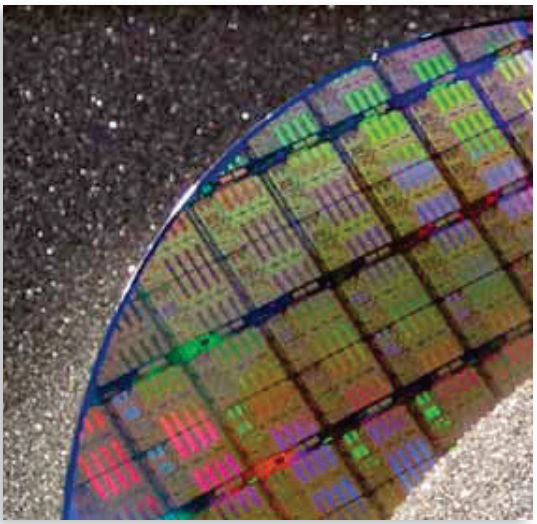
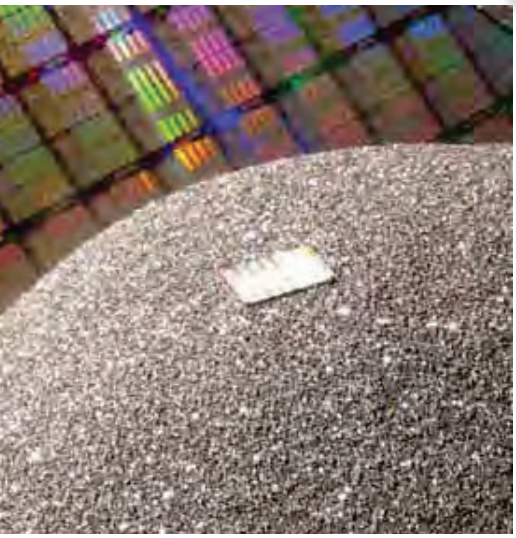
DoubleTree by Hilton Orlando
at Sea World® Orlando, FL
January 18-20, 2012

Electronic Materials and Applications 2012





MEETING GUIDE

Organized by
The American Ceramic Society and
The American Ceramic Society's Electronics Division and Basic Science Division

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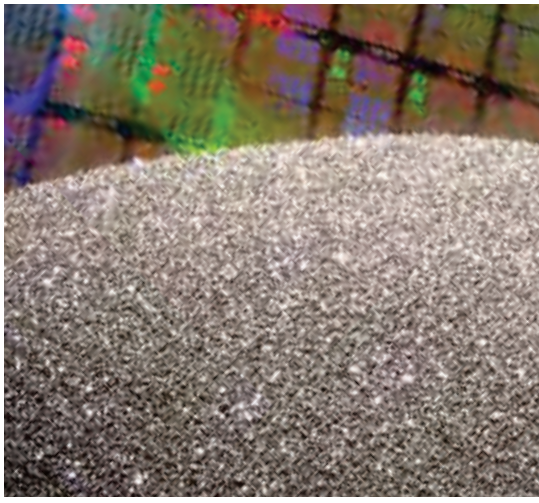

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pressure and flow rate. The resulting films were annealed in a rapid thermal processor in nitrogen at 900 °C for 5 min and analyzed using photoluminescence spectroscopy, X-ray diffraction and Hall effect measurements. The results obtained indicate that films deposited on sapphire heated in oxygen prior to deposition had greatly improved optical properties. Other optimum conditions were a deposition temperature of 300 oC, a pressure of 10 mTorr and a gas flow rate of 20 standard cubic centimeter per minute. This film had a luminescence peak at 3.347 eV with a full-width-half maximum (FWHM) value of 15 meV when measured at 10 K. The XRD 2θ-scans had peaks at about 34.5° with the best FWHM value of only 0.10°. Results from p-type doping currently being performed using these optimized growth conditions will be also presented.

2:00 PM

(EMA-S1-003-2012) Fibrous BaTiO3 Filler / PVDF Composite Sheet for Transducer Application

K. Fukata*, K. Kakimoto, Nagoya Institute of Technolohgy, Japan; H. Ogawa, Otsuka Chemical Co., Ltd, Japan

Piezoelectric ceramic filler / polymer composite sheet shows high bending flexibility in comparison to monolithic ceramics, hence it can be applied to transducer devices such as touch panel sensors and vibration energy harvesters. In this work, fibrous BaTiO3 / polyvinylidene fluoride (PVDF) composite sheets were fabricated for the first time, and their electric-field-induced strain curves and piezoelectric output voltages were measured. Fibrous BaTiO3 powder, fabricated by the molten salt method, was mixed with the ratio of 0~30 vol% in the PVDF solution dissolved in dimethylsulfoxide at 140 oC. The mixture was spin-coated to make thin film, then the stacked films were thermally pressed and extended toward an uniaxial direction by a hot rolling technique with a temperature kept at 90 oC. The extension ratio is 3 times and larger to form a piezoelectric β phase of PVDF. The measured electric-field-induced strain in the 31 direction was enhanced in the sheet having higher volume ratio of fibrous BaTiO3 powder, which was more obvious than the case of the reference specimens using spherical BaTiO3 powders. The effect of filler shape on the piezoelectric property in the PVDF matrix composite sheet was discussed.

2:15 PM

(EMA-S1-004-2012) Contribution of non-180° domain wall motion and lattice strain to the frequency dependence of the piezoelectric coefficient in ferroelectric ceramics

S. Banavara Seshadri*, A. D. Prewitt, University of Florida, USA; D. Damjanovic, Swiss Federal Institute of Technology - EPFL, Switzerland; A. J. Studer, ANSTO, Australia; J. L. Jones, University of Florida, USA

Thus far, all descriptions of the logarithmic frequency dependence of the macroscopic piezoelectric coefficient, d_{33}, have been phenomenological in nature. In this work the extent of the contribution of non-180° domain wall motion to the frequency dependence of the macroscopic d_{33} has been determined experimentally using time resolved, in-situ neutron diffraction measurements. Lattice strains and domain wall motion were measured as a function of frequency in a soft commercial PZT material. These results were then compared to macroscopic d_{33} measured as a function of frequency. It was found that both lattice strain and non-180° domain wall motion show a linear decrease with the logarithm of the frequency of applied field indicating that they contribute to the frequency dependence of macroscopic d_{33}. The magnitude of the contribution of non-180° domain wall motion and lattice strain to the macroscopic d_{33} was also quantitatively established.

2:30 PM

(EMA-S1-005-2012) Microstructure Fractal Analysis of Er Doped BaTiO3-ceramics

V. Mitic*, V. Paunovic, J. Purenovic, L. Kocic, Faculty of Electronic Engineering, Serbia; S. Jankovic, Faculty of Mathematics, Serbia; V. Pavlovic, Faculty of Agriculture, Serbia

In this paper the influence of Er2O3 on microstructure and dielectrical properties of BaTiO3-ceramics has been investigated. BaTiO3-ceramics doped with 0.01 up to 1 wt% of Er2O3 were prepared by conventional solid state procedure and sintered at 1320°C for four hours. Microstructural investigations were carried out by using scanning electron microscopy (JEOL-JSM 5300) equipped with EDS (QX 2000S) system. The new correlation between microstructure and dielectric properties of doped BaTiO3-ceramics based on fractal geometry and contact surface probability has been developed. Using the fractals and the grains contact surface statistics, a reconstruction of microstructure configurations, like grains shapes, or intergranular contacts has been successfully done. The presented results indicate that fractals analysis and statistics model of contact surfaces different shapes are very important for BaTiO3-ceramics microstructure and dielectric properties prognosis in function of intergranular and total impedances in higher level of circuit packaging integrations.

3:15 PM

(EMA-S1-006-2012) Atom Probe Tomography of Oxide Ceramics

R. Kirchhofer, D. R. Diercks, B. P. Gorman*, Colorado School of Mines, USA

Atom Probe Tomography (APT) has the unique ability to provide chemical composition information (chemical resolution <1 ppm) paired with high spatial resolution (~2 Å). This unique characterization technique enables quantitative determination of internal interfaces and nanostructures with unprecedented accuracy. Traditionally, field evaporation using pulsed electric fields has limited the applicability of APT to highly conductive materials. The introduction of a laser to assist the field evaporation has opened up the technique to ceramic materials; however, challenges arise from the effect of the laser on the specimen. Poor heat dissipation from the tip results in delayed evaporation that limit the mass resolving power and ultimately affect the compositional information. Significant loss of spatial resolution due to surface diffusion has also been observed at high laser powers. For these experiments a focused, low power laser (1-10 pJ/pulse) was used to assist in field emission of ions to avoid surface diffusion and ion clustering. Combining experimental modifications to the specimen geometry during sample preparation and revised laser pulsing strategies has improved the cation / oxygen stoichiometry and spatial resolution. Specific examples include ion conducting ceramics, transparent conducting oxides, dielectric and ferroelectric thin films, and grain boundary effects in conducting oxides.

3:30 PM

(EMA-S1-007-2012) Mechanically Activated BaTiO3 Microstructure Fractal Nature

V. Mitic*, Faculty of Electronic Engineering, Serbia; V. Pavlovic, Faculty of Mechanical Engineering, Serbia; L. Kocic, V. Paunovic, J. Purenovic, J. Nedin, Faculty of Electronic Engineering, Serbia; V. Pavlovic, Faculty of Agriculture, Serbia

Increasing demands on the quality of electronic ceramics requires a well-controlled correlation between particle morphology and processing conditions. Since mechanical activation is one of the methods for modification of physico-chemical properties of dispersed systems, in this study a correlation between the densification rate microstructure evolution and fractal nature of mechanically activated BaTiO3 has been analyzed. The high purity commercial BaTiO3 powder was mechanically activated in a planetary ball mill in a continual regime for 60 and 120 minutes. Sintering under non isothermal conditions was carried out up to 1380oC. The shrinkage behaviour of mechanically activated samples, has been analyzed by a

sensitive dilatometer. Densification rate as a function of relative density for different activation times has been calculated. Microstructure investigations of sintered samples were carried out, using a scanning electron microscope (SEM). The presented results enable establishing processing parameters that are indisensable for obtaining materials with advanced properties.

3:45 PM

(EMA-S1-008-2012) Intense cooperative upconversion emission in Yb/Er : TeO2-Li2O-WO3 oxyfluoride glass ceramics

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There has been a great deal of interest in cooperative upconversion of Yb3+ ions advantage over Tm3+ doped glass ceramics for blue emission in display technology . We have fabricated transparent glass- ceramics based on selected glass of (70-x)TeO2-16.5Li2O-13WO3-0.5 ErF3- xYbF3 (where x =1-3mol%) by melt quenching and subsequent heating at first crystallization temperature. The crystallinity of the glass ceramic has been examined by X-ray technique. Under 980nm diode laser excitation of 2mol% Yb3+ sample produced an intense blue at 487nm , very weak green at 525nm and 550nm ,and red at 650nm emission signals. This intense blue emission attributed through cooperative upconversion due to Yb3+ -Yb3+ clusters and LiErF4 crystalline phase precipitation. The red and green emissions are mainly attributed to energy transfer from Yb3+ions to Er3+ ions. The cooperative up conversion mechanism for the couple of Yb3+ ions is dominated over the excitated state absorption process at less than 0.5mol % of Er3+ content. The dependence of 487nm intensity versus laser power is equal to 1.75 confirm that two-photons contribute to blue cooperative upconversion.In addition, these oxyfluoride materials were robust, easy and flexible to process, and possible to be fabricated in the fiber form for device applications.

4:00 PM

(EMA-S1-009-2012) Analytical model for ion-implanted 4H silicon carbide metal-semiconductor field-effect transistors

S. Wang*, Northwest University, China

In order to design ion-implanted 4H-SiC MESFETs (Silicon Carbide Metal-Semiconductor Field-Effect Transistors), an analytical model is present. The implant depth profile is simulated using the Monte Carlo simulator TRIM. The calculation methods for the channel depth, the pinch-off voltage and the output current-voltage characteristics of ion-implanted 4H-SiC MESFETs are given. The effects of parameters such as the ions activation rate, the acceptor density of the epitaxial layer and temperature on the channel depth have been studied. The output current-voltage characteristics for the multiple ion-implanted 4H-SiC MESFETs designed and the drain current with the effect of temperature are given. The model can be used to give some helps to the designers of ion-implanted SiC MESFETs before the fabrication process.

S3: Symposium on Thin Film Integration and Processing Science

Complex Oxide Thin Film Synthesis

Room: Pacific
Session Chair: Christopher Shelton, NCSU

1:30 PM

(EMA-S3-015-2012) Advanced chemical solution deposition methods of complex electronic oxide films (Invited)

T. Schneller*, RWTH Aachen, Germany

Complex electronic oxide films offer a unique potential for applications in microelectronics, microsystems, and alternative energy devices. Thus there is an increasing interest in dielectric, ferroelectric, piezoelectric, and conducting ceramic films. Among the chemical deposition techniques for such oxides, chemical solution deposition (CSD) features high flexibility with regard to composition, materials, and substrates while maintaining cost efficiency. Besides the thermal processing conditions the precursor chemistry has a significant influence on the final film quality. The increased scientific knowledge obtained in recent years opened up further interesting application areas such as deposition on oxygen sensitive base metals for capacitors and coated super conductors or low temperature fabrication of proton conducting films for solid oxide fuel cells. This presentation will review the established aspects of CSD for high-permittivity, ferroelectric, and other complex electronic oxide films. Attention is given to precursors, solution chemistry, and process development with focus on the structural evolution of the precursor solution into the crystalline state and the impact of precursor chemistry and film fabrication conditions on the transformation process. Moreover a novel approach based on dispersions of microemulsion derived nanoparticles complements the traditional precursor methods.

2:00 PM

(EMA-S3-016-2012) Orientation Control in Pb(Zr0.52 Ti0.48)O3 Thin Films for Use in Multilayer Actuators

L. M. Sanchez*, D. Potrepka, Army Research Laboratory, USA; G. Fox, Fox Materials Consulting LLC, USA; I. Takeuchi, University of Maryland, USA; R. G. Polcawich, Army Research Laboratory, USA

Using (111) oriented Pt as the bottom electrode, (001) textured CSD PZT (52/48) thin films were processed using a PbTiO3 seed layer and a 2-Methoxyethanol based solution. Leveraging the texture optimization on single 500nm thick PZT thin films, the focus of this research was to analyze orientation control of the PZT films in multiple Pt/PZT/Pt layers for use in multilayer actuators (MLA). On the first sample, the PbTiO3 seed layer was only used on the first layer of PZT. Accordingly, a highly (001/(100) textured film is observed in the first Pt/PZT/Pt layer. However, this orientation declines by 6.9% and 10.3% in subsequent layers. In addition, both (110) and (111) orientations develop in the PZT layers. In the second sample, the PbTiO3 seed layer was used on top of each Pt layer. Orientation declines by 6.8% between layers 1 and 2, however no further decrease in orientation is observed in the other layers. The (110) portion is less prominent in the sample with the PT seed layer. The measurements on these films are encouraging for achieving high piezoelectric coefficient MLA's for use in tactical radios and mm-scale robotics. This presentation will cover the development of textured PZT in multilayers and will report on dielectric, ferroelectric, and piezoelectric response of multilayer PZT thin film capacitors and actuators.

2:15 PM

(EMA-S3-017-2012) Microstructual Evolution of Flux-Grown Barium Titanate Thin Films

M. J. Burch*, A. Moballegh, D. T. Harris, J. Maria, E. C. Dickey, North Carolina State University, USA

The role of the $BaO{\bullet}B_2O_3$ (BBO) fluxing agent on the microstructured evolution of pulsed-laser deposited (PLD) $BaTiO_3$ thin films was studied. Transmission electron microscopy (TEM) of both ex-situ and in-situ annealed samples was utilized to study the boron distribution in the films and the $BaTiO_3$ microstructure as a function of time and temperature. To facilitate these studies, thin films were directly deposited on TEM grids. A heating TEM holder was used to anneal the samples in order to observe the dynamics of crystallization and grain growth during annealing. The as-deposited films were found by diffraction to be highly disordered with no indication of long range order. The 5% BBO samples annealed at 900 °C were highly crystalline with grain size varying from 0.1 to 0.5 μm, whereas the thin films with no fluxing agent present had a grain size less than 0.1 μm and a higher porosity. The improved microstructure of the flux grown $BaTiO_3$ films lead to enhanced dielectric properties.