**NANOMATERIALS**


The formation of the interface during the deposition of iron on polycrystalline aluminium has been studied at room temperature using AES, factor analysis, XPS and angle-resolved XPS. The information obtained by these techniques is consistent with a two-stage mechanism for iron growth: a first stage characterized by the formation of FeAl islands 10 ML thick up to a coverage of theta/sub FeAl/=0.65, followed by the formation of metallic iron islands of constant thickness 8 ML that grow over the intermetallic islands formed previously. Also, the simultaneous lateral growth of both kinds of islands is observed during the second stage. (26 References).


The nanostructure and magnetic properties of composite CoPt:C films at room temperature were investigated as a function of annealing temperature, carbon concentration, and film thickness. CoPt:C films with a variety of carbon concentrations were fabricated by cosputtering Co, Pt, and C onto water-cooled Si(100) substrates followed by annealing. X-ray diffraction and transmission electron microscopy analyses indicate that nanocrystallites of face-centered-tetragonal (fct) CoPt phase, which has a uniaxial magnetocrystalline anisotropy constant of about 5*10/sup 7/ erg/cm/sup 3/, can be formed in carbon matrix when the annealing temperature is higher than 600 degrees C. The grain sizes of the fct CoPt crystallites are about 10 nm and the coercivities can be as high as 12 kOe. Higher annealing temperature and lower carbon concentration generally lead to larger grain sizes and perhaps more complete formation of the fct CoPt phase, and therefore higher coercivities. The coercivity is insensitive to the film thickness until the thickness is smaller than the CoPt grain size, when the coercivity starts to decrease with film thickness. The magnetic activation volumes are typically around 1*10/sup 18/ cm/sup 3/. The nanostructure and the associated magnetic properties of these composite CoPt:C films are promising as potential media for extremely high-density recording. (16 References).


Three-layer structures of thick (>5 mu m) films of nanosized titanium dioxide, zirconium dioxide, and carbon have been screen-printed on a semi-production level for use in photosensitized photovoltaic devices. The films have been characterized using scanning electron microscopy (SEM), X-ray diffraction (XRD), and nitrogen adsorption/desorption. The rheology of the screen-printing pastes has been measured, and qualitatively matched to the quality of the resultant film. Three titanium dioxide candidates were evaluated for performance. At low light levels (<300 lux, i.e., typical indoor light levels), photosensitized photovoltaic modules made from these screen-printed structures exhibited equal or superior performance to a commercially available amorphous silicon module. (28 References).


We have developed a local probe technique in order to investigate single quantum confined nanostructures. In our mu-photoluminescence (mu-PL) setup the laser probe is focused on the sample surface by a long working distance microscope objective and the photoluminescence of the sample is collected in backscattering mode by the same objective. Both the optical laser pump and the collected signal are fiber optic coupled, in order to increase the flexibility of the system. A wide range of temperatures (25 K-300 K) is achieved by means of a closed cycle He-cryostat, modified in order to damp mechanical vibrations and to avoid spatial resolution losses. Photoluminescence maps are provided by a motorized X-Y translation stage, that scans the microscope objective over the sample surface. The overall resolution of the system is of about 600 nm, including the laser focused spot size (lambda =514 nm), the cryostat vibrations and the motorized stage resolution. A few selected mu-PL experiments on quantum wires (QWR) and quantum dots (QD) are presented and discussed. (6 References).


We report a study of the thermodynamic properties of indium clusters on a SiN (x) surface during the early stages of thin film growth using a sensitive nanocalorimetry technique. The measurements reveal the presence of
abnormal discontinuities in the heat of melting below 100 degrees C. These discontinuities, for which temperature separation corresponds to a spatial periodicity equal to the thickness of an indium monolayer, are found to be related to the atomic "magic numbers," i.e., the number of atoms necessary to form a complete shell of atoms at particle surface.


We report the first experimental observation of nonclassical morphological equilibration of a corrugated crystalline surface. Periodic rippled structures with wavelengths of 290-550 nm were made on Si(001) by sputter rippling and then annealed at 650-750 degrees C. In contrast to the classical exponential decay with time, the ripple amplitude A(\lambda)(t) followed an inverse linear decay, A(\lambda)(t) = A(\lambda)(0)/(1+k(\lambda)t), agreeing with a prediction of Ozdemir and Zangwill. We measure the activation energy for surface relaxation to be 1.6+/-.2 eV, consistent with the fundamental energies of creation and migration on Si(001).


We have investigated Pb(Zr/sub X/Ti/sub 1-X)/sub 3/ films on Pt/SiO/sub 2//Si substrates formed by pulsed laser deposition (PLD) and subsequent rapid thermal annealing (RTA) under various growth conditions. X-ray diffraction analysis revealed that preferentially (100)-oriented perovskite PZT films with trigonal structure were formed after RTA from as-deposited films which had consisted of small grains with pyrochlore structure. The degree of (100)-orientation of the PZT film increased with the oxygen partial pressure during PLD. The capacitors made from these films showed higher remnant polarization than those from randomly oriented films. (4 References).


We describe a new class of nanoscale structured metals wherein the effects of quantum confinement are combined with dispersive metallic electronic states to induce modifications to the fundamental low-energy microscopic properties of a three-dimensional metal: the density of states, the distribution of Fermi velocities, and the collective electronic response.


In this study, a novel sol-gel synthesis procedure using HMDS as surface modifier and acetone as solvent without solvent exchange step for the preparation of SiO/sub 2/ xerogel thin film is proposed. The concentration of modifying agent as HMDS was also optimized for the high porous SiO/sub 2/ xerogel film. The microstructural and electrical properties of SiO/sub 2/ xerogel films for applications as intermetal dielectrics according to the new method were studied. (5 References).


The current research is aimed at producing kilogramme quantities of Al nanomaterials, derived from mechanically alloyed (MA) and atomised precursors. Although MA was a time intensive process, it gave bulk quantities of fine powders featuring a smaller grain size (>or=14 nm) than found in atomised material. Consolidation was achieved at 350 degrees C by HIP/forge and extrusion methods but produced grain growth; despite this growth, MAed materials remained >40% harder than atomised specimens, which was attributed to a fine grain structure (<160 nm diameter) in the former material. (5 References).


A method is described for depositing onto medical instruments highly biocompatible and bioactive surface coatings that can promote and stabilize cell attachment. The coatings were made by first depositing thin films of materials, such as diamond-like carbon, or metals, including tantalum, tungsten, platinum, gold, iridium, palladium, and brass. These surfaces were further altered to either promote or inhibit cell growth and spreading by an additional overcoat of biological materials, including the extracellular matrix proteins, laminin, fibronecin, and collagen IV. The deposition technique used a metal or carbon plasma, and the important properties of film adhesion, hardness, density, and smoothness are tailored by control of the ion bombardment energy. The films are translucent enough to permit high resolution light microscopy for rapid and detailed examination of tissue response. These bioactive substrates have been tested on primary central nervous system neurons, and the growth response is excellent. Equally successful have been our attempts to anchor neurons, without associated proliferation of non-neuronal cells, using coatings of poly-d-lysine. The method and the materials could have important ramifications in a number of areas of research and biotechnology, for example for chronic implantation...
of microelectrode arrays in the cerebral cortex for neuroprosthetic and neural monitoring application and for research on the human central nervous system. Possible application in nonneuronal fields, such as for coronary artery stents and pacemaker electrodes, also are discussed.


Carbon nanomaterials were prepared by chemical vapor deposition (CVD) and hot-filament CVD (HF-CVD) methods. The substrates were silicon (100) and copper plates on which catalytic metal or metal-oxide thin films were coated by means of the cathodic arc deposition technique. Ethylene gas was used as a precursor. HF-CVD with a filament temperature of 1,000 degrees C yielded a larger amount of carbon deposit at a lower furnace temperature of 600 degrees C. High-resolution microscopic observation revealed a variety of amorphous carbon nanomaterials, such as frost columns, coral beads, microcoils, nanocoils, and amorphous nanotubes. (19 References).


Ferroelectric lead zirconate titanate (PZT) thin films have been investigated for a variety of applications such as piezoelectric, pyroelectric, electro-optic and ferroelectric devices. However, the degradation of ferroelectric properties induced by inter-diffusion or poor crystalline quality at the film-substrate interface leaves a problem to be solved still now. Many authors have tried to resolve these obstacles by using buffer layers or seed layers for low temperature process. Especially, sol-gel method is so attractive for its uniform control of composition and ease of layer-by-layer deposition. In this work, ultrathin PZT layer containing various contents of excess Pb was used as an interfacial layer to investigate the role of excess Pb on the formation of interfacial region between PZT film and Pt bottom electrode. (2 References).


Multilayered face-centered cubic Co/Pt and CoNi/Pt nanostructures grown on a Pt(111) or Cu(111) single-crystal substrate by electrodeposition under potential control, respectively, exhibit a remanent perpendicular magnetization and a large magnetic coercivity which depend on the multilayer growth mechanism. The role of the codeposition of Ni as an inhibitor for the nucleus growth process as well as for the dissolution of Co during the Pt deposition is of great importance for the occurrence of the multilayered nanostructure. (8 References).


We describe the optical, radiative, and laser-plasma physics of a new type of nanostructured surface especially promising as a very high absorption target for high-peak-power subpicosecond laser-matter interaction. This oriented-nanowire material, irradiated by 1 ps pulses at intensities up to 10(17) W cm(-2), produces picosecond soft x-ray pulses 50x more efficiently than do solid targets. We compare this to &quot;smoke&quot; or metallic clusters, and solid nanogroove-grating surfaces; the &quot;metal-velvet&quot; targets combine the high yield of smoke targets with the brief emission of grating surfaces.


The electromechanical behaviour of the (1-x)PMN-xPT (x&lt;or=0.1) bulk ceramics is studied in particular through the sensitivity of its nanostructure to the electric field, stress and temperature. At first, it was shown by deviation to the Curie-Weiss type behaviour that a local polarisation appears at a T/sub d/ temperature (around 200 degrees C) i.e. largely above the temperature of the maximum of permittivity (T/sub m/, respectively -13 degrees C and +36 degrees C for x=0 and 0.1), which is consistent with the nucleation of polar clusters within a paraelectric matrix. Moreover, the dielectric relaxation observed for 0.9Pb1/3Nb/sub 2/3O/sub 3//sub 3/-0.1PbTiO/sub 3/-0.12MgO, in a large frequency range (100 Hz-15 MHz), and corresponding to a multi-Debye process with broadening of the relaxation time distribution as the temperature decreases, has been correlated to a nucleation and growth mechanism of polar clusters with decreasing temperature below T/sub d/ which might result from the successive transitions of different compositions. This hypothesis has been confirmed by nanoanalysis thanks to EDXS and EELS techniques: in fact large fluctuations of the local composition around the nominal one have been revealed, lead and magnesium deficient areas enriched in niobium coexisting with nanodomains (around 10 nm) strongly enriched in lead and slightly in magnesium. Consequently, due to such heterogeneities, the material remains

The results of recent experimental X-ray structural studies of nanostructured metals processed by severe plastic deformation are presented. Characteristic features of X-ray diffraction patterns of these materials are described. Among them there are changed relative intensity, significant broadening, a shift in position of centroids, change in X-ray peak profile shape and elevated diffusion background of X-rays scattering. The interpretation of the obtained results using X-ray patterns multiple computer simulation was made. The obtained results are used for developing a structural model of nanomaterials. (18 References).


The relationship between nanostructure and properties in polysiloxane layered silicate nanocomposites is presented. Solvent uptake (swelling) in dispersed nanocomposites was dramatically decreased as compared to conventional composites, though intercalated nanocomposites and immiscible hybrids exhibited more conventional behavior. The swelling behavior is correlated to the amount of bound polymer (bound rubber) in the nanocomposites. Thermal analysis of the bound polymer chains showed an increase and broadening of the glass-transition temperature and loss of the crystallization transition. Both modulus and solvent uptake could be related to the amount of bound polymer formed in the system. (40 References).


FePt/B$_2$/sub 2/O/sub 3/ multilayers were deposited by magnetron sputtering onto 7059 glass substrates. By annealing the as-deposited films at 550 degrees C, nanostructured FePt:B$_2$/sub 2/O/sub 3/ films consisting of FePt grains with L1/sub 0/ structure, embedded in a glassy B$_2$/sub 2/O/sub 3/ matrix, were obtained. The c axes of the FePt grains can be made to align with the film normal direction, which results in a perpendicular anisotropy constant of 3.5*10/7 erg/cc. The films remain layered structures after annealing when the B$_2$/sub 2/O/sub 3/ layer thickness exceeds 16 AA. The nanostructure of the films was investigated by transmission electron microscopy. The coercivities and the average grain sizes of the films are dependent on the B$_2$/sub 2/O/sub 3/ concentrations, with coercivities varying from 4 to 12 kOe, while average grain sizes vary from 4 to 17 nm. Strong perpendicular anisotropy, adjustable coercivity, and fine grain size suggest this nanocomposite system might have significant potential as recording media at extremely high areal density. (2 References).


Unique properties of nanomaterials are elaborated. The structure, classification and characterization are summarized. The applications of nanomaterials are introduced. (9 References).


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We present the principles of an approach for the synthesis of nanostructured films based on the deposition of supersonic cluster beams. Using a novel pulsed microplasma cluster source, intense and stable cluster beams can be produced allowing film deposition rates up to several nm/min over large surfaces. By separation effects typical of supersonic beams it is possible to select different mass distributions of neutral clusters in the beam, allowing the deposition of thin films with controlled nanostructure. Carbon thin films with interesting functional and structural properties have been deposited by using different precursor clusters. (19 References).


The results of recent experimental X-ray structural studies of nanostructured metals processed by severe plastic deformation are presented. Characteristic features of X-ray diffraction patterns of these materials are described. Among them there are changed relative intensity, significant broadening, a shift in position of centroids, change in X-ray peak profile shape and elevated diffusion background of X-rays scattering. The interpretation of the obtained results using X-ray patterns multiple computer simulation was made. The obtained results are used for developing a structural model of nanomaterials. (18 References).


Nanoscale architecture was used to control energy transfer in semiconducting polymers embedded in the channels of oriented, hexagonal nanoporous silica. Polarized femtosecond spectroscopies show that excitations migrate unidirectionally from aggregated, randomly oriented polymer segments outside the pores to isolated, aligned polymer chains within the pores. Energy migration along the conjugated polymer backbone occurred more slowly than Forster energy transfer between polymer chains. The different intrachain and interchain energy
transfer time scales explain the behavior of conjugated polymers in a range of solution environments. The results provide insights for optimizing nanostructured materials for use in optoelectronic devices.


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The nanostructure of C<sub>60</sub> photopolymers has been investigated using in situ Fourier-transform infrared spectroscopy (FTIR), X-ray photoelectron spectroscopy (XPS), and scanning tunneling microscopy (STM). The FTIR and XPS studies revealed that the C<sub>60</sub> photopolymer has cross-linking via a 2+2 cycloaddition four-membered ring and formed a 2D rhombohedral structure when the polymerization was saturated. Using STM, we have successfully observed the direct real-space imaging of the C<sub>60</sub> dimers and trimers in a C<sub>60</sub>/monolayer supported on a clean semiconductor surface. (15 References).


Optically thin palladium films evaporated on different silicon-based substrates are investigated following exposure to different concentrations of hydrogen gas in air. Laser modulated reflectance off the palladium surface of silicon oxide, silicon nitride and polycrystalline silicon substrates is used to recover information regarding changes in optical properties of the samples due to the absorption of hydrogen. Simple index of refraction arguments are sufficient to explain the results. Structural changes of the palladium films have been investigated using atomic force microscopy before and after hydrogen exposure. An interesting nanostructure formation is evident in some of the samples, leading to a possible means of fabricating nanodevices. (7 References).


Yttria-stabilised zirconia powders and thick films with nanocrystalline structure have been obtained using an original hydrothermal route allowing the crystallisation at low temperatures. The microstructure evolution has been revealed using TDA and TG, RX diffraction and SEM. The mechanism of powder and film formation is proposed. (16 References).


The contact line tension of a three-phase system (solid-liquid-vapor) is determined from the liquid surface topography data obtained with scanning force microscopy. The data are analyzed in two completely complementary ways, one of which is based on the modified Young equation, the other on the effective interface potential derived from the profile of the liquid-vapor interface in the three-phase region. The two methods agree quite well for the systems investigated. Contact line tensions are in the range of 10(-11) to 10(-10) J/m, which is consistent with theory.


Utilizing coordination as a motif, the self-organization of six ditopic and four tritopic building blocks leads to the formation of nanoscale adamantanoid frameworks.


The microstructure and shape-memory properties of norbornyl-POSS hybrid copolymers having either cyclohexyl corner groups (CyPOSS) or cyclopentyl corner groups (CpPOSS) were investigated by transmission electron microscopy and thermomechanical analysis. Here, POSS refers to the polyhedral oligomeric silsesquioxane macromer. Samples containing 50 wt.% of POSS macromer have been mechanically drawn at temperatures above their glass transition temperatures, followed by rapid quenching in LN/sub 2/. Shape memory properties of such drawn samples were explored by measuring recovered strain while heating above the T/sub g/ using thermomechanical analysis. Incorporation of POSS comonomers within PN is found to slightly reduce the percentage recovery, while improving thermal stability significantly. Interestingly, the types of corner groups in the POSS macromer affect the shape memory behaviour, with the CyPOSS copolymer showing lower percentage recovery than the CpPOSS copolymer due to enhanced aggregation of CyPOSS macromers. (16 References).


Various three-dimensional structures were generated using the dielectric-breakdown model where parameter alpha in the model was switched from alpha /sub 1/=2 to alpha /sub 2/=0 at time tau /sub 1/ during the growth. A part of these structures, possibly realized as nanostructured materials, looks like a nebula, in which the volume of the extensions is controlled by tau /sub 1/. The spectral statistics of a quantum particle in these structures are analyzed, indicating the existence of an Anderson transition. An extended electron showing quantum chaos becomes localized as tau /sub 1/ increases. (34 References).


Codeposition of hydrocarbons is a severe problem during focused electron beam writing of pure metal nanostructures. When using organometallic precursors, a low metal content carbonaceous matrix embedding and separating numerous nanosized metal clusters is formed. In this work, we present a new and easy approach to obtain high purity gold lines: the use of inorganic PF/sub 3/AuCl as a precursor. Electrical resistivities as low as 22 mu Omega cm at 295 K (ten times the bulk Au value) were obtained. This is to our knowledge the best value for focused electron beam deposition obtained from the vapor phase so far. No special care was taken to prevent hydrocarbon contamination. The deposited nanostructure consists of gold grains varying in size and percolation with beam parameters. (17 References).


Multiphase nanocomposite coatings (3-20 mu m thick) consisting of nanocrystalline TiN, amorphous Si/sub 3/N/sub 4/-, and amorphous and nanocrystalline TiSi/sub 2/-, nc-TiN/a-Si/sub 3/N/sub 4/-, and nc-TiSi/sub 2/- were deposited on steel substrates by means of plasma CVD. The load-independent Vickers microhardness from 80 to >105 GPa was measured by the load-depth sensing technique for applied loads between 30 and 200 mN and verified by measuring the size of the remaining plastic indentation using SEM. The results of a complex analysis provide a consistent picture of the nature of the grain boundaries which determines the hardness in the whole range of silicon content between approximately 3 and 22 at.%. At a high discharge current density of >or=2.5 mA/cm/sup 2/ the a-Si/sub 3/N/sub 4/- forms the grain boundaries and the nanocomposites are superhard (40-50 GPa) as we reported earlier. At a lower current density of <or=1 mA/cm/sup 2/ a mixture of TiSi/sub 2/- and Si/sub 3/N/sub 4/- is formed. With increasing Si-content the amount of a-TiSi, in the grain boundaries of the TiN nanocrystals increases, and above 10 at.% of Si approximately 3 nm small TiSi/sub 2/- nanocrystals precipitate. The hardness depends critically and in a complex way on the Si/sub 3/N/sub 4/- content and the TiSi/sub 2/- ratio. The ultrahardness of >or=80 GPa is achieved when the surface of the TiN nanocrystals is covered with approximately one monolayer of Si/sub 3/N/sub 4/-, Under these conditions the ultrahardness of 80-100 GPa depends on the amount of a- and nc-TiSi/sub 2/-. (27 References).


In course of further development of our generic concept for the design of novel superhard nanocomposites we have recently developed new multi-phase ultrahard nanocomposite coatings with Vickers microhardness of 80 to 105 GPa which is in the range of natural diamond. The coatings show a high elastic recovery of up to 90% upon a relatively large indentation deformation. The hardness measured by the depth sensing technique agree with those calculated from the area of the remaining pseudoplastic deformation. The very high apparent fracture toughness is illustrated by the absence of any radial cracks upon indentation with a large load of 1 N into 10.3 mu m thick film. The unusual combination of high hardness, elastic recovery and apparent fracture toughness was attributed to the ample possibility of cracks deflection, meandering and termination during loading and cracks closure upon unloading. The suggested nanostructure of the coatings has been elucidated on a basis of a complex analysis by means XRD, EDX, ERD, XPS and HR TEM. (34 References).

Zeolites NaZSM-5 and NaY as hosts for producing nanoscale silver iodide guest were studied with the goal of investigating the optical properties of the prepared host-guest nanocomposite materials. The host-guest nanocomposite materials of NaY-AgI and (NaZSM-5)-AgI were prepared by a heat diffusion method. The nanocomposite materials prepared were characterized by X-ray diffraction (XRD), differential thermal analysis (DTA), X-ray photoelectric spectroscopy (XPS), and adsorption. The properties of the diffuse reflectance absorption spectra and the surface photovoltage spectra of the prepared nanocomposite materials were investigated. The quantum confinement effect of the channels of zeolites made the prepared host-guest nanocomposite materials show some interesting optical properties. This makes the investigated nanomaterials suitable for use as quantum electronic and optoelectric materials. (23 References).


Various properties of spinel iron oxide nanoparticles are reviewed in relation to the control of the particle size and the control of their dispersion in a variety of matrices. The deep knowledge of the different synthesis parameters and the interfacial oxide-solution characteristics allows to prepare a large variety of materials like calibrated nanoparticles and inorganic or hybrid nanocomposites. (19 References).


The large interest in nanostructures results from their numerous potential applications in various areas such as materials and biomedical sciences, electronics, optics, magnetism, energy storage, and electrochemistry. Ultrasmall building blocks have been found to exhibit a broad range of enhanced mechanical, optical, magnetic, and electronic properties compared to coarser-grained matter of the same chemical composition. In this paper various template techniques suitable for nanotechnology applications with emphasis on characterization of created arrays of tailored nanomaterials have been reviewed. These methods involve the fabrication of the desired material within the pores or channels of a nanoporous template. Track-etch membranes, porous alumina, and other nanoporous structures have been characterized as templates. They have been used to prepare nanometer-sized fibrils, rods, and tubules of conductive polymers, metals, semiconductors, carbons, and other solid matter. Electrochemical and electroless depositions, chemical polymerization, sol-gel deposition, and chemical vapour deposition have been presented as major template synthetic strategies. In particular, the template-based synthesis of carbon nanotubes has been demonstrated as this is the most promising class of new carbon-based materials for electronic and optic nanodevices as well as reinforcement nanocomposites. (141 References).


Osteoblast, fibroblast, and endothelial cell adhesion on nanophase (that is, materials with grain sizes less than 100 nm) alumina, titania, and hydroxyapatite (HA) was investigated using in vitro cellular models. Osteoblast adhesion was significantly (p < 0.01) greater after 4 h on nanophase alumina, titania, and HA than it was on conventional formulations of the same ceramics. In contrast, compared to conventional alumina, titania, and HA, after 4 h fibroblast adhesion was significantly (p < 0.01) less on nanophase ceramics. Examination of the underlying mechanism(s) of cell adhesion on nanophase ceramics revealed that these ceramics adsorbed significantly (p < 0.01) greater quantities of vitronectin, which, subsequently, may have contributed to the observed select enhanced adhesion of osteoblasts. Select enhanced osteoblast adhesion was independent of surface chemistry and material phase but was dependent on the surface topography (specifically on grain and pore size) of nanophase ceramics. The capability of synthesizing and processing nanomaterials with tailored (through, for example, specific grain and pore size) structures and topographies to control select subsequent cell functions provides the possibility of designing the novel proactive biomaterials (that is, materials that elicit specific, timely, and desirable responses from surrounding cells and tissues) necessary for improved implant efficacy. Copyright 2000 John Wiley & Sons, Inc.


Summary form only given. We have constructed a hybrid chemical/physical vapor deposition (CVD/PVD) tool by combining low-pressure high-density inductively coupled plasma with balanced magnetron sputtering. We show that such a hybrid deposition tool allows the independent control of energy and flux of ionic species bombarding the deposition surface. Using such a deposition tool, fully dense refractory ceramic thin films such as TiN can be deposited at ~100 K. The combination of CVD and PVD in such a deposition tool allows the deposition of
TiC/amorphous hydrocarbon (a-C:H) nanocomposite coatings with wide ranging TiC volume fractions. Microstructures of these ceramic/ceramic nanocomposites will be described. Our results demonstrate the utility of low-pressure high-density plasmas in synthesis of novel thin film nanomaterials. (3 References).


The magnetocaloric effect of superparamagnetic nanocomposites composed of iron-oxide or iron-nitride grains dispersed in a silver matrix was studied by evaluating the magnetic entropy change Delta S induced by demagnetization. The nanocomposites were synthesized by inert gas condensation technique and nitridation by heat treatment in an ammonia gas stream. Average sizes of the iron-containing grains were 10-35 nm. Magnetic phases in the materials were Fe/sub 3/O/sub 4/ or gamma Fe/sub 2/O/sub 3/ for the oxide-composites and gamma Fe/sub 4/N or epsilon Fe/sub 3/N for the nitride-composites. Values of the Delta S were obtained by applying a thermodynamic Maxwell's relation, (delta S/ delta H/ H= delta M/ delta T), to data set of magnetization M measured at various temperatures T. They clearly indicated significant enhancement due to the nanostructure as predicted. (7 References).


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Nanostructure polymer-ceramic composite with high dielectric constant (epsilon/sub tau/ ~90) has been developed for embedded capacitor application. This polymer-ceramic system consists of lead magnesium niobate-lead titanate (PMN-PT) ceramic particle and modified high-dielectric constant low-viscosity epoxy resin. In order to obtain precise prediction of effective dielectric constant of this composite, an empirical prediction model based on self-consistent theory is proposed. The electrical polarization mechanism and interaction between epoxy resin and ceramic filler has been studied. This model can establish the relevant constitutional parameters of polymer-ceramic composite materials such as particle shape, composition, and connectivity that determine the dielectric properties of the composite. This model is simpler, uses fewer parameters and its prediction compares better with experiment (error <10%). The precision and simplicity of the model can be exploited for predictions of the properties and design of nanostructure ferroelectric polymer-ceramic composites. The effective-medium theory (EMT) has been proved a good tool to predict effective properties of nanocomposites. (14 References).


Dynamic observation of the growth of Cu on clean and hydrogen-terminated Si(111) surfaces was carried out by using low energy electron microscopy (LEEM). On the clean surface, the two-dimensional "5*5" structure is formed, and the formation process of the "5*5" structure depends on the substrate temperature. Triangular islands are grown on the "5*5" structure after further deposition of Cu. On the other hand, the nanoscale islands are directly formed on the hydrogen-terminated surface below about 400 degrees C. Above about 400 degrees C, however, the Cu-induced desorption of hydrogen takes place, and the growth process becomes similar to that on the clean surface. (18 References).


The melting behavior of 0.1-10-nm-thick discontinuous indium films formed by evaporation on amorphous silicon nitride is investigated by an ultrasensitive thin-film scanning calorimetry technique. The films consist of ensembles of nanostructures for which the size dependence of the melting temperature and latent heat of fusion are determined. The relationship between the nanostructure radius and the corresponding melting point and latent heat is deduced solely from experimental results (i.e., with no assumed model) by comparing the calorimetric
measurements to the particle size distributions obtained by transmission electron microscopy. It is shown that the melting point of the investigated indium nanostructures decreases as much as 110 K for particles with a radius of 2 nm. The experimental results are discussed in terms of existing melting point depression models. Excellent agreement with the homogeneous melting model is observed. (39 References).