product is a cluster $V_2\text{-O-C}$, responsible for the first maximum of softening, is offered. (Rev.Adv.Mater.Sci. (RAMS) No 2, Vol. 20, 2009, pages 187-189)

Behavior of Amorphous Metallic Alloys under the Action of Destabilizing Influences

Victor A. Fedorov, Alexey V. Jakovlev andrey N. Kapustin and Irina V. Vasileva

The paper describes the investigations on the change of metallic glass (MG) plasticity for two techniques of annealing: on a ceramic substrate and in stable plates at different temperatures. The change of metallic glass mechanical characteristics under action of laser irradiation and the behavior of annealed metallic glass under the uniaxial tension are studied. (Rev.Adv.Mater.Sci. (RAMS) No 2, Vol. 20, 2009, pages 179-186)

Dynamics of Stress Fields near a Crack Tip in Alkali-Halide under the Influence of Electromagnetic Radiation

Tatjana N. Plushnikova, Roman A. Kirillov, Victor A. Feodorov and Irina V. Vasileva

This paper investigates the change in stress fields at crack tips in alkali-halide crystals under the influence of electromagnetic radiation in visible, ultraviolet and X-ray wavelength ranges. It is shown that electromagnetic radiation causes the relaxation of mechanical stress in crack tips. The relaxation is caused by reversible motion of dislocations into a crack cavity. It is established that the largest stress relaxation is observed under the influence of X-ray radiation. (Rev.Adv.Mater.Sci. (RAMS) No 2, Vol. 20, 2009, pages 176-178)

Analysis of Residual Stress State in Welded Steel Plates by X-Ray Diffraction Method

Vladimir I. Monin, Tatiana Gurova, X. Castello and S.F. Estefen

There were investigated geometrical distortions of two steel plates jointed by metal inert gas welding. The distributions of residual stresses in this welded joint were measured by X-ray diffraction method. The measured residual stress distributions were compared with residual stress state obtained by means of finite element

analysis with using of ABAQUS software. A good agreement was obtained between experimental and analytical data. (Rev.Adv.Mater.Sci. (RAMS) No 2, Vol. 20, 2009, pages 172-175)

Analysis of Displacement and Broadening of X-Ray Diffraction Lines Caused by Surface Stress Gradient: Computer Simulation and Measurement

Vladimir I. Monin, Joaquim T. Assis, Sergei A. Filippov and S.M. Iglesias

Some problems arise in the case of residual stresses measurements by X-ray diffraction technique when analyzed stress state is characterized by strong gradient on the surface of a material. These problems include the fact that linear dependence of the diffraction angle $\varphi_{\Psi} = f(\sin^2\Psi)$ becomes nonlinear. Besides, there is broadening of diffraction line caused by surface stress gradient. If the first problem makes difficulty to calculate the value of mechanical stresses, the second provides an opportunity to find the relationship between the diffraction line width and stress gradient parameters. Analysis of nonlinear displacement with broadening of diffraction line and development of methodology of stress determination with strong gradient is the objective of this paper. (Rev.Adv.Mater.Sci. (RAMS) No 2, Vol. 20, 2009, pages 166-171)

Nonlinear Dynamic Model of Kinetocilia Motion: 2D Case

Irina V. Ogneva and Vladimir V. Eliseev

The article includes a proposed approach to eukaryotic flagellums and cilium (kinetocilia) mathematical modeling. The approach is based on the total system of nonlinear elasticity theory equations, which was modified. Kinetocilia motion is examined in one plane. It makes possible to compare experimental data with results of mathematical modeling. (Rev.Adv.Mater.Sci. (RAMS) No 2, Vol. 20, 2009, pages 158-165)

Influence of the Dispersion on the Equations for Nonhomogeneous Mechanics

Evelina V. Prozorova

The consequences from the calculation of an angular moment in an elementary volume of gases, liquids or solids are discussed. The modified laws of conservation for gases, fluids and solids were received for the particles without structure. The

equations for the gases follow from the modified Boltzmann equation. Usually the law of angular momentum is postulated in the form of the symmetric stress tensor in spite of the fact that in general case the movement of particles is non-inertial. Taking into account the angular moment law, a nonsymmetrical stress tensor is received. The method for calculation of nonsymmetrical part is suggested. Besides, the local equilibrium distribution function f_0 , as the basis in the solution of the Boltzmann equation by the Chapman-Enskog method, is verified. Steady motion of conducting fluids in pipes under transverse magnetic fields is investigated for the modified equations. Other examples are discussed. (Rev.Adv.Mater.Sci. (RAMS) No 2, Vol. 20, 2009, pages 152-157)

Endochronic Presentation of the Theory of Nonlinear Creep by Rabotnov

Georgy D. Fedorovsky

Updating the equation of nonlinear Rabotnovs theory of creep with the help of endochronic concept is made. Analytical expression for determining functions of this transformation is received in the case of Rabotnov nucleus for creep and its nonlinear function as a power expression. The complex form of scale for generalized time is found. Additional endochronic generalization of Rabotnovs theory is offered that allows describe accelerated and sloweddown restoration media (hardening and softening). (Rev.Adv.Mater.Sci. (RAMS) No 2, Vol. 20, 2009, pages 148-151)

Determination of Mechanical Properties of Nanostructures with Complex Crystal Lattice Using Moment Interaction at Microscale

Olga S. Loboda and Anton M. Krivtsov

The paper considers a discrete nano-crystalline model with complex crystal lattices. There are non close-packed lattices, typical for some metals and for solids with covalent bonds, for example, diamond, graphite. Traditionally to describe this kind of lattices one used many-particle-interaction potentials. The alternative approach considers rotational degree of freedom and allows the moment contribution in interatomic interaction. The particles interact, using forces and moments. In this paper the characteristics of interatomic bonds are determined for crystals with diamond structure (carbon, silicon and germanium). It is shown that relation of bending stiffness of carbon covalent bonds to longitudinal one is between 0.49 0.72 (in diamond crystals). Hence, the bending stiffness is

comparable with longitudinal and it should be taken into account on calculation for covalent crystals. For crystals of silicon and germanium, this relation is equal 0.34. The strength of covalent bonds decreases with the rise of interatomic distance in sequence C-Si-Ge. (Rev.Adv.Mater.Sci. (RAMS) No 2, Vol. 20, 2009, pages 143-147)

Simulation of Stress-Deformed States of High Pressure Apparatus for Sintering Nanomaterials

Sergey Turbinsky, Vladimir Urbanovich and Viacheslav Antonovich

Calculation of coordinate and equivalent stress distribution in volume and on the surface of an anvil is realized at first time at three general states of high pressure apparatus (HPA) for sintering nanomaterials: "assembly", "loading" and "unloading" by finite element analysis. Zones of extreme stresses demanding modernization of the geometrical profile of an anvil at their places are revealed. It allows decrease unevenness of stress distribution and thereby to increase a service time of the apparatus. Maximal disruptive stresses are concentrated at the edge of recess bottom. It is shown that maximal stresses are arisen in an anvil under pressure relief in the apparatus. Real picture of anvil destruction during a working process of the HPA and the character of calculated stress distribution are in accordance with each other. (Rev.Adv.Mater.Sci. (RAMS) No 2, Vol. 20, 2009, pages 136-142)

$\alpha \rightarrow \gamma$ Transformation in Fe-ni Agglomerated Nanoparticles

Lidia Karkina and Ilya Karkin

$\alpha \rightarrow \gamma$ transformation in two and three-particle agglomerates of $\text{Fe}_{80}\text{Ni}_{20}$ alloy clusters upon heating and subsequent cooling is studied by the molecular dynamic method. It is shown that the temperature of the transformation beginning is distinguished for all particles. There was investigated the type of domain structure and its dependence on the number of particles in the configuration. (Rev.Adv.Mater.Sci. (RAMS) No 2, Vol. 20, 2009, pages 131-135)

Microcrack Nucleation in Ti_3Al Due to Dislocation Interactions

Liudmila Yakovenkova and Lidia Karkina

The reactions of interaction between the superdislocations, which accomplish deformation in the basal, prism and pyramidal (I and II types) planes in the single

crystal of Ti_3Al are examined. Interaction modes, which lead to the formation of dislocation barriers - the microcrack nucleation are established. The force and energy conditions for the formation of microcracks are examined. The classification of the types of microcracks in the dependence on the orientation of the deformation axes of the single crystals is carried out. The regions of stereographic triangle, the characterized by preferred type crack openings are found. (Rev. Adv. Mater. Sci. (RAMS) No 2, Vol. 20, 2009, pages 125-130)

Physics of Granular Matter: Pattern Formation and Applications

Christof A. Kruelle

A summary of results is presented from experiments in granular systems, which are excited by vertical and/or horizontal vibrations. The transitions between different dynamic states depend on internal properties of the granular system like the density of particles and on external parameters of the driving shakers. Characteristic for granular systems are such counterintuitive phenomena as the crystallization by increasing the vibration amplitude and thereby the energy input, or the rise of large particles in a sea of smaller ones (Brazil-nut effect). For horizontal shaking of a binary system the demixing of small and large particles is found to occur at the same critical particle density as the liquid-solid transition. The combined action of both vertical and horizontal vibrations for the controlled transport of bulk solids is utilized already for a long time in industrial applications. In a certain driving range it is known that standing surface waves occur at half the forcing frequency. The three experiments presented here indicate that the four major concepts describing the complex behavior of a vibrated granular system, namely phase transition, segregation, pattern formation and transport are closely related and yield a rewarding field for future research. (Rev. Adv. Mater. Sci. (RAMS) No 2, Vol. 20, 2009, pages 113-124)

Optical, Structural and Surface Morphological Studies of N-methylaniline Capped Lead Sulphide Nanoparticles

M. Navaneethan, K.D. Nisha, S. Ponnusamy and C. Muthamizhchelvan

N-Methylaniline (N-MA) capped lead sulphide (PbS) nanoparticles have been synthesized by wet chemical route. N-Methylaniline serves as a good capping agent for synthesizing nanoparticles in the quantum confinement regime and it acts as a passivated layer of the PbS particles. Synthesized N-Methylaniline capped PbS nanoparticles has been characterized by XRay powder diffraction (XRD),

UV-Visible spectrophotometry, FTIR spectroscopy, transmission electron microscopy (TEM), Energy dispersive X-Ray absorption spectroscopy (EDAX) and photoluminescence spectral studies. Size of the PbS nanoparticles observed from TEM is 5 nm which are in uniform distribution. The synthesized PbS nanoparticles exhibit strong blue shift in the optical spectrum. (Rev.Adv.Mater.Sci. (RAMS) No 2, Vol. 21, 2009, pages 217-224)

Purification of Polluted Waters by Funtionalized Membranes

J. Ramírez-Flores, E. Rubio, V. Rodríguez-Lugo and V.M. Castaño

Chromium VI was adsorbed by maleic acid-funtionalized cellulose membranes (MACellulose) from an aqueous solution at a concentration of 200 ppm. Three different types of supports were used for the membranes: nylon mesh, polyester membrane (as primary support) and polyester fabric, which were coated by modified cellulose microparticles (with commercial fixer). The reaction between MA-Cellulose and Chromium VI was analyzed in aqueous solution and a first order type of reaction was obtained, with a value of k' of 0.00869 with 0.99768 correlation factor. The polyester fabric membrane showed 40% higher flow rate than nylon mesh and polyester membranes and a two-fold Cr VI adsorption capacity increase. (Rev.Adv.Mater.Sci. (RAMS) No 2, Vol. 21, 2009, pages 211-216)

Forced Organization of Magnetic Quasi-one-dimensional Iron-organic Nanostructures on Inorganic Matrices

Vladimir M. Smirnov, Elena G. Zemtsova and Pavel E. Morozov

The magnetic properties of nanostructures based on quasi-one-dimensional iron-organic .brushes. attached to silica are studied for the first time. The non-compensated antiferromagnetism is established at the chemical constructing of iron-organic nanostructures on silica surface. The data obtained indicate the perspectives of such structures for spin electronics. (Rev.Adv.Mater.Sci. (RAMS) No 2, Vol. 21, 2009, pages 205-210)

The Effect of Heat Treatment Temperature on CeO_2 and Y_2O_3 Doped CeO_2 Electrospun Fibers

A.K. Alves, F.A. Berutti, F. Clemens, T. Graule and C.P. Bergmann

Electrospinning was employed to produce homogeneous inorganic.organic composite fibers from alcoholic solutions containing polyvinyl butyral (PVB) and

precursor of yttrium and cerium ions. Upon heat treatment, ceria and yttria-doped ceria fibers were obtained. The fibers retained the original morphology observed in the as-spun composition. X-ray diffraction was used to identify the crystalline phases of the final products. Scanning electron microscopy (SEM), thermogravimetric analysis (TGA), differential thermal analysis (DTA) and BET analysis were employed to study the ceramic-phase formation and the morphological evolution of the fibers. Thus, several micrometers long, uniform ceria and yttria-doped ceria fibers of high-phase purity were produced. The CeO_2 and the CeO_2 with Y_2O_3 fibers presented average diameter that ranged from 19 to 25 μm and the distribution of specific surface ranged from 33 to 43 m^2/g . (Rev.Adv.Mater.Sci. (RAMS) No 2, Vol. 21, 2009, pages 200-204)

Effects of Tungsten Nanoparticles Additions on the Densification of Micron Size Tungsten Powder

O.V. Tolochko, O.G. Klimova, S.S. Ordanian, D.I. Cheong and Y.M. Kim

Low temperature activated sintering of 3 μm tungsten powder was studied. Sintering process was activated by vibration milling and by additions of W nanopowder of less than 10 nm in mean diameter, as well as combination of those techniques. There were no any additions of transition metals such Ni, Co or Fe. The blend of W micron size powder after mechanoactivation with 20% of W nanopowder showed sintering density up to 97% of theoretical density and high chemical purity. (Rev.Adv.Mater.Sci. (RAMS) No 2, Vol. 21, 2009, pages 192-199)

Correlation Between Overall Elastic Stiffness, Bulk Modulus and Interatomic Distance in Anisotropic Materials: Semiconductors

Mohamed Gaith and Imad Alhayek

In this study, the correlation between macroscopic and microscopic properties of the IIIIV semiconductor compounds CdX ($\text{X}=\text{S}, \text{Se}, \text{Te}$) is investigated. Based on constructing orthonormal tensor basis elements using the form-invariant expressions, the elastic stiffness for cubic system materials is decomposed into two parts; isotropic (two terms) and anisotropic parts. A new scale for measuring the overall elastic stiffness of these compounds is introduced and its correlation with the calculated bulk modulus and lattice constants is analyzed. The overall elastic stiffness is calculated and found to be directly proportional to bulk modulus and

inversely proportional to lattice constants. A scale quantitative comparison of the contribution of the anisotropy to the elastic stiffness and to measure the anisotropy degree in an anisotropic material is proposed using the Norm Ratio Criteria (NRC). It is found that among these compounds CdS is the nearest to isotropy (or least anisotropic) while CdTe is the least near to isotropy (or nearest to anisotropic). The norm and norm ratios are found to be very useful for selecting suitable materials for optoelectric devices, transducers, modulators and acousto-optic devices. (Rev.Adv.Mater.Sci. (RAMS) No 2, Vol. 21, 2009, pages 183-191)

Effect of Ni and Cu Intermediate Layers on the Sinterability of a Ti-35Si-10 MG (% AT.) Mixture Synthesized by Mechanical Alloying

M. Caetano, F.J. Oliveira, R.F. Silva, F. Simões and B. Trindade

A Ti-35Si-10Mg (at.%) mixture was synthesized by mechanical alloying from Ti, Mg and Si elemental powders. After milling the surface of the particles was chemically modified by the deposition of Ni and Cu thin layers by d.c. magnetron sputtering. Coated and uncoated particles were subsequently consolidated by two different routes: (i) cold isostatic pressing followed by pressureless sintering at $T = 1300\text{ }^{\circ}\text{C}$ in vacuum and (ii) cold isostatic pressing followed by hot isostatic pressing at $T = 900\text{ }^{\circ}\text{C}$ with an applied pressure of 1500 MPa. The results showed that all samples were formed by a final $\text{Ti}_3\text{Si}_5 + \text{Mg}_2\text{Si}$ microstructure. Cu and Ni existed as single phases after hot isostatic pressing. Ni and Cu coatings acted as auxiliary sintering elements during compaction of the mechanically alloyed Ti-35Si-10Mg powders, giving rise to better final compacts. The higher values of hardness and Young's modulus were obtained for the HIP'ed coated samples, as result of their better densification. (Rev.Adv.Mater.Sci. (RAMS) No 2, Vol. 21, 2009, pages 173-182)

Achieving Optimum Adhesion of Conductive Adhesive Bonded Flip-chip on Flex Packages

M.A. Uddin, M.Y. Ali and H.P. Chan

Anisotropic conductive adhesives film (ACF) is a thermosetting epoxy matrix impregnated with small amount of electrically conductive particles and used as an interconnect materials for flip chip on flex (FCOF) packages. However, it remains a challenge to develop the reliable packaging know-how in processing of ACF

materials. Considerable research has been conducted recently to investigate the effect of different parameters on the performances. One of the main reliability factors in characterizing the performance of ACF joints is adhesion strength. This review article will discuss the critical issues that can easily control the adhesion of ACF joints in flip chip on flex packages. These mainly include surface cleanliness, bonding tracks, process parameters and operating environmental related issues. The findings can serve as a guide for optimizing the process parameters in the packaging of flip chip on flex with ACF. By preventing the usual degradation, the manufacturer can easily proceed for mass commercialization of ACF as an environmental friendly solder replacement in the electronic packaging industry. (Rev.Adv.Mater.Sci. (RAMS) No 2, Vol. 21, 2009, pages 165-172)

Materials and Fabrication Issues of Optical Fiber Array

M.A. Uddin, M.Y. Ali and H.P. Chan

Photonic devices are becoming widespread as an advanced information-communications network of the 21st century. With the increased use of photonic devices, there is a need for optical connecting path between photonic devices. The optical fiber array is such a smart approach for all optical functionality of the optical chip without any need of electrical wiring. However, it remains a challenge to develop the reliable fabrication know-how in manufacturing of fiber array. This paper will discuss the issues required in the reliable fabrication of optical fiber array and integrating them to address the future needs of the information and communication technology sector. Issues affecting the quality of the optical fiber array mainly include the material selection, processing condition and bonding technique. The advantages and disadvantages of each materials and fabrication method are discussed with the major failure issues. The findings can serve as a guide for optimizing the materials and process parameters in the reliable fabrication of optical fiber array in Photonic industry. (Rev.Adv.Mater.Sci. (RAMS) No 2, Vol. 21, 2009, pages 155-164)

Plastic Flow in Amorphous Covalent Solids and Nanoceramics with Amorphous Intergranular Layers

M.Yu. Gutkin and I.A. Ovid'ko

A theoretical model is suggested which describes plastic flow in amorphous covalent solids and amorphous intergranular boundaries in nanoceramics. On the basis of computer simulations (M.J. Demkowicz, A.S. Argon // Phys. Rev. Lett.

93 (2004) 025505), it is supposed that plastic flow in these amorphous structures is carried by liquid-like phase nuclei which form and grow in size within solid-like matrix phase. The nuclei suffer plastic shears modeled as glide dislocation loops. Energetics of formation and growth of the nuclei is examined in bulk amorphous silicon, silicon nitride and nanocomposite nc-TiC/a-Si₃N₄ ceramics. Within the model, it is shown that plastic flow in amorphous covalent solids tends to be localized at high stresses and low temperatures. Also, it is revealed that plastic flow within intergranular amorphous layers of a-Si₃N₄ in nanocomposite nc-TiC/a-Si₃N₄ can initiate cracks whose equilibrium and critical (Griffith) lengths depend on grain size and temperature. (Rev.Adv.Mater.Sci. (RAMS) No 2, Vol. 21, 2009, pages 139-154)

Growth of Diamond Films from Tequila

J. Morales, L.M. Apórtiga and V.M. Castaño

Diamond thin films were growth using Tequila as precursor by Pulsed Liquid Injection Chemical Vapor Deposition (PLI-CVD) onto both silicon (100) and stainless steel 304 at 850 °C. The diamond films were characterized by Scanning Electron Microscopy (SEM) and Raman spectroscopy. The spherical crystallites (100 to 400 nm) show the characteristic 1332 cm⁻¹ Raman band of diamond. (Rev.Adv.Mater.Sci. (RAMS) No 2, Vol. 21, 2009, pages 134-138)

Size-dependent Effects in Properties of Nanostructured Materials

R.A. Andrievski

Size-dependent effects in nanostructured (nanocrystalline, nanophase or nanocomposite) materials are of great importance both for fundamental considerations and modern technology. The effect of the nanoparticle/nanocrystallite size on surface energy, melting point, phase transformations and phase equilibriums is considered as applied to nanostructured materials. The role of size-dependent effects in phonon, electronic, superconducting, magnetic and partly mechanical properties is also analyzed in detail. Special attention is paid to the contribution of other factors such as the grain boundary segregations, interface structure, residual stresses and pores, nonuniform distribution of grain sizes and so on. The little explored and unresolved problems are pointed and discussed. (Rev.Adv.Mater.Sci. (RAMS) No 2, Vol. 21, 2009, pages 107-133)

Aromatic Polysulfones Used in Sensor Applications

M. Ciobanu, L. Marin, V. Cozan and M. Bruma

Aromatic poly(ether sulfone)s are a family of amorphous thermoplastics that possess unique high performance properties as engineering materials: high strength, the highest service temperature of all melt-processable thermoplastics, low creep, good electrical characteristics, transparency, self-extinguishing properties and resistance to greases, many solvents and chemicals. They may be processed by extrusion and injection molding. Since the chemical and physical properties of polymers may be tailored by the chemist for particular needs, they gained importance in the construction of sensor devices. The knowledge of new materials, such as polysulfone allows to expand the possibilities of constructing potentiometric and amperometric sensors. Recently polysulfones have been used in the fabrication of sensors in various fields such as: humidity sensor, gas sensors, biosensors, immobilization of enzyme, enzyme membrane reactor, etc. (Rev.Adv.Mater.Sci. (RAMS) No 1/2, Vol. 22, 2009, pages 89-96)

Tribological Properties of Tialcrn Thin Films

B. Warcholinski, A. Gilewicz and P. Myslinski

The dry sliding wear of monolayer TiAlN, TiAlCrN and multilayer TiAlN/CrN coatings have been investigated against alumina counterpart. All tested films were deposited using cathodic arc evaporation with Ti/Al and Cr cathode. All coatings were deposited on Cr and CrN sublayers, which reduces stresses between film and substrate and causes adhesion increasing. Coatings with chromium show lower friction coefficient when compared with TiAlN film and meaningful lower wear rate of the coating. Increasing the normal force and bilayer thickness of multilayer coating causes reduction the friction coefficient from 0.85 to 0.77 and from 0.90 to 0.77 respectively. Wear rate for TiAlN was measured as 5×10^{-6} mm³/Nm, for TiAlCrN 5×10^{-7} mm³/Nm, for TiAlN/CrN 3×10^{-6} mm³/Nm. Wear rate for alumina counterpart was at least an order of magnitude lower than tested coatings. (Rev.Adv.Mater.Sci. (RAMS) No 1/2, Vol. 22, 2009, pages 81-88)

Binding Agent Affect on the Structural and Optical Properties of ZnO Nanoparticles

T.M. Hammad, Jamil K. Salem and Roger G. Harrison

In this study, different concentrations of hydroxyl-footed methylresorcinarene (HFMR) are selected to bind zinc acetate in order to investigate its role on the formation of ZnO nanoparticles. Accordingly, the size of produced ZnO nanoparticles are affected by the existence of the binding agent as observed by XRD and TEM analysis. The particle size increases from 28 to 43 nm with increasing amounts of binding agent. The SEM and TEM micrographs show hexagonal morphology. The UV-vis absorption and PL spectra show that the absorption edge shifts to red. (Rev.Adv.Mater.Sci. (RAMS) No 1/2, Vol. 22, 2009, pages 74-80)

Nano Zirconia and Sulfated Zirconia from Ammonia Zirconium Carbonate

Efrain Rubio, Ventura Rodriguez-Lugo, Rogelio Rodriguez and Victor M. Castaño

A novel method for producing either nanosized zirconia or sulfated zirconia from ammonia zirconia carbonate, an inexpensive chemicals commodity, is described. Thermal, morphological and crystallographic characterization vs the particle size and phase were determined, sulfation efficiency of the process was increased. (Rev.Adv.Mater.Sci. (RAMS) No 1/2, Vol. 22, 2009, pages 67-73)

Hydrothermal Synthesis of Co_3O_4 Nano-Octahedra and Their Magnetic Properties

Ana Fernández-Osorio, América Vázquez-Olmos, Roberto Sato-Berru and Roberto Escudero

Highly uniform cobalt oxide (Co_3O_4) nano-octahedra with mean edge length about 16.4 ± 3.1 nm have been prepared using a hydrothermal method. X-ray diffraction pattern shows the normal spinel structure with formula $\text{Co}^{2+}(\text{Co}^{3+})_2\text{O}_4$ as the only crystallographic phase. The Co_3O_4 nanoparticles were characterized by UV-Vis and Raman spectroscopies and its morphology was determined by scanning and high resolution transmission electron microscopies. Magnetic properties of Co_3O_4 nano-octahedra were determined with a MPMS SQUID magnetometer. The blocking temperature (T_b) at 8K and a slight hysteresis loop indicating a

ferrimagnetic behavior were observed. The magnetic response could be explained by uncompensated surface spins of the Co_3O_4 nanoparticles. (Rev.Adv.Mater.Sci. (RAMS) No 1/2, Vol. 22, 2009, pages 60-66)

Behaviour of Semi-insulating GaAs Energy Levels

P.H. Yannakopoulos, G.E. Zardas, G.J. Papaioannou, Ch.I. Symeonides, M. Vesely and P.C. Euthymiou

The behaviour of EL2 intrinsic defect in the Semi-Insulated (SI) undoped and Cr-doped GaAs is studied by measuring the Demer effect short circuit current. Appropriate illumination with peak in the 1100 nm region results in the transition of the EL2 state to its metastable one (EL2M). Of major importance is the Cr concentration, which is influencing the photoconductivity spectra, as in high concentrations its contribution in the photoconductivity overlaps the EL2 contribution. (Rev.Adv.Mater.Sci. (RAMS) No 1/2, Vol. 22, 2009, pages 52-59)

Mobility of Triple Junctions of Grain Boundaries During Their Migration in Deformed Nanocrystalline Materials

S.V. Bobylev and I.A. Ovid'ko

A theoretical model is suggested that describes stress-driven migration of grain boundaries (GBs) and their triple junctions in deformed nanocrystalline ceramics and metals. Within the model, the migration process carries plastic flow and is accompanied by both increase in the GB length and transformations of GB dislocations and disclinations at migrating triple junctions. With these factors taken into account, it is found that geometry of triple junctions strongly influences their mobility characterized by the stress level needed to drive migration of GBs and their triple junctions in deformed nanocrystalline materials. (Rev.Adv.Mater.Sci. (RAMS) No 1/2, Vol. 22, 2009, pages 39-51)

Contributions to the Modelling of the Milling Process in a Planetary Ball Mill

Gy. Kakuk, I. Zsoldos, Á. Csanády and I. Oldal

Further improving the previous models describing the operation of planetary ball mills, the study determines the impact energy transmitted towards the material during the milling and the milling power. It points out relationship between the ratio

between the angular velocity of the sun disk and the vials and the geometrical parameters of the mill. By exploring the relationship between the model created for the milling process taking place in the planetary ball mill and the milling parameters depending on the mill and using the calculations executed, data more authentic than previous ones can be obtained on the energy transferred to the mill product during the milling process and on the efficiency of milling. This information provides more plannable mechanical milling for researchers decomposing materials in planetary mills and for specialists dealing with the improvement and application of these technologies. (Rev.Adv.Mater.Sci. (RAMS) No 1/2, Vol. 22, 2009, pages 21-38)

Synthesis, Structure and Properties of Nanosized Silicon Carbide

R.A. Andrievski

Features of synthesis of particles, wires, tubes, films and bulk materials based on silicon carbide in nanocrystalline/amorphous condition are considered. The main attention is taken to the preparation of nanotubes/nanowires, films and nanosized SiC inclusions in matrixes. Their structure, physical, chemical and mechanical properties are discussed in connection with the influence of size effects and other features in detail. Such new results, as the hardness essential increase, display of the nanowire high plasticity, substantial increase of photoluminescence spectra intensity, biocompatibility, good resistance to amorphization under irradiation and so on, are described. Applications in electronics, optics, nanotechnics and medicine are pointed. Some unresolved problems are underlined. (Rev.Adv.Mater.Sci. (RAMS) No 1/2, Vol. 22, 2009, pages 1-20)

Current Status in Layered Ternary Carbide Ti_3SiC_2 , a Review

H.B. Zhang, Y.W. Bao and Y.C. Zhou

This article provides a review of current research activities that concentrate on Ti_3SiC_2 . We begin with an overview of the crystal and electronic structures, which are the basis to understand this material. Followings are the synthetic strategies that have been exploited to achieve and the formation mechanism of Ti_3SiC_2 . Then we devote much attentions to the mechanical properties and oxidation/hot corrosion behaviors of Ti_3SiC_2 as well as some advances achieved recently. At the end of this paper, we elaborate on some new discoveries in the Ti_3SiC_2 system and also give a brief discussion focused on the "microstructure-property" relationship. (Journal of Materials Sciences and Technology 2009, 25(01) 1-38)

Complete Composition Tunability of Cu(Ni)-Ti-Zr Alloys for Bulk Metallic Glass Formation

Ze-xiu Zhang, Chun-li Dai and Jian Xu

In the Cu-Zr-Ti ternary system, a new composition zone of bulk metallic glasses (BMGs) formation was discovered, locating at the 55-57 at. pct Cu, 30-31 at. pct Ti and 13-14 at. pct Zr and near Cu-Ti binary subsystem rather than the Cu-Zr binary. For these alloys, BMG rods of 2 mm in diameter can be fabricated by using copper mould casting. It is expected that these BMG-forming alloys correlate with (L-CuTi+Cu₂TiZr+Cu₅₁Zr₁₄) eutectic reaction that the undercooled melt undergoes during solidification. Adopting "3D pinpointing approach", compositional dependence of glass-forming ability (GFA) in Cu(Ni)-Ti-Zr pseudo ternary system was revisited. Optimized BMG-forming composition is located at Cu_{50.4}Ni_{5.6}Ti₃₁Zr₁₃, with a critical diameter of 6 mm for complete BMG formation. Its GFA is significantly superior to Vit 101 (Cu₄₇Ni₈Ti₃₄Zr₁₁) previously developed by Caltech group. The effect that the GFA of the ternary base alloy was improved by substitution of Ni for Cu is attributed to a role of retarding the crystallization of Cu₅₁Zr₁₄ intermetallics. (Journal of Materials Sciences and Technology 2009 Vol. 25 (01): 39-47)

Crystallization and Hardness of Melt Spun Fe₇₃Si₁₃B₉Nb₄Cu₁ Alloy

J.I. Akhter, M. Iqbal, M. Siddique, M. Ahmad, M.A. Haq, M.A. Shaikh and Z.Q. Hu

An alloy having composition Fe₇₃Si₁₃B₉Nb₄Cu₁ was synthesized by melt spinning to investigate the kinetics of crystallization. Techniques of differential scanning calorimetry (DSC), X-ray diffraction (XRD) and Mössbauer spectroscopy were employed to characterize the phases produced due to annealing at various temperatures. High temperature DSC revealed two stage crystallization reactions. First stage, crystallization occurs at temperature around 514°C with the production of α-Fe (bcc) and Fe₃Si phases. In the second stage, Fe₂B and α-Fe (Si,Nb) phases were produced. Mössbauer results revealed the formation of Fe₃Si, Fe₁₃Si₃ and Fe₇Si₁ in the first stage and Fe₃Si, Fe₁₃Si₃, Fe₂B and α-Fe (Si,Nb) phases in the second stage of crystallization. An abrupt change in average internal magnetic field was observed at 500°C. The maximum hardness value was found for the sample heat-treated at 500°C. (Journal of Materials Sciences and Technology 2009 Vol. 25 (01): 48-52)

Fabrication and Wettability of ZnO Nanorod Array

Meng Sun, Yi Du, Weichang Hao, Huaizhe Xu, Youxing Yu and Tianmin Wang

ZnO nanorod arrays were prepared in an open system by using a simple aqueous solution method. Spindle-like, wimble-like, tower-like and hexagonal rod-like ZnO rods were obtained under different conditions. ZnO nanorod arrays with different morphology and size were studied by X-ray diffraction (XRD), scanning electron microscopy (SEM) and contact angle measurement (CAM). The size of ordered zinc oxide rods can be controlled by temperature of water bath, because this temperature can influence growing speeds in different crystal directions. Some additives, such as urea and thiourea, were introduced into reaction solution to improve quality of arrays. Surface character of ZnO nanorod arrays can be changed from hydrophilic to hydrophobic, which was proved to be dependence on size of air grooves on surface. (Journal of Materials Sciences and Technology 2009 Vol. 25 (01): 53-57)

Preparation of New Type Ni-P Micro/Nano Metal Material Based on Bacteria Shape

Xin Liang, Jianhua Liu and Songmei Li

A new type of Ni-P alloy with rod-shape was prepared by electroless deposition method based on the shape of *Nocadia*, a kind of bacteria. The material was characterized by microbiological method, scanning electron microscope, energy dispersion spectroscopy, transmission electron microscopy, fourier transform infrared spectroscopy, X-ray diffraction and vibrant sample magnetometer. It was found that Ni-P alloy deposited on *Nocadia* surface was amorphous when pH=8.0. The amount of Ni crystalline increased with pH of plating solution. Ni-P nano-particles deposited on active locations on the surface at the initial stage and then homogeneous Ni-P film formed with time. *Nocadia* remained their original rod shape after Ni-P nano-particles deposition. The new type metal material formed of Ni-P alloy with nano-particles was prepared. The magnetization of the material prepared at pH=9.7 is greater than that prepared at pH=8.0. The magnetic loss of the material prepared at pH=9.7 is less than 0.1. The dielectric loss exceeds 0.3 when frequency is higher than 14 GHz, which is 1.5 at 18 GHz. The new type Ni-P metal material with *Nocadia* shape has dielectric loss property. (Journal of Materials Sciences and Technology 2009 Vol. 25 (01): 58-62)

Combination of Instrumented Nanoindentation and Scanning Probe Microscopy for Adequate Mechanical Surface Testing

Enrico Tam, Mikhail Petrzhik, Dmitry Shtansky and Marie-Paule Delplancke-Ogletree

The elastic indentation modulus and hardness of standard bulk materials and advanced thin films were determined by using the nanoindentation technique followed by the Oliver-Pharr post-treatment. After measurements with different loading/unloading schemes on chemically polished bulk titanium a substantial decrease of both modulus and hardness vs an increasing loading time was found. Then, hard nanostructured TiBN and TiCrBN thin films deposited by magnetron sputtering (using multiphase targets) on substrates of high roughness (sintered hard metal) and low roughness (silicon) were studied. Experimental modulus and hardness characterized by using two different nanoindenter tools were within the limits of standard deviation. However, a strong effect of roughness on the spread of the experimental values was observed and it was found that hardness and elastic indentation modulus obeyed a Gaussian distribution. The experimental data were discussed together with scanning probe microscopy (SPM) images of typical imprints taken after the nanoindentation tests and the local topography's strong correlation with the results of nanoindentation was described. (Journal of Materials Sciences and Technology 2009 Vol. 25 (01): 63-68)

Salt-assisted Low Temperature Solid State Synthesis of High Surface Area CoFe_2O_4 Nanoparticles

Runhua Qin, Fengsheng Li, Wei Jiang and Li Liu

A novel salt-assisted low temperature solid state method using $\text{CoCl}_2 \cdot 6\text{H}_2\text{O}$, $\text{FeCl}_3 \cdot 6\text{H}_2\text{O}$ and NaOH as precursor and using NaCl as a dispersant to synthesize high surface area CoFe_2O_4 nanoparticles, has been investigated. The effects of the molar ratio of added salt and calcination temperature on the characteristics of the products were investigated by X-ray diffraction (XRD), transmission electron microscopy (TEM), vibrating sample magnetometer (VSM) and Brunauer, Emmett and Teller (BET) surface area analysis. Results showed that the introduction of leachable inert inorganic salt as a hard agglomeration inhibitor in the mixture precursor led to the formation of high dispersive CoFe_2O_4 nanoparticles; and the increase in specific surface area from 28.28 to 73.97 m^2/g and the saturation magnetization is 84.6 emu/g. (Journal of Materials Sciences and Technology 2009 Vol. 25 (01): 69-72)

(N, F)-codoped TiO₂ Nanocrystals as Visible Light-activated Photocatalyst

Yanling Meng, Jiansong Chen, Ying Wang, Hanming Ding and Yongkui Shan

(N, F)-codoped anatase TiO₂ nanocrystals with active visible light response were prepared by using a simple sol-gel approach. X-ray photoelectron spectroscopy measurements suggested that the substitutional N and F species replaced the lattice oxygen atoms in TiO₂ nanocrystals. Such nanocrystals showed strong absorption from 400 to 550 nm, which was mainly induced by nitrogen doping. The phase transformation from anatase to rutile was hindered by fluorine doping at high calcination temperatures, which was verified by XRD patterns. The N₂ adsorption-desorption isotherms revealed the absence of mesopores in these nanocrystals. The (N, F)-codoped TiO₂ nanocrystals showed satisfying photocatalytic activity on the photo-degradation of methylene blue under visible light. (Journal of Materials Sciences and Technology 2009 Vol. 25 (01): 73-76)

Residual Strains in a Nanometer Thick Cr Film Measured on Micromachined Beams

Z.M. Zhou, Yong Zhou, Ying Cao and Haiping Mao

A Cr film with a 75 nm thickness sputtered on a Si substrate was used to fabricate microbridge and microcantilever samples with the MEMS (microelectromechanical system) technique. The profile of the buckled beams was measured by using the interference technique with white light and fitted with a theoretical result. The uniform residual strain in the bridge samples was deduced from the variation of buckling amplitude with the beam length. On the other hand, the gradient residual strain was determined from the deflection profile of the cantilever. The residual uniform and gradient strain in the Cr film are about 4.96×10^{-3} and 4.2967×10^{-5} , respectively. (Journal of Materials Sciences and Technology 2009 Vol. 25 (01): 77-80)

A New Attempt to Obtain Bulk Nanocrystalline Steel

Shengjie Yao, Linxiu Du, Xianghua Liu and Guodong Wang

Bulk nanocrystalline steel sample was obtained in laboratory through refining of austenite grains and controlled rolling. Transmission electron microscopy micrographs show that some textures are evolved in the process of the treatment

and two typical carbides are classified according to their size and location. The tensile strength of the nanocrystalline sample is obviously lower than conventional consideration and scanning electron microscopy observation shows that the existence of the first type of carbide is considered as the main reason for the failure. (Journal of Materials Sciences and Technology 2009 Vol. 25 (01): 81-84)

Metal Organic Chemical Vapour Deposited Thin Films of Cobalt Oxide Prepared via Cobalt Acetylacetonate

C.U. Mordi, M.A. Eleruja, B.A. Taleatu, G.O. Egharevba, A.V. Adedeji, O.O. Akinwunmi, B. Olofinjana, C. Jeynes and E.O.B. Ajayi

The single solid source precursor, cobalt (II) acetylacetonate was prepared and characterized by infrared spectroscopy. Thin films of cobalt oxide were deposited on soda lime glass substrates through the pyrolysis (metal organic chemical vapour deposition (MOCVD)) of single solid source precursor, cobalt acetylacetonate, $\text{Co}[\text{C}_5\text{H}_7\text{O}_2]_2$ at a temperature of 420°C . The compositional characterization carried out by rutherford backscattering spectroscopy and X-ray diffraction (XRD), showed that the films have a stoichiometry of Co_2O_3 and an average thickness of 227 ± 0.2 nm. A direct energy gap of 2.15 ± 0.01 eV was calculated by the data obtained by optical absorption spectroscopy. The morphology of the films obtained by scanning electron microscopy, showed that the grains were continuous and uniformly distributed at various magnifications, while the average grain size was less than 1 micron for the deposited thin films of cobalt oxide. (Journal of Materials Sciences and Technology 2009 Vol. 25 (01): 85-89)

Creep Behavior and Its Influence on the Mechanics of Electrodeposited Nickel Films

Zengsheng Ma, Shiguo Long, Yong Pan and Yichun Zhou

In order to improve the accuracy and comparability of hardness and elastic modulus measurements in nanoindentation, an evaluation of the creep behavior and its influence on the mechanical properties of the electrodeposited nickel film has been conducted. The influence of loading time and hold period on the hardness and elastic modulus results at maximum load $5000 \mu\text{N}$ has also been examined. It is found that with increasing the loading time, the creep value is decreased. However, the creep value is increased when the hold period is increased. The elastic modulus results are more reliable if the hold period is longer. If the hold

period is long enough, the loading time has no remarkable effect on the hardness and elastic modulus measured. (Journal of Materials Sciences and Technology 2009 Vol. 25 (01): 90-94)

Effect of Oxide Inclusions on Electrochemical Properties of Aluminium Sacrificial Anodes

M. Emamy, A. Keyvani, M. Mahta and J. Campbell

Oxide films are incorporated into melts by an entrainment process and are expected to be present in most metals, but particularly cast Al alloys. The oxides are necessarily present as folded-over double films (bifilms) that are effectively cracks. Their effect on the electrochemical behaviour of cast Al-5Zn-0.02In sacrificial anodes was studied in 3 wt pct sodium chloride solution using the NACE efficiency evaluation. Three methods were employed to entrain progressive amounts of oxide in the alloy, including the addition of Al-Zn-In machining chips to the charge, increasing the pouring height and agitating the melt. The introduction of oxide bifilms in the cast alloy resulted in the deterioration of the electrochemical properties of the sacrificial anodes, such as current capacity and anode efficiency and introduced increasing variability in these properties. The results suggest that corrosion behaviour is strongly related to the presence of bifilms suspended in the liquid alloy because bifilms provide crack paths allowing the corrodant to penetrate deeply into the metal matrix and simultaneously provide localized galvanic cells because of the precipitation of Fe rich intermetallic compounds on their outer surfaces. (Journal of Materials Sciences and Technology 2009 Vol. 25 (01): 95-101)

Vanadium-Doped Semi-Insulating 6H-SiC for Microwave Power Device Applications

NING Li-Na Zhi-Hong FENG Ying-Ming WANG Kai ZHANG Zhen FENG

Two-inch semi-insulating SiC bulk crystals with resistivity higher than $1 \times 10^6 \Omega\text{cm}$ were achieved by vanadium doping during sublimation. Secondary-ion-mass-spectrometry (SIMS) was employed to determine the concentration of impurities in the crystals, such as B, Al, V and N. These results indicated that the concentration of nitrogen and aluminum kept on decreasing and the concentration of B and V was almost constant during the whole growth. An inner crucible was used to control the exhausting of vanadium, which made the uniformity of the high resistivity ($>1 \times 10^6 \Omega\text{cm}$) in the wafer up to 80%. High-performance AlGaN/GaN

high-electron- mobility-transistor (HEMT) materials and devices were grown and fabricated on semi-insulating 6H-SiC sub- strates. The two-dimensional electron gas (2DEG) mobility at room-temperature was $1795 \text{ cm}^2/\text{V}\cdot\text{s}$. The charge carrier concentration of the substrate determined by capacitance-voltage (C-V) test was $7.3 \times 10^{15} \text{ cm}^{-3}$. The device with a gate width of 1 mm exhibits a maximum output power of 5.5 W at 8 GHz, which proves the semi-insulating property of the substrates indirectly. (Journal of Materials Sciences and Technology 2009 Vol. 25 (01): 102-104)

Microstructure and Thermoelectric Properties of Bi- and Cu-Substituted $\text{Ca}_3\text{Co}_4\text{O}_9$ Oxides

Haoshan Hao, Limin Zhao and Xing Hu

Bi- and Cu-substituted $\text{Ca}_3\text{Co}_4\text{O}_9$ samples were prepared by conventional solid-state reaction method and the effect of element substitution on the microstructures and thermoelectric properties was investigated. Partial substitution of Cu for Co leads to an increase in electrical conductivity and a decrease in Seebeck coefficient due to the rise of hole concentration. The microstructure of Cu-substituted sample is almost unchanged compared with undoped $\text{Ca}_3\text{Co}_4\text{O}_9$. On the other hand, partial substitution of Bi for Ca gives rise to a significant increase in the grain size and c-axis-oriented structure can be formed in $\text{Ca}_{2.7}\text{Bi}_{0.3}\text{Co}_4\text{O}_9$, resulting in an obvious increase in electrical conductivity. Cu and Bi co-substitution further increases the grain growth and the electrical conductivity of $\text{Ca}_{2.7}\text{Bi}_{0.3}\text{Co}_{3.7}\text{Cu}_{0.3}\text{O}_9$. Thus, Cu and Bi co-substitution samples possess the optimal thermoelectric performance at high temperature and the highest value of power factor can reach $3.1 \times 10^{-4} \text{ Wm}^{-1}\text{K}^{-2}$ at 1000 K. (Journal of Materials Sciences and Technology 2009 Vol. 25 (01): 105-108)

The Infiltration Process and Texture Transition of 2D C/C Composites

Hejun Li, Guozhong Xu, Kezhi Li, Chuang Wang, Wei Li and Miaoling Li

2D needle-punched fiber felt was infiltrated by a kind of rapid isothermal chemical vapor infiltration technique. The infiltration process and texture transition of the infiltrated C/C composites were investigated. The porosity and the variations of the cumulative pore volume were determined by mercury porosimetry. The texture of matrix carbon was studied under a polarized light microscope. The results show that the relative mass gain of the sample increases directly as the infiltration time at

the initial stage until 20 h and subsequently the increasing rate of the relative mass gain decreases gradually with the prolonging of infiltration time. Three layers of pyrocarbon were formed around fibers. Low-textured pyrocarbon was obtained at the initial stage. With the densification going on, high-textured pyrocarbon was formed on the surface of low-textured pyrocarbon. Then, low-textured pyrocarbon was produced again during the final stage of densification. The texture transition is ascribed to the variation of the ratio of cumulative inner surface area to volume of pores and the gas partial pressure in pores. (Journal of Materials Sciences and Technology 2009 Vol. 25 (01): 109-114)

Thermal Oxidation of Silicon Carbide Substrates

Xiufang Chen, Lina Ning, Yingmin Wang, Juan Li, Xiangang Xu, Xiaobo Hu and Minhua Jiang

Thermal oxidation was used to remove the subsurface damage of silicon carbide (SiC) surfaces. The anisotropy of oxidation and the composition of oxide layers on Si and C faces were analyzed. Regular pits were observed on the surface after the removal of the oxide layers, which were detrimental to the growth of high quality epitaxial layers. The thickness and composition of the oxide layers were characterized by Rutherford backscattering spectrometry (RBS) and X-ray photoelectron spectroscopy (XPS), respectively. Epitaxial growth was performed in a metal organic chemical vapor deposition (MOCVD) system. The substrate surface morphology after removing the oxide layer and gallium nitride (GaN) epilayer surface were observed by atomic force microscopy (AFM). The results showed that the GaN epilayer grown on the oxidized substrates was superior to that on the unoxidized substrates. (Journal of Materials Sciences and Technology 2009 Vol. 25 (01): 115-118)

Fabrication and Properties of DC Magnetron Sputtered Indium Tin Oxide on Flexible Plastic Substrate

Hui Lin, Junsheng Yu, Nana Wang, Shuangling Lou and Yadong Jiang

Indium tin oxide (ITO) thin films deposited on flexible polyethylene terephthalate (PET) substrates at low temperature by DC magnetron sputtering from an In-Sn (90{10 wt pct) alloy target were studied. The correlation between deposition conditions and ITO property was systematically investigated and characterized. These as-deposited ITO films were used as the anode contact for flexible organic light-emitting diodes (FOLEDs). The fabricated FOLEDs with a structure of

PET/ITO/NPB (50 nm)/Alq (20 nm)/Mg:Ag (100 nm) showed a maximum luminance of 2125 cd/m² at 13 V. (Journal of Materials Sciences and Technology 2009 Vol. 25 (01): 119-122)

Study on Beta-TCP Coated Porous Mg as a Bone Tissue Engineering Scaffold Material

Fang Geng, Lili Tan, Bingchun Zhang, Chunfu Wu, Yonglian He, Jingyu Yang, Ke Yang

Three-dimensional honeycomb-structured magnesium (Mg) scaffolds with interconnected pores of accurately controlled pore size and porosity were fabricated by laser perforation technique. Biodegradable and bioactive β -tricalcium phosphate (β -TCP) coatings were prepared on the porous Mg to further improve its biocompatibility and the biodegradation mechanism was simply evaluated *in vitro*. It was found that the mechanical properties of this type of porous Mg significantly depended on its porosity. Elastic modulus and compressive strength similar to human bones could be obtained for the porous Mg with porosity of 42.6%-51%. It was observed that the human osteosarcoma cells (UMR106) were well adhered and proliferated on the surface of the β -TCP coated porous Mg, which indicates that the β -TCP coated porous Mg is promising to be a bone tissue engineering scaffold material. (Journal of Materials Sciences and Technology 2009 Vol. 25 (01): 123-129)

Effect of Solid Solution Supersaturation on Precipitation of γ' in Rapidly Quenched Ni-Al Binary Alloys

A. Samadi, A. Abdollah-zadeh, S. Behrouzghaemi and S.H. Razavi

The effect of solid solution supersaturation on the precipitation of γ' in rapidly quenched Ni-Al binary alloys containing 11.6, 14.2 and 16.5 at. pct Al was investigated. The samples were solutioned at 1250 °C, quenched in iced brine and then analyzed by electron microscopy and XRD (X-ray diffraction) techniques. In Ni-11.6 at. pct Al alloy, ordering and phase separation took place simultaneously, resulting in a uniform distribution of γ' . A transition from uniform to bimodal γ' phase distribution occurred in the composition range between 14.2 and 16.5 at. pct Al. This transition was accompanied by changes in the morphology of γ' precipitates. The microstructural observations were discussed in view of both kinetics and crystallographic considerations. (Journal of Materials Sciences and Technology 2009 Vol. 25 (01): 130-134)

Pulsed-Laser Annealing of NiTi Shape Memory Alloy Thin Film

S.K. Sadrnezhaad, E. Rezvani, S. Sanjabi and A.A. Ziaei Moayed

Local annealing of amorphous NiTi thin films was performed by using an Nd:YAG 1064 nm wavelength pulsed laser beam. Raw samples produced by simultaneous sputter deposition from elemental Ni and Ti targets onto unheated Si (100) and Silica (111) substrates were used for annealing. Delicate treatment with 15.92 W/mm² power density resulted in crystallization of small spots; while 16.52 and 17.51 W/mm² power densities caused ablation of the amorphous layer. Optical microscopy, scanning electron microscopy, X-ray diffraction and atomic force microscopy were performed to characterize the microstructure and surface morphology of the amorphous/crystallized spot patterns. (Journal of Materials Sciences and Technology 2009 Vol. 25 (01): 135-140)

Internal Friction on the Bake-Hardening Behavior of 0.11C-1.67Mn-1.19Si TRIP Steel

Renyu Fu, Yu Su, Ping Ye, Xicheng Wei, Lin Li and Jicheng Zhang

The bake-hardening (BH) values and the "internal friction-temperature" spectrums were studied for the baked 0.11C-1.67Mn-1.19Si TRIP (transformation induced plasticity) specimens with 0%, 2% and 6% prestrain. Results show that the experimental TRIP steel deserves good bake-hardening ability and Cottrell atmosphere is the reason for its bake hardening characteristic. It is also concluded that both the number and the saturation degree of Cottrell atmosphere might affect the BH value of TRIP steel. (Journal of Materials Sciences and Technology 2009 Vol. 25 (01): 141-144)

Non-isothermal Crystallization Kinetics of Polyamide 6/Diamine-modified MWNTs Nanocomposite

Hong Meng, Guoxin Sui, Guangyou Xie and Rui Yang

The non-isothermal crystallization kinetics of polyamide 6/diamine-modified multi-walled carbon nanotube (PA6/D-MWNT) nanocomposite was investigated by differential scanning calorimetry (DSC). The modified Avrami equation, the Ozawa equation and the combined Avrami/Ozawa equation were employed to analyze the non-isothermal crystallization data. The crystallization activation energies were also evaluated by the Kissinger method. It was found that the combined Avrami/Ozawa

equation could successfully describe the non-isothermal crystallization process. The results showed that D-MWNTs not only acted as effective heterogeneous nucleating agents for PA6 and noticeably increased the crystallization temperature of PA6, but also influenced the mechanism of nucleation and crystal growth of PA6 and then reduced the overall crystallization rate of the neat PA6 matrix. The crystallization activation energy for the nanocomposite sample was greater than that of the neat PA6, which indicated that the addition of D-MWNTs hindered the mobility of PA6 chain segments. (Journal of Materials Sciences and Technology 2009 Vol. 25 (02): 145-150)

Magnetization Reversal for Ni Nanowires Studied by Micromagnetic Simulations

Nianmei Han, Guanghua Guo, Lamei Zhang, Guangfu Zhang and Wenbin Song

The magnetization reversal mechanisms for Ni nanowires with different diameters were investigated by micromagnetic simulations. The results show that the reversal mechanisms are significantly dependent on the diameter of wire. For very thin wires, the reversal occurs by pseudo-coherent rotation. With increasing diameter, magnetization reversal takes place via different nucleation (the transverse domain wall and the vortex domain wall) and subsequent propagation. The reason of transition from the transverse domain wall to the vortex domain wall is given by analytical studies. With further increase of the diameter, the reversal nucleation domain wall becomes tulip-shaped form. As the diameter increases, the width of wall becomes larger. (Journal of Materials Sciences and Technology 2009 Vol. 25 (02): 151-154)

Preparation of α -Fe₂O₃ Nanodisks by Blocking the Growth of (001) Plane

Baoliang Lv, Yao Xu, Dong Wu and Yuhua Sun

Based on the difference of hydroxy group configuration on different planes of α -Fe₂O₃ nanoparticles, using the special adsorption and coordination of phosphate on the (001) plane of α -Fe₂O₃, well-crystallized and well dispersed α -Fe₂O₃ nanodisks with diameter of 150-200 nm and thickness of 40-80 nm were synthesized *via* a hydrothermal method. The magnetic properties of synthesized nanodisks were investigated. It was found that the nanodisks possessed a saturation magnetization (M_s) of 0.38 emu/g, a remanent magnetization (M_r) of 0.031 emu/g and a coercivity of 452.91 Oe at room temperature. The M_r and

coercivity of synthesized α -Fe₂O₃ nanodisks are higher and the Ms is lower than those of other previously reported α -Fe₂O₃ nanostructures. (Journal of Materials Sciences and Technology 2009 Vol. 25 (02): 155-158)

Epoxy Resin/Nano Ni@C Composites Exhibiting NTC Effect with Tunable Resistivity

Bangwen Zhang, Baowei Li and Changsheng Xie

Epoxy resin/Ni@C nanoparticle composites with aligned microstructure were prepared by using a procedure of magnetic field assisted curing. The results show that the resistivity of composites exhibits negative temperature coefficient (NTC) effect above room temperature, and can be adjusted by varying the content filler and the magnitude of magnetic field applied. Hill's quantum tunneling model was modified to understand the electrical conduction mechanism in the composites. It shows that the NTC effect ascribes to the dominant thermal activated tunneling transport of electron across adjacent nanoparticles, as well as the low thermal expansivity of epoxy resin matrix. (Journal of Materials Sciences and Technology 2009 Vol. 25 (02): 159-163)

Graphitization in CK 45 Steel

A.R. Kiani-Rashid

The purpose of this study was to determine the influence of heat treatment cycle on graphite phase formation on CK 45 steel. The presence of well distributed graphite in the matrix is responsible for the good mechanical and thermal properties of this kind of alloy. Such properties include excellent wear resistance, higher resistance to thermal shock, and higher resistance to oxidation at high temperature. A number of specimens were made up of appropriate design to provide the experimental materials. The transformation phase to a free carbon microstructure during graphitization under different conditions was then examined for the most successful experimental steels. Austenitising temperature of 920 °C and the following isothermal heat treatment of 750 °C at different holding times were used. Microstructures were examined by OM (optical microscopy) and SEM (scanning electron microscopy). Furthermore, it was found that isothermal transformation at 750 °C for different soaking times produced a typical microstructure. Also, the amount of graphite increased with increasing isothermal heat treatment time. Heat treatment leading to supersaturation of iron with carbon was described and some of the consequences of the supersaturation were

presented. Finally, the formation of the thermodynamically stable state of the graphite taken from the supersaturated solid solution was discussed. (Journal of Materials Sciences and Technology 2009 Vol. 25 (02): 164-168)

SCC of X70 and Its Deteriorated Microstructure in Simulated Acid Soil Environment

Zhiyong Liu, Guoli Zhai, Xiaogang Li and Cuiwei Du

In order to study the stress corrosion cracking (SCC) of X70 pipeline steel and its weld joint in acid soil environment of southeast of China, two simulating methods were used here. The one was to obtain the bad microstructures in heat affected zone by annealing at 1300°C for 10 min and air cooling to room temperature, the other was to get a series of simulating solutions of the acid soil environment. SCC susceptibilities of X70 pipeline steels before and after being normalized in the simulated solutions were studied by slow strain rate test (SSRT) and microstructural observation of fracture areas. Potentiodynamic polarization curves were used to study the electrochemical behaviour of different microstructures. SCC does occur to both the as-received material and normalized microstructure after heat treatment as the polarization potential decreased. Hydrogen embrittlement (HE) is indicated occurring to all tested materials at -850 mV (*vs* SCE) and -1200 mV (*vs* SCE). The SCC mechanisms are different within varying potential range. Anodic dissolution is the key cause as polarization potential higher than null current potential, and HE will play a more important role as polarization potential lower than the null current potential. (Journal of Materials Sciences and Technology 2009 Vol. 25 (02): 169-174)

Behavior of AISI 316L Steel Subjected to Uniaxial State of Stress at Elevated Temperatures

Josip Brnic, Jitai Niu, Marko Canadija, Goran Turkalj and Domagoj Lanc

This paper presents an experimental investigation on an AISI 316L stainless steel regarding mechanical properties and short uniaxial creep tests at elevated temperatures. The short time creep tests were carried out under different but constant stresses. The obtained data of ultimate tensile strength, yield strength, creep curves and effects of elevated temperatures on mechanical properties were presented. For a selected rheological model, material parameters were obtained. As a justification, such rheological model is implemented in the finite element procedure for an uniaxially stressed specimen in selected environmental conditions. (Journal of Materials Sciences and Technology 2009 Vol. 25 (02): 175-180)

Tensile and Impact Properties of Shielded Metal Arc Welded AISI 409M Ferritic Stainless Steel Joints

K. Shanmugam, A.K. Lakshminarayanan and V. Balasubramanian

The present study is concerned with the effect of filler metals such as austenitic stainless steel, ferritic stainless steel and duplex stainless steel on tensile and impact properties of the ferritic stainless steel conforming to AISI 409M grade. Rolled plates of 4 mm thickness were used as the base material for preparing single pass butt welded joints. Tensile and impact properties, microhardness, microstructure and fracture surface morphology of the joints fabricated by austenitic stainless steel, ferritic stainless steel and duplex stainless steel filler metals were evaluated and the results were reported. From this investigation, it is found that the joints fabricated by duplex stainless steel filler metal showed higher tensile strength and hardness compared to the joints fabricated by austenitic and ferritic stainless steel filler metals. Joints fabricated by austenitic stainless steel filler metal exhibited higher ductility and impact toughness compared with the joints fabricated by ferritic stainless steel and duplex stainless steel filler metals. (Journal of Materials Sciences and Technology 2009 Vol. 25 (02): 181-186)

Corrosion and Fatigue Testing of Microsized 304 Stainless Steel Beams Fabricated by Femtosecond Laser

Qiang Zhang, Xingpeng Guo, Nengli Dai and Peixiang Lu

The 304 stainless steel (SS) microcantilever specimens with dimensions of $30\text{ }\mu\text{m}\times 30\text{ }\mu\text{m}\times 50\text{ }\mu\text{m}$ (thickness $\times$ width $\times$ length) were fabricated by femtosecond (fs) laser. The microsized cantilevers of good quality with structure and dimensions according commendably with that of the designed cantilever were obtained. The result shows that fs laser micromachining is a promising method for directly fabricating metallic microcomponents. Corrosion and fatigue properties of microsized specimens were carried out on the microsized 304 SS cantilever beams by a newly developed fatigue testing machine. The results show that the microsized 304 SS specimens appear to have an improved resistance towards localized corrosion compared to ordinary-sized 304 SS specimens after the static corrosion testing. The testing result shows that the presence of corrosive solution reduces the fatigue lifetime of the 304 SS specimen by a factor of 10-100. The maximum bending loads measured by fatigue testing machine decrease rapidly at the terminal

stage of environment assisted fatigue testing. Corrosion fracture first occurred at the range of notch with a higher tensile bending stress, and exhibited clear evidence of trans-columnar fracture detected by SEM (scanning electron microscopy). (Journal of Materials Sciences and Technology 2009 Vol. 25 (02): 187-193)

Boundary Element Method (BEM) Analysis for Galvanic Corrosion of Hot Dip Galvanized Steel Immersed in Seawater

Xiao Tang, Yuzhi Zhang, Meng Liu and Yan Li

A numerical analysis of galvanic corrosion of hot-dip galvanized steel immersed in seawater was presented. The analysis was based on the boundary element methods (BEMs) coupled with Newton-Raphson iterative technique to treat the nonlinear boundary conditions, which were determined by the experimental polarization curves. Results showed that galvanic current density concentrates on the boundary of steel substrate and zinc coating, and the sacrificial protection of zinc coating to steel substrate results in overprotection of steel cathode. Not only oxygen reduction but also hydrogen reduction could occur as cathode reactions, which probably led up to the adsorption and absorption of hydrogen atoms. Flat galvanized steel tensile sample shows a brittle behavior similar to hydrogen embrittlement according to the SSRT (show strain rate test) in seawater. (Journal of Materials Sciences and Technology 2009 Vol. 25 (02): 194-198)

Cementite Decomposition in Spherical Graphite Iron by Electropulsing

Qingchun Li, Guowei Chang and Qijie Zhai

The influence of electropulsing on cementite decomposition in the spherical graphite iron has been studied. The results indicated that the cementite was decomposed in a short time by high current density electropulsing. With increasing electropulsing time, the *in situ* nucleation of graphite in cementite was accompanied with the quick decomposition of cementite. The dislocation accumulation adjacent to the cementite and the quick diffusion of carbon atom by electropulsing were main reasons for the quick decomposition of cementite. The *in situ* nucleation of graphite in the cementite resulted from the dislocation climbing crossing the cementite lamellae. (Journal of Materials Sciences and Technology 2009 Vol. 25 (02): 199-202)

Effect of Reaction Layers on the Residual Stress of the Brazed TiC Cermets/Steel Joints

Lixia Zhang and Jicai Feng

For the first time, considering the effect of reaction layers, numerical simulation calculation of residual stress on brazed TiC cermets/steel joint was studied by finite element method (FEM). The calculation results show that, when the joint is brazed at 1123 K for 300 s (low brazing parameters), the maximum shear stress value occurs on (Cu, Ni) layer near TiC cermets, which is 92.16 MPa as the temperature is 300 K. When the joint is brazed at 1273 K for 900 s (high brazing parameters), the maximum shear stress value occurs on (Cu, Ni)+(Fe, Ni) layer, which is 39.18 MPa as the temperature is 300 K. The fracture sites of the joints obtained from numerical simulation calculation accord with experimental results. (Journal of Materials Sciences and Technology 2009 Vol. 25 (02): 203-207)

Structure and Thermal Parameters of Ni₂₀Pd₈₀ Alloy

S. Ahmad, A.B. Ziya, A. Aziz and Z.I. Zafar

The structure and thermal parameters of Ni₂₀Pd₈₀ alloy were studied by X-ray diffraction (XRD). The diffraction experiments performed in the temperature range of 308-1100 K revealed that the alloy formed a face centered cubic (fcc) A1-type structure. The temperature dependence of the lattice parameters was investigated by using the Bragg line displacement method showing that the lattice parameter increases with the increase of temperature. The mean linear thermal expansion (MLTE(%)), coefficient of thermal expansion (CTE, α), the characteristic Debye temperature (θ_D) and mean square amplitudes of vibration were determined from XRD data. The value of Debye temperature was found to be 253 K. It was found that temperature factor was independent of the static displacements. (Journal of Materials Sciences and Technology 2009 Vol. 25 (02): 208-210)

Intrinsic Strengthening of Coherent Twin Boundaries in Copper

Yanfen Luo, Yuchen Wang, Yanbo Wang, Yuanming Wang and Manling Sui

Molecular dynamics (MD) simulations were applied to simulate the deformation process of copper with different density of parallel coherent twin boundaries (TBs). It is shown that the strength of perfect copper crystal enhances with increasing coherent TB density. Based on the local hydrostatic pressure analysis, we found that stress concentrations are more likely to form in the interior of the

crystal rather than around the TBs. Since the dislocation nucleation is suppressed in the vicinity of the coherent TBs and each TB plane hinders dislocations from propagating, the coherent TBs can be regarded as an intrinsic strengthening phase relative to perfect crystal. (Journal of Materials Sciences and Technology 2009 Vol. 25 (02): 211-214)

A Comparative Study of Elastic Constants of NiTi and NiAl Alloys from First-Principle Calculations

Jianmin Lu, Qingmiao Hu and Rui Yang

To investigate the origin of the strong dependence of martensitic transformation temperature on composition, the elastic properties of high temperature B2 phases of both NiTi and NiAl were calculated by a first-principle method, the exact-muffin orbital method within coherent potential approximation. In the composition range of 50-56 at. pct Ni of NiTi and 60-70 at. pct Ni of NiAl in which martensitic transformation occurs, non-basal-plane shear modulus c_{44} increases with increasing Ni content, while basal-plane shear modulus c' decreases. In the above composition ranges however the transformation temperature of NiAl increases with increasing Ni content while that of NiTi decreases from experimental observation. The softening of c' is experimentally observed only in NiAl, and the decrease of c' with increasing Ni content is responsible for the increase of transformation temperature. The result of the present work demonstrates that, besides c' , c_{44} also influences the martensitic transformation of NiTi and plays quite important a role. (Journal of Materials Sciences and Technology 2009 Vol. 25 (02): 215-218)

Texture Evolution in Heavily Cold-Rolled FeCo-2V Alloy during Annealing

Jiangning Deng, Yanling Yang, Yandong Wang, Jingeng CHEN and Rulin Peng

The recrystallization texture evolution in heavily cold-rolled (93%) FeCo-2V alloy with annealing temperature and time was investigated by X-ray diffraction and electron backscatter diffraction. It was found that the orientation density of α -fiber texture component fluctuates with increasing annealing temperature and time. The transmission electron microscopy images show that abundant precipitates appear inside the recrystallized grains and around the grain boundaries. The amount and size of the precipitates also vary with annealing temperature and time. The enhancement of the α -fiber coincides well with the increase of number density of fine precipitates, indicating that the fine precipitates facilitate the development of

α -fiber. The annealing texture evolution observed in the FeCo alloy could be attributed to the facilitating effect of the precipitates on the development of α -fiber and the ordering process. (Journal of Materials Sciences and Technology 2009 Vol. 25 (02): 219-224)

Influence of Al Content on the Atmospheric Corrosion Behaviour of Magnesium-Aluminum Alloys

Ruiling Jia, Chuanwei Yan and Fuhui Wang

The influence of Al content on the Mg-Al alloys corrosion performance during sodium chloride induced atmospheric corrosion has been studied. It was found that the corrosion rate of three Mg-Al alloys was accelerated with increasing Al content. The poor corrosion resistance was attributed to the galvanic coupling between the α phase and eutectic phase or β phase and the formation of porous corrosion products. (Journal of Materials Sciences and Technology 2009 Vol. 25 (02): 225-229)

Aging Strengthening in Rapidly Solidified Cu-Cr-Sn- Zn Alloy

Juanhua Su, Fengzhang Ren, Baohong Tian, Pin Liu and Qiming Dong

It is known that the strength of alloys can be successfully improved by rapid solidification. The paper presents a process where Cu-Cr-Sn-Zn lead frame alloy is produced by rapid solidification and aging. The microcrystalline structure of rapidly solidified Cu-Cr-Sn-Zn alloy is smaller grain structure examined by optical metallography. The effects of aging processes on the microstructure and properties of the lead frame alloy were investigated. Aged at 500°C for 15 min the fine coherent precipitates Cr distribute in Cu matrix observed by transmission electron microscopy and the properties of hardness and electrical conductivity properties can reach 178HV and 61%IACS, respectively. (Journal of Materials Sciences and Technology 2009 Vol. 25 (02): 230-232)

La-doped Copper Nitride Films Prepared by Reactive Magnetron Sputtering

Xingoao Li, Jianping Yang, Anyou Zuo, Zuobin Yuan, Zuli Liu and Kailun Yao

Copper nitride film (Cu_3N) and La-doped copper nitride films ($\text{La}_x\text{Cu}_3\text{N}$) were prepared on glass substrates by reactive magnetron sputtering of a pure Cu and a pure La targets under N_2 atmosphere. The results show that La-free film was

composed of Cu_3N crystallites with anti- ReO_3 structure with (111) texture. The formation of the $\text{La}_x\text{Cu}_3\text{N}$ films is affected strongly by La, and the peak intensity of the preferred crystalline [111]-orientation decreases with increasing the concentration of La. High concentration of La may prevent the formation of the Cu_3N from crystallization. Compared with the Cu_3N films, the resistivity of the $\text{La}_x\text{Cu}_3\text{N}$ films have been decreased. (Journal of Materials Sciences and Technology 2009 Vol. 25 (02): 233-236)

Pyrite Films Grown by Sulfurizing Precursive Iron of Different Crystallizing Status

Liuyi Huang, Yanhui Liu and Liang Meng

Precursive iron films with different grain sizes were prepared by magnetron sputtering on substrates heated at different temperatures. The iron films were sulfurized at 673 K for 20 h to form pyrite films. The structural and electrical characters were determined. High substrate temperatures produce large crystallites in the precursive iron films. The pyrite films are composed of a surface layer with coarse columnar grains and a bottom layer with fine equiaxed grains. With the increase of iron grain scale, the carrier concentration decreases and the carrier mobility increases. The electrical resistivity of the pyrite films increases to a maximum in the precursive iron films with increasing the grain size to about 39 nm. Sufficient formation and growth of iron grains result in improved crystallinity and high continuity of the pyrite films. The crystal defect density, transformation stress level and atom diffusion behavior are responsible for the characteristics of the electrical properties dependent on the crystallinity and continuity of the pyrite films or the crystallizing status of the precursive iron films. (Journal of Materials Sciences and Technology 2009 Vol. 25 (02): 237-241)

Composition and Morphology of Electrodeposited CuInSe_2 Precursor Films

Fangyang Liu, Zhian Zhang, Yanqing Lai, Jie Li and Yexiang Liu

CuInSe_2 (CIS) precursor films have been prepared by electrodeposition in aqueous solution. The electrodeposited films were characterized by X-ray diffraction (XRD), scanning electron microscopy (SEM) and energy dispersive X-ray spectroscopy (EDS) for structural, morphological and componential properties. The influence of deposition potential and Na-citrate concentration on composition and morphology of electrodeposited films was studied in detail. It is

found that the film morphology is strongly influenced by deposition potential and Na-citrate concentration. Films with large and homogenous grain size and ratio of Cu/In approaching 1 were obtained at deposition potentials of -0.7 and -0.75 V vs the saturated calomel electrode (SCE) and Na-citrate concentration of 500 mmol/L. Chalcopyrite phase CuInSe_2 is contained in precursor films that have poor crystallinity. (Journal of Materials Sciences and Technology 2009 Vol. 25 (02): 242-246)

Electrical and Mechanical Properties of PMMA/nano-ATO Composites

Wei Pan, Huiqin Zhang and Yan Chen

Conducting nanocomposites of poly (methyl methacrylate) (PMMA) and antimony doped tin oxide (ATO) were prepared by solution blending. The influences of ATO content on the electrical conductivity, thermal stability, and mechanical properties of the nanocomposites were investigated. A homogeneous dispersion of silane coupling agent modified ATO was achieved in PMMA matrix as evidenced by scanning electron microscopy. The resultant PMMA/silane-ATO nanocomposites were electrically conductive with significant conductivity enhancement at 4 wt pct. It was found that the composition at 4 wt pct ATO gave the higher tensile strength. Furthermore, it gave the largest elongation at break value among all the compositions. Thermal stability of the nanocomposites was remarkably enhanced by the incorporation of silane-ATO. (Journal of Materials Sciences and Technology 2009 Vol. 25 (02): 247-250)

Influence of Thermal Shock on the Mechanical Behavior of Si-SiC Coated Carbon/Carbon Composites

Qiangang Fu, Hejun Li, Yongjie Wang, Kezhi Li and Lu Wei

Si-SiC coating was prepared on the surface of carbon/carbon (C/C) composites by a two-step technique of pack cementation, and the influences of thermal shock between 1773 K and room temperature in air on the mechanical property and fracture behavior of the coated C/C were studied. The results show that, after thermal shock between 1773 K and room temperature for 5, 10 and 15 times, the flexural strength of coated composites increases by 4.29%, 15.00% and 24.20%, respectively. The toughness of the coated C/C enhances gradually during the thermal shock test. The improvement of the mechanical property after the thermal

shock test is primarily caused by the weakening of the fiber-matrix interface and the reduction of residual thermal stresses by thermal shock. (Journal of Materials Sciences and Technology 2009 Vol. 25 (02): 251-253)

Preparation of $\text{Gd}_2\text{O}_2\text{S}:\text{Pr}$ Scintillation Ceramics by Pressureless Reaction Sintering Method

Jingbao Lian, Xudong Sun, Tie Gao, Qiang Li, Xiaodong Li and Zhigang LIU

Fabrication of $\text{Gd}_2\text{O}_2\text{S}:\text{Pr}$ scintillation ceramics by pressureless reaction sintering was investigated. The $2\text{Gd}_2\text{O}_3 \cdot 3\text{y}(\text{Gd}, \text{Pr})2(\text{SO}_4)_3 \cdot m\text{H}_2\text{O}$ precursor was made by hydrothermal reaction using commercially available Gd_2O_3 , Pr_6O_{11} and H_2SO_4 as the starting materials. Then single phase $\text{Gd}_2\text{O}_2\text{SO}_4:\text{Pr}$ powder was obtained by calcining the precursor at 750°C for 2 h. The $\text{Gd}_2\text{O}_2\text{SO}_4:\text{Pr}$ powder compacts can be sintered to single phase $\text{Gd}_2\text{O}_2\text{S}:\text{Pr}$ ceramics with a relative density of 99% and mean grain size of $30\text{ }\mu\text{m}$ at 1750°C for 2 h in flowing hydrogen atmosphere. Densification and microstructural development of the $\text{Gd}_2\text{O}_2\text{S}:\text{Pr}$ ceramics were examined. Luminescence spectra of the $\text{Gd}_2\text{O}_2\text{S}:\text{Pr}$ ceramic under 309 nm UV excitation and X-ray excitation show a green emission at 511 nm as the most prominent peak, which corresponds to the $^3\text{P}_0\text{-}^3\text{H}_4$ transition of Pr^{3+} ions. (Journal of Materials Sciences and Technology 2009 Vol. 25 (02): 254-258)

Synthesis and Growth Mechanism of Carbon Filaments by Chemical Vapor Deposition without Catalyst

Shuhe Liu, Feng Li and Shuo Bai

Carbon filaments with diameter from several to hundreds micrometers were synthesized by chemical vapor deposition of methane without catalyst. The morphology, microstructure and mechanical properties of the carbon filament were investigated by scanning electronic microscopy, optical microscopy, X-ray diffraction and mechanical testing. The results show that the carbon filament is inverted cone shape and grows up along the gas flow direction. The stem of it is formed of annular carbon layers arranged in a tree ring structure while the head is made up of concentric layers. The tensile strength of the carbon filament is increased after graphitization for the restructuring and growing large of graphene. The growth mechanism of carbon filament was proposed according to the results of two series of experiments with different deposition time and intermittent deposition cycles. (Journal of Materials Sciences and Technology 2009 Vol. 25 (02): 259-263)

Influence of the Compacts Homogeneity on the Incidence of Cracks during Thermal Debinding in Ceramic Injection Molding

Xianfeng Yang, Zhipeng Xie and Yong Huang

During thermal debinding in ceramic injection molding, the inhomogeneity of green body is a key origin of cracks. In this study, the impact of low molecular weight binders on the homogeneity of the green body was investigated. Incidence of cracks during thermal debinding indicated that the volume ratio of wax to stearic acid should be out of high viscosity and incompletely wetting region. In these two formulation regions, typical inhomogeneous microstructures were observed. By mercury intrusion method, it was shown that pore size distribution of the debinded compacts was determined by thermal degradation of low molecular weight binders. A particle-rich region model was established to predict the nucleation of cracks caused by solid loading fluctuation. The criterion of cracks nucleation was that local capillary force from solid loading fluctuation was larger than the suction force from the surroundings. (Journal of Materials Sciences and Technology 2009 Vol. 25 (02): 264-268)

Co-firing of LNT/Ag Multilayer Sheets Prepared by Aqueous Tape Casting

Shaochun Li, Qilong Zhang and Hui Yang

Multilayer ceramic sheets composed of $\text{Li}_{1.075}\text{Nb}_{0.625}\text{Ti}_{0.45}\text{O}_3$ (LNT) layers and silver metal layers were fabricated by aqueous tape-casting method. LNT green tape was prepared using PVA (polyvinyl alcohol) as binder and ethylene glycol as plasticizer. The influence of the slurry composition on the rheological properties of the slurries and the properties of the resultant green tapes were studied. The slurry exhibited a typical shear thinning behavior. The increase in the PVA content increased the tensile strength of the tapes. The slip compositions with 5 wt pct PVA produced green tapes with satisfactory tensile strength. Ethylene glycol additions enhanced the flexibility of the green tapes but also produced a decrease in the tensile strength. Silver inner-electrode was pasted on LNT green tapes and the sheets were stacked, pressed and sintered at 900°C for 2 h. SEM (scanning electron microscopy) micrographs showed that the multilayer sheets were fully dense with fairly uniform microstructure and no reaction was observed between LNT and silver layers. (Journal of Materials Sciences and Technology 2009 Vol. 25 (02): 269-272)

Preparation of Semisolid A356 Alloy Feedstock Cast *via* a Pipe Consisting of Partial Inclined and Partial Vertical Sections

Xiaorong Yang and Weimin Mao

In the present work, the microstructures of A356 feedstock cast via a pipe consisting of partial inclined and partial vertical sections were investigated. The experimental results indicate that semisolid feedstock with ideal microstructures can be obtained at higher temperatures 645°C and above by the proposed process, and the solid shell inside the pipe can be avoided at the optimum pouring temperature. Thus the process is attractive for industrial applications. The slanted angle of inclined section has an influence on the optimum pouring temperature. That is, the bigger the slanted angle, the higher the optimum pouring temperature, but accordingly, the greater the possibility of solid shell occurring inside the pipe. Therefore, small slanted angle should be considered first on the premise of ensuring a certain nucleation. The formation of semisolid feedstock is owed to the coactions of wall nucleation and stirring resulting from fluid flow. The inclined section greatly affects nucleation, and the vertical section has an important effect on both nucleation and generating stirring. (Journal of Materials Sciences and Technology 2009 Vol. 25 (02): 273-276)

Investigation of Micro Formability of Bulk Amorphous Alloy in the Supercooled Liquid State Based on Fluid Flow and Finite Element Analysis

M. Cheng and S.H. Zhang

Research results on the viscous flow deformation behavior of bulk amorphous alloy in different systems are reviewed. The material exhibits an ideal Newtonian fluid at a high temperature. Analytical solution of lamellar fluid flow behavior is used to discuss the viscous flow behavior of the bulk amorphous alloy in the supercooled liquid state. A material model, which describes such deformation behavior of $\text{Mg}_{60}\text{Cu}_{30}\text{Y}_{10}$ amorphous alloy, is introduced into the finite element method of microforming process. Surface feature size was investigated and found not sensitive to the micro formability. Bulk amorphous alloy may possibly be applied to micro-electro-mechanical-systems (MEMS) fabrication. (Journal of Materials Sciences and Technology 2009 Vol. 25 (02): 277-280)

Parametric Analysis of Tensile Properties of Bimodal Al Alloys by Finite Element Method

W.L. Zhang, S. Li and S.R. Nutt

An axisymmetrical unit cell model was used to represent a bimodal Al alloy that was composed of both nano-grained (NG) and coarse-grained (CG) aluminum. Effects of microstructural and materials parameters on tensile properties of bimodal Al alloy were investigated by finite element method (FEM). The parameters analyzed included aspect ratios of CG Al and the unit cell, volume fraction of CG Al (VFCG), and yield strength and strain hardening exponent of CG Al. Aspect ratios of CG Al and the unit cell have no significant influence on tensile stress-strain response of the bimodal Al alloy. This phenomenon derives from the similarity in elastic modulus and coefficient of thermal expansion between CG Al and NG Al. Conversely, tensile properties of bimodal Al alloy are extremely sensitive to VFCG, yield strength and strain hardening exponent of CG Al. Specifically, as VFCG increases, both yield strength and ultimate tensile strength (UTS) of the bimodal Al alloy decreases, while uniform strain of bimodal Al alloy increases. In addition, an increase in yield strength of CG Al results in an increase in both yield stress and UTS of bimodal Al alloy and a decrease in uniform strain of bimodal Al alloy. The lower capability in lowering the increase of stress concentration in NG Al due to a higher yield strength of CG Al causes the lower uniform strain of the bimodal Al alloy. When strain hardening exponent of CG Al increases, 0.2% yield stress, UTS, and uniform strain of the bimodal Al alloy increases. This can be attributed to the increased work-hardening ability of CG Al with a higher strain hardening exponent. (Journal of Materials Sciences and Technology 2009 Vol. 25 (02): 281-288)

Challenges in Atomic-Scale Characterization of High-k Dielectrics and Metal Gate Electrodes for Advanced CMOS Gate Stacks

Xinhua Zhu, Jian-min Zhu, Aidong Li, Zhiguo Liu and Naiben Ming

The decreasing feature sizes in complementary metal-oxide semiconductor (CMOS) transistor technology will require the replacement of SiO₂ with gate dielectrics that have a high dielectric constant (high- k) because as the SiO₂ gate thickness is reduced below 1.4 nm, electron tunnelling effects and high leakage currents occur in SiO₂, which present serious obstacles to future device reliability. In recent years significant progress has been made on the screening and selection

of high- k gate dielectrics, understanding their physical properties, and their integration into CMOS technology. Now the family of hafnium oxide-based materials has emerged as the leading candidate for high- k gate dielectrics due to their excellent physical properties. It is also realized that the high- k oxides must be implemented in conjunction with metal gate electrodes to get sufficient potential for CMOS continue scaling. In the advanced nanoscale Si-based CMOS devices, the composition and thickness of interfacial layers in the gate stacks determine the critical performance of devices. To build up a full atomic-scale understanding of high- k gate stacks, including their ultimate electrical properties, a thorough atomic-scale physical analysis of these ultrathin gate stacks are highly required. High-resolution microscopic and spectroscopic methods are central in facilitating high- k gate dielectrics to be integrated in CMOS devices and to continue scaling. In this review, we summarize the strengths and capabilities of several high-resolution electron, ion, and photon-based techniques currently used to characterize the high- k gate dielectrics at atomic scale. Particularly, we review the enormous progresses on characterizing interface behavior and structural evolution in the high- k gate dielectrics by high-resolution transmission electron microscopy (HRTEM), and the related techniques based on scanning transmission electron microscopy (STEM), including high-angle annular dark-field (HAADF) imaging (also known as Z-contrast imaging), electron energy-loss spectroscopy (EELS), and energy dispersive X-ray spectroscopy (EDS). This review is organized into five sections. In the first section, we briefly introduce the working principles of each technique and outline their key features. And then we critically review the advances on microstructural characterization of high- k gate dielectrics at atomic scale by electron microscopy, citing some recent results reported on high. (Journal of Materials Sciences and Technology 2009 Vol. 25 (03): 289-313)

Electrical Properties of Li-doped P-type ZnO Ceramics

A.H. Salama and F.F. Hammad

Li-doped p-type ZnO ceramics were prepared by conventional methods according to the chemical formula $\text{Zn}_{1-x}\text{Li}_x\text{O}$ where $x=0.5, 1.0, 1.5$ and 2.0 mole fraction, respectively. The crystal structures of the prepared samples were studied by X-ray diffraction analysis. The dielectric properties (including dielectric constant ϵ' and dielectric loss ϵ'') and dc-electrical conductivity [$\sigma(\Omega^{-1}\cdot\text{cm}^{-1})$] were investigated. The dielectric constant ϵ' was sharply decreased at the low frequency range and independent on frequency at high frequency range. Otherwise, the dielectric loss ϵ'' varied with frequency and showed absorption peak located from 200 Hz to 4 kHz and moved to higher frequency as the concentration of Li^+

doped increased. It was found that dc-electrical conductivity $\log^{3/4}$ varied from -9 to -5 and the energy gap width were calculated by using Arrhenius equation. The p-type conductivity of Li-doped ZnO may be attributed to the formation of a LiZn-Li_i donor complex, which is limited by reducing the amount of Li_i . (Journal of Materials Sciences and Technology 2009 Vol. 25 (03): 314-318)

Fabrication and Characterization of FeNiCr Matrix-TiC Composite for Polishing CVD Diamond Film

Yuan Zewei, Zhuji Jin, Xingwei Ma and Boxian Dong

Dynamic friction polishing (DFP) is one of the most promising methods appropriate for polishing CVD diamond film with high efficiency and low cost. By this method CVD diamond film is polished through being simply pressed against a metal disc rotating at a high speed utilizing the thermochemical reaction occurring as a result of dynamic friction between them in the atmosphere. However, the relatively soft materials such as stainless steel, cast iron and nickel alloy widely used for polishing CVD diamond film are easy to wear and adhere to diamond film surface, which may further lead to low efficiency and poor polishing quality. In this paper, FeNiCr matrix-TiC composite used as grinding wheel for polishing CVD diamond film was obtained by combination of mechanical alloying (MA) and spark plasma sintering (SPS). The process of ball milling, composition, density, hardness, high-temperature oxidation resistance and wear resistance of the sintered piece were analyzed. The results show that TiC was introduced in MA-SPS process and had good combination with FeNiCr matrix and even distribution in the matrix. The density of composite can be improved by mechanical alloying. The FeNiCr matrix-TiC composite obtained at 1273 K was found to be superior to at 1173 K sintering in hardness, high-temperature oxidation resistance and wearability. These properties are more favorable than SUS_{304} for the preparation of high-performance grinding wheel for polishing CVD diamond film. (Journal of Materials Sciences and Technology 2009 Vol. 25 (03): 319-324)

Effect of Elastic Modulus on Biomechanical Properties of Lumbar Interbody Fusion Cage

Yue Zhu, Fusheng Li, Shujun Li, Yulin Hao and Rui Yang

This work focuses on the influence of elastic modulus on biomechanical properties of lumbar interbody fusion cages by selecting two titanium alloys with different elastic modulus. They were made by a new β type alloy with chemical composition

of Ti-24Nb-4Zr-7.6Sn having low Young's modulus ~ 50 GPa and by a conventional biomedical alloy Ti-6Al-4V having Young's modulus ~ 110 GPa. The results showed that the designed cages with low modulus (LMC) and high modulus (HMC) can keep identical compression load ~ 9.8 kN and endure fatigue cycles higher than 5×10^6 without functional or mechanical failure under 2.0 kN axial compression. The anti-subsidence ability of both group cages were examined by axial compression of thoracic spine specimens ($T_9 \sim T_{10}$) dissected freshly from the calf with averaged age of 6 months. The results showed that the LMC has better anti-subsidence ability than the HMC ($p < 0.05$). The above results suggest that the cage with low elastic modulus has great potential for clinical applications. (Journal of Materials Sciences and Technology 2009 Vol. 25 (03): 325-328)

Effect of Reactivity of Quick Lime on the Properties of Hydrated Lime Sorbent for SO₂ Removal

H.G. Shin, H. Kim, Y.N. Kim and H.S. Lee

The hydration of quick lime and the sulfation of hydrated lime were carried out for verification of relationship between the reactivity of quick lime and the properties of hydrated lime as a sorbent. The effect of reactivity of quick lime was investigated with the change of calcination temperature and time. Results obtained showed that the temperature rise during the hydration of quick limes varied from 31 to 69°C with the variation of calcination temperature and time. The specific surface area and the sulfation ability of hydrated lime prepared by hydration of quick lime showed a proportional relationship with the reactivity of quick lime. The hydrated lime which was prepared by hydration of quick lime calcined at 1100°C had the highest reactivity and showed 41.53 m²/g of the specific surface area, 0.16 cm³/g of the pore volume and 87% of the removal efficiency for SO₂ removal. (Journal of Materials Sciences and Technology 2009 Vol. 25 (03): 329-332)

Influence of Carrier Gas on Analysis of MgO Powders by Laser Ablation Inductively Coupled Plasma Mass Spectrometry

J.S. Lee, Y.S. Lee, C.J. Park, H.S. Lee and D.S. Lee

Laser ablation inductively coupled plasma mass spectrometry (LA-ICP-MS) has been widely adopted for the direct multi-elemental analysis with high sensitivity. Especially analysis of fine ceramics by LA-ICP-MS without time-consuming sample decomposition process has been one of the most expecting application field. Small additive elements in MgO powders were analyzed by LA-ICP-MS.

For precise and accurate analysis influence of carrier gas (Ar or He) was presented by the signal intensities of ICP-MS, relative standard deviation of signal intensities and ablated particle size distribution. Ablated particles were collected and analyzed by scanning electron microscopy (SEM) to investigate the particle size distribution, and the ablated sample surface was examined by camscope. In He gas atmosphere, the signal was more stable than in Ar gas atmosphere. The signal intensity was higher in Ar than in He. Examination of ablated particles and sample surface reveals that more particles were generated in Ar atmosphere and the distribution of particle size was larger. (Journal of Materials Sciences and Technology 2009 Vol. 25 (03): 333-335)

Microstructure of Epitaxial $\text{La}_{0.7}\text{Ca}_{0.3}\text{MnO}_3$ Thin Films Deposited by Direct Current Magnetron Sputtering on LaAlO_3 Substrate

Mingguang Wang and Hengqiang Ye

Transmission electron microscopy (TEM) and high resolution electron microscopy (HREM) have been used to study the microstructural properties of $\text{La}_{0.7}\text{Ca}_{0.3}\text{MnO}_3$ films on (001) LaAlO_3 substrates prepared by direct current magnetron sputtering technique. The as-grown thin films with different thickness are perfectly coherent with the substrates. The film suffers a tetragonal deformation in the area near the interface between the film and the substrate. With increasing thickness, the film is partially relaxed. It was found that $\text{La}_{0.7}\text{Ca}_{0.3}\text{MnO}_3$ films consist of two types of oriented domains described as: (1) $(110)_f$ $[001]_f \parallel (001)_s [100]_s$ and $(1\bar{1}0)_f$ $[001]_f \parallel (001)_s [100]_s$ and (2) $(110)_f$ $[001]_f \parallel (001)_s [010]_s$ and $(1\bar{1}0)_f$ $[001]_f \parallel (001)_s [010]_s$. Upon annealing, the film is relaxed by the formation of misfit dislocations. Other than misfit dislocations, two types of threading dislocations with Burgers vector of $\langle 100 \rangle$ and $\langle 110 \rangle$ were also identified. (Journal of Materials Sciences and Technology 2009 Vol. 25 (03): 336-340)

Weibull Probability Model for Fracture Strength of Aluminium (1101)-Alumina Particle Reinforced Metal Matrix Composite

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In recent times, conventional materials are replaced by metal matrix composites (MMCs) due to their high specific strength and modulus. Strength reliability, one of the key factors restricting wider use of composite materials in various

applications, is commonly characterized by Weibull strength distribution function. In the present work, statistical analysis of the strength data of 15% volume alumina particle (mean size 15 μm) reinforced in aluminum alloy (1101 grade alloy) fabricated by stir casting method was carried out using Weibull probability model. Twelve tension tests were performed according to ASTM B577 standards and the test data, the corresponding Weibull distribution was obtained. Finally the reliability of the composite behavior in terms of its fracture strength was presented to ensure the reliability of composites for suitable applications. An important implication of the present study is that the Weibull distribution describes the experimentally measured strength data more appropriately. (Journal of Materials Sciences and Technology 2009 Vol. 25 (03): 341-343)

Si-Al-Ir Oxidation Resistant Coating for Carbon/Carbon Composites by Slurry Dipping

Min Huang, Kezhi Li, Hejun Li, Qianggang Fu and Yu Wang

A Si-Al-Ir oxidation resistant coating was prepared for SiC coated carbon/carbon composites by slurry dipping. The phase composition, microstructure and oxidation resistance of the as-prepared Si-Al-Ir coating were studied by XRD (X-ray diffraction), SEM (scanning electron microscopy), and isothermal oxidation test at 1773 K in air, respectively. The surface of the as-prepared Si-Al-Ir coating was dense and the thickness was approximately 100 μm . Its anti-oxidation property was superior to that of the inner SiC coating. The weight loss of SiC/Si-Al-Ir coated carbon/carbon composites was less than 5 wt. pct after oxidation at 1773 K in air for 79 h. The local oxidation defects in the coating may result in the failure of the SiC/Si-Al-Ir coating. (Journal of Materials Sciences and Technology 2009 Vol. 25 (03): 344-346)

An Investigation on Hall-Petch Relationship in Electrodeposited Nanocrystalline Cu-Ni-P Alloys

Haiqing Sun and Yinong Shi

Nanocrystalline Cu-Ni-P alloys with average grain sizes of 7, 10 and 24 nm were synthesized by means of electrodeposition. The grain size dependences of tensile strength and hardness of the nanocrystalline Cu alloys were investigated. The breakdown of Hall-Petch relation was exhibited in both tensile strength and hardness. (Journal of Materials Sciences and Technology 2009 Vol. 25 (03): 347-350)

Effect of Y Addition on Microstructure and Mechanical Properties of Friction Stir Welded ZK60 Alloy

G.M. Xie, Z.Y. Ma and L. Geng

6 mm thick ZK60 and ZK60-Y alloy plates were successfully friction stir welded (FSW) at a tool rotation rate of 1200 r/min and a traverse speed of 100 mm/min. FSW resulted in the dissolution of MgZn_2 particles in the ZK60 and the breakup and dispersion of W-phase ($\text{Mg}_3\text{Zn}_3\text{Y}_2$) particles in the ZK60-Y alloy, thereby leading to a decrease in the hardness of the nugget zone (NZ) for the ZK60 alloy and an increase in the hardness of the NZ for the ZK60-Y alloy, respectively. While two FSW joints exhibited similar joint efficiency (87%{89% of ultimate tensile strengths of the parent materials), the yield strength of the FSW ZK60-Y joint was substantially higher than that of the FSW ZK60 joint. The fracture occurred in the NZ and the heat affected zone for the ZK60 and ZK60-Y joints, respectively, which were consistent with the lowest hardness distribution of the welded joints. (Journal of Materials Sciences and Technology 2009 Vol. 25 (03): 351-355)

Microstructure and Mechanical Properties of Mg-3Al-1Zn-xRE Alloys

Wei Qiu, Enhou Han and Lu Liu

In this work, the influence of element RE on the microstructures and mechanical properties of the hot extruded Mg-3Al-1Zn-xRE alloys (with element RE content of 0.05, 0.1 and 0.2 wt pct) has been investigated and compared. It was found that RE can bring about precipitations phase that is identified as $\text{Al}_{11}\text{RE}_3$ by X-ray diffraction and transmission electron microscopy (TEM). The grain sizes would not be refined after adding RE element. $\text{Al}_{11}\text{RE}_3$ phase would increase strength and decrease the ductility. The addition of RE element affects dynamic recrystallized process and even reorientation of recrystallized grains. The results showed that the mechanical properties of AZ31+RE alloy are affected by combination of Al atoms, Mn atoms, $\text{Al}_{11}\text{RE}_3$ phase and grains orientation. It is important to consider the ratio of RE/Al when designing new Mg-Al-RE alloys. (Journal of Materials Sciences and Technology 2009 Vol. 25 (03): 356-360)

Formation of Re-containing Carbides in a Second Generation Directionally Solidified Ni Base Superalloy

Tan Zhao, Dong Wang, Jian Zhang, Guang Chen and Langhong Lou

The precipitates at grain boundary in a directionally solidified Ni base superalloy after heat treatment, aging at 975°C, and creep rupture test have been characterized. Besides the primary MC carbides and fine particles of μ phase, the Re-containing $M_{23}C_6$ was observed. The precipitation kinetics revealed that the formation of $M_{23}C_6$ was associated with the dissolution of μ phase and MC carbides. TEM image shows that the continuous precipitation of $M_{23}C_6$ particles effectively hinders the dislocation movement and strengthens the grain boundaries. The high strength of the alloy suggests that $M_{23}C_6$ carbides are beneficial to the properties although Re as an important matrix strengthening element was consumed. (Journal of Materials Sciences and Technology 2009 Vol. 25 (03): 361-364)

Textural Evolution of AZ31B Magnesium Alloy Sheets Undergoing Repeated Unidirectional Bending at Room Temperature

Guangsheng Huang, Wei Xu, Guangjie Huang, Hongcheng Li and Bo Song

Magnesium alloy sheets have poor plasticity and formability due to their strong (0002) basal textural component. In this paper, a new method, repeated unidirectional bending (RUB), was applied to improve the texture of AZ31B magnesium alloy sheets so as to enhance their stamping properties. The samples undergoing RUB were annealed at different temperatures. The mechanical properties, formability, textural components and microstructure of the samples before and after RUB were characterized and compared. It was found that the basal textural component was reduced dramatically by RUB and some other textural components appeared. The formability of the sheets was greatly enhanced after RUB, after which their percentage elongation and Erichsen value were considerably increased. The relationship between the improvement of the formability of the AZ31B magnesium alloy sheets and their textural evolution is discussed. (Journal of Materials Sciences and Technology 2009 Vol. 25 (03): 365-369)