Ferroelectricity Newsletter

A quarterly update on what's happening in the field of ferroelectricity

Volume 4, Number 2 Spring 1996

MORE RESOURCES FOR YOUR RESEARCH ACTIVITIES

In the Winter issue we brought you a research report on novel oxide composites for phased array antennas from the Army Research Laboratory. Beginning on page 2, you will find another report by Louise and Somnath Sengupta and their colleagues, this time on **thick film fabrication of ferroelectric phase shifter materials**.

A major part of this issue is devoted to **new publications** pertaining to ferroelectrics and related materials. On page 6 we introduce the journal *Microelectronic Engineering*, on page 10, the book ***Microwave Dielectric Spectroscopy of Ferroelectrics and Related Materials*** by **Jonas P. Grigas**, and on pages 11 to 15, **new publications from the Materials Research Society**.

Slides about the distribution and other aspects of the ***Ferroelectricity Newsletter***, as shown at ISIF 96 in Tempe, Arizona, are on pages 8 and 9.

Figure 1 (page 8), **mailing list, destinations**, depicts the newsletter distribution in **countries other than the United States**, with 240 subscribers in Europe, 161 in East Asia, 100 in the Americas, 28 in South Asia, 27 in Australia, 5 in Southwest Asia, 3 in Southeast Asia, and 2 in Africa.

Figure 2 (page 8) gives us a picture of the **webpage Internet domains** of WWW users including the United States. In this case, the Americas comprise the biggest percentage, followed in almost equal proportions by "Unresolved" (which means that these webpage users have not yet registered their Internet protocol address--IP address--with their domain servers), East Asia, and Europe.

Figure 3 (page 9) shows **when the newsletter webpage was accessed most frequently**, whereas Figure 4 (page 9) shows **frequency of access with reference to time.** Keeping in mind the global time zones, the graph shows least activity at 10 pm, followed by 7 pm and 5 am Pacific Standard Time. How is that for trivia?

As a new feature, we will introduce **book reviews** in upcoming issues. Please contact us if you want to join the ever growing circle of contributors.

Rudolf Panholzer
Editor-in-Chief

IN THIS ISSUE

From the Editor 1
Papers
ISIF 96 2
Research
Thick film fabrication of ferroelectric phase shifter materials 2
Professional Journals
Microelectronic Engineering 6
Readership statistics 8
New Publications
Jonas Grigas, *Microwave dielectric spectroscopy* 10
New MRS publications 11
Upcoming Meetings
3rd Pacific Rim Conference 16
Short Course: Ferroelectrics and their applications 16
ISAF '96 18
Electroceramics V 19
Mailbox 19
Calendar of Events 20

Ferroelectricity Newsletter

Volume 4, Number 1
Spring 1996

The *Ferroelectricity Newsletter* is published quarterly by the Naval Postgraduate School, Space Systems Academic Group, Monterey, California, with the support of the Defense Advanced Research Projects Agency (DARPA) and the Office of Naval Research (ONR).

Prof. Rudolf Panholzer
Editor-in-Chief
e-mail: rpanholzer@nps.navy.mil

Dr. Hannah Liebmann
Managing Editor
500 Glenwood Circle, Suite 238
Monterey, CA 93940-4724, USA
phone: +(408) 649-5899
fax: +(408) 655-3734

© 1996 NPS Space Systems Acad. Group

ISIF 96 PAPERS

Plenary session

Challenges in ULSI technology
Y. Nishi

Challenges and opportunities for ferroelectric thin films: An ARPA perspective
J. Alexander

Integrated ferroelectrics as a strategic device
H. Takasu

Material and process technologies for high-density ferroelectric nonvolatile memories developed at NEC
Y. Miyasaka

Quantum jump and 'Kaizen' toward commercialization of ferroelectric ULSI memories
H. Esaki

Ferroelectrics in integrated circuit technology
J.A. Akimer

Applications and devices (nonvolatile memories)

Performance of $SrBi_2Ta_2O_9$ for low-voltage, nonvolatile memory applications
R.E. Jones et al

256bit CMOS nonvolatile memory using low fatigue/imprint PZT capacitors
J.T. Evans et al

A critical comparative review of $Pb(Zr_x,Ti_{1-x})O_3$and $SrBi_2Ta_2O_9$-based science and technology for nonvolatile ferroelectric memories
O. Auciello et al

--continued on page 3

RESEARCH

THICK FILM FABRICATION OF FERROELECTRIC PHASE SHIFTER MATERIALS

The article in the Winter '96 issue of the ***Ferroelectricity Newsletter*** from the Army Research Laboratory in Maryland discussed the fabrication of ferroelectric bulk composites and their electronic properties. The application is in the phased array antennas. The thickness limitation of the bulk materials, however, is around 3-4 mils, which can be used up to approximately 15 GHz. In order to increase the operating frequencies of the phase shifter, thick films were fabricated, using nonaqueous tape-casting. The tapes were electrically characterized and compared to bulk ceramics. Laminated stacks of high dielectric constant and low dielectric alternating layers were also fabricated.

EXPERIMENTS

The tapes of the barium strontium titanium oxide (BSTO) composites were cast onto Teflon-coated mylar sheets at a doctor blade setting of 20 mils. This resulted in green body thicknesses from 5-13 mils. The tapes were then removed from the mylar carriers. Single layer tapes were either fired at temperatures which had been previously determined by employing deflectometer, such as the Mitutoyo digimatic indicator and miniprocessor (Mitutoyo Corp., Paramus, NJ) or were screen-printed with a conductive ink and then fired. The laminated structure was accomplished by stacking 5 layers of alternating high and low dielectric constant tapes. The part was uniaxially pressed in a heated platen (65˚C) to a pressure of 1000 psi. This structure was sintered at 1500˚C and subsequently metallized with ink #E3309. Metallization of the tapes was accomplished by screening a guard ring pattern on one side of the green (unfired) tape and a ground plane on the other side. The ink used for this was product #E1162, 40 percent Au, 20 percent Pd, and 40 percent Pt (firing temperature of 1350˚C) obtained from Ferro Corporation, Electronic Materials Division, Santa Barbara, CA. Fired tapes (10, 20, 40, and 60 wt percent oxide III) were also screen printed with product #E3309 acquired from Ferro Corporation and subsequently fired at 850˚C.

Table 1 shows the densities which were obtained from He pycnometer measurements for the BSTO, BSTO / 10wt percent oxide III, BSTO / 20wt percent oxide III, BSTO / 40wt percent oxide III, BSTO / 60wt percent oxide III / oxide III and the laminated tape stack.

RESULTS AND DISCUSSION

Examination of the SEM of the tapes shows that ink 1 (Ferro #E1162 adheres well to the surface of these tapes since the sintering temperatures do not exceed the recommended firing temperature for the ink. As expected, ink 2 (Ferro #E8809) also adheres well to these surfaces. It has also been clear from the micrographs that the cofired ink is peeling back from the tape surfaces since the firing temperature is 1400˚C for tapes of these compositions. Ink 2, however, is adhering well to the tape surfaces. Analysis of the

-- continued on page 3

RESEARCH

THICK FILM FABRICATION OF FERROELECTRIC PHASE SHIFTER MATERIALS

-- continued from page 2

grain size of the tapes shows that the grain size is slightly reduced as oxide III content is increased. No formation of secondary phases was evident. This was also the case for the bulk ceramic materials.

Oxide III Content (wt%)	*Thickness (mils, microns)*	*Pycnometric Density (g/cc)*
0 wt%	4.4, 112.0	5.549
10 wt%	2.5, 64.3	5.413
20 wt%	3.6, 92.3	5.006
40 wt%	1.8, 45.4	4.420
60 wt%	2.7, 69.0	4.254
pure Oxide III	5.3, 133.7	3.584
Laminate	39.3, 991.0 7.8, 200.0	4.040

TABLE 1. Thicknesses and densities of BSTO/oxide III composite tapes and laminate

TAPES

Oxide III Content (wt %)	***Dielectric Constant***	***Loss Tangent***	***% Tunability***	***Electric Field (V/μm)***
0.0	3192.2	0.0056	43.52	2.00
10.0 (ink 1)	1390.2	0.0015	15.03	2.00
10.0 (ink 2)	1245.1	0.0024	11.40	2.00
20.0 (ink 1)	616.44	0.0012	15.45	2.00
20.0 (ink 2)	779.10	0.0049	14.30	2.00
40.0 (ink 1)	193.60	0.0012	16.50	2.10
40.0 (ink 2)	357.30	0.0041	14.00	2.00
60.0 (ink 1)	91.16	0.0008	10.41	2.00
60.0 (ink 2)	65.67	0.0183	11.70	2.00
100.0	2.81*	0.0621*		
LAMINATE	21.34	0.0086	14.48	2.00

*** Not fully sintered**

**** Tunability was measured perpendicular to laminate direction due to design considerations for antenna.**

TABLE 2. Electronic properties of BSTO (Ba = .60) and oxide III composite tapes, and laminated tape stack measured at 1KHz (ink 1 = #E1162, 1350˚C, ink 2 = #E3350, 850˚C)

-- continued on page 4

ISIF 96 PAPERS

-- continued from page 2

Bismuth based layered perovskite thin films as a charge storage material for low power nonvolatile GaAs memory applications
B.M. Melnick et al

Applications and devices (optical and pyroelectric)

Uncooled IR imaging
H. Beraton

Spatially resolved electrooptic measurements of $Pb(Zr,Ti)0_3$ thin films
M.B Sinclair et al

New optical effects in ferroelectric films
J.F. Scott and R.A. Sullivan

Crystal structure and optical properties of ion exchanged y ferroelectrics H_xLi_{1-x}, NbO_3, $H_xLi_{1-x}TaO_3$ and $Zn_{x/2}Li_{1-x}TaO_3$ for integrated optics
V.A. Fedorov and Y.N. Korkishko

Potassium tantalate niobate thin films for spaceborne pyroelectric detectors
H.B. Cherry et al

Design and properties of uncooled infrared sensors based on ferroelectric films
V.V. Chernokozhin et al

Properties of $PbTiO_3$ La-modified $PbTiO_3$ and $Pb(Zr, Ti)O_3$ ferroelectric thin films and their application to infrared sensors
W. Ren et al

Device integration issues and testing

Process integration technologies on half-micron, mega-bits ferroelectric memories
K. Kakiyama

-- continued on page 4

ISIF 96 PAPERS

-- continued from page 3

Process and properties of PVPb(Zr, Ti)O_3/Pt integrated ferroelectric capacitors
K. Torii et al

Analysis of the degradation of PZT and $SrBi_2Ta_2O_9$ thin films with a reductive process
T. Hase et al

Characterization of self-patterned $SrBi_2Ta_2O_9$ thin films from photosensitive solutions
H. Uchida et al

The superiority of Ru electrodes for gigabit DRAMs
N. Mikami et al

Plasma etch processing of advanced ferroelectric devices
A, Cofer et al

Integration technology of ferroelectric thin films and its applications to Si devices
E. Fujii et al

Capacitor test simulation of retention and imprint characteristics for ferroelectric memory operation
S.D. Traynor et al

Ferroelectric fatigue in perovskite oxides
W.L. Warren et al

The effects of ferroelectric capacitor testing methods on predicted imprint failure points
R.I. Suizu et al

High frequency testing methodology and investigation of the high frequency behavior of layered

-- continued on page 5

RESEARCH

THICK FILM FABRICATION OF FERROELECTRIC PHASE SHIFTER MATERIALS

-- continued from page 3

Electronic properties

The results for the electronic properties of the BSTO/oxide III tapes and laminated stack are shown in Table II. The dielectric constants and loss tangents of the tape-cast specimens, similar to the bulk composites, decrease with increase in oxide III content and vary less than 2 percent with frequency (from 1KHz-1MHz). The magnitude of the dielectric constants are very similar to those of the bulk ceramics except for the 20 wt percent and 40 wt percent tapes with the cofired electrodes (#E1162).

As shown in Fig. 1, the dielectric constants of the 20 wt percent and 40 wt percent tapes are less than those of the corresponding bulk ceramic composite samples. This may be due to the delamination of the electroding materials as discussed before.

Fig. 2 shows that the loss tangents of the tapes are also almost the same as those measured for the bulk ceramics. The percent tunability of the tapes as well as of the bulk material is around 15.00 percent with 2.00 V/µm at 10 wt percent oxide III and reduces to only around 12 percent for the 60 wt percent oxide III/BSTO composite. This trend was explained previously in the bulk ceramics by the position of the Curie temperatures and the size of the additive (oxide III). The addition of oxide III shifts the Curie temperature of the material to -30˚C (from 1wt percent to 50 wt percent oxide content) and to <-55˚C for >60wt percent oxide content. This accounts for the reduction in the loss tangent. The small size of the additive permits this tunability to be maintained up to 60 wt percent oxide III content.

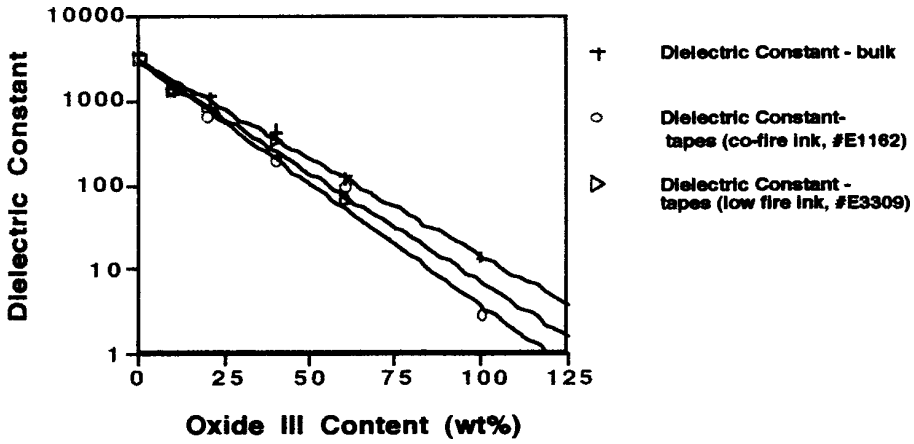


FIGURE 1. Semilog plot of dielectric constant versus oxide III content of the bulk ceramics and the tapes measured at 1 KHz (lines represent best fit of the data)

-- continued on page 5

RESEARCH

THICK FILM FABRICATION OF FERROELECTRIC PHASE SHIFTER MATERIALS

-- continued from page 4

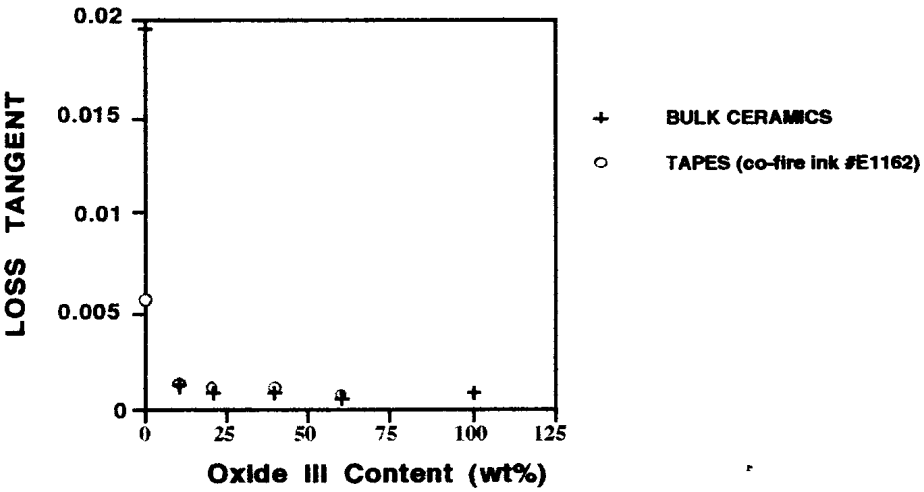


FIGURE 2. Loss tangent versus oxide III content (wt percent) of the bulk ceramics and the tapes measured at 1 KHz.

CONCLUSIONS

Nonaqueous tape of BSTO/oxide III ceramics have been fabricated and characterized. The tapes have demonstrated adjustable electronic properties similar in value to those obtained for their bulk counterparts. The BSTO/oxide III tapes and bulk materials exhibit low loss (<0.005) and tunability of 12-15 percent (2.0 V/µm) up to 60 wt percent oxide III content. The laminated tape stack displayed a very low dielectric constant (~22.0) and a high tunability (14.5 percent). Incorporation of the single layer tapes and the laminated stacks into coplanar waveguide shifters has been achieved in collaboration with ARL-PSD and NRL. The results of those incorporations will be discussed elsewhere.

L.C. Sengupta, S. Stowell, E. Ngo, and S. Sengupta
Army Research Laboratory, APG, MD 21005-5069

Author contact: Louise C. Sengupta: lsengup@arl.mil

□

ISIF 96 PAPERS

-- continued from page 4

perovskite and PZT ferroelectric capacitors
A.D. DeVibiss et al

Materials processing (sol-gel)

Orientation effects and low temperature (<450˚C) perovskite phase formation in $Pb(Zr_{0.4}Ti_{0.6})0_3$ thin films derived using the MMAP approach
Y. Liu and P.P. Phule

Densification and stress development in integrated electroceramic thin layers prepared by a sol-gel method
S.S. Sengupta et al

Phase formation and characterization of the $SrBi_2Ta_2O_9$ layered perovskite ferroelectric
M.A. Rodriguez et al

Hysteresis in ultrathin ferroelectric polymer films observed by capacitance versus voltage measurements
A. Guy and I.L. Guy

Effects of solution precursor characteristics on the crystallization behavior of sol-gel derived PZT thin films
R.W. Schwartz et al

Effect of excess and substoichiometric deficient PbO contents on the properties of sol-gel derived PZT films
G. Teowee et al

Sol-gel preparation of BST films
V.I. Petrovsky et al

-- continued on page 6

ISIF 96 PAPERS

-- continued from page 5

Preparation and humidity sensing property of K_2O-TiO_2 ultrafine powder by sol-gel method
L.B. Kong et al

The effect of base electrodes on the crystallization and electrical properties of PLT
A. Grill et al

Low ε ferroelectric thin films for ferroelectric memory FETs
T. Nakamura et al

Thickness dependent properties of acetate-derived PLZT films
G.H. Haertling

Integrated passive components
M. Klee et al

Applications and devices (microwave and biomedical)

$YBa_2Cu_3O_{7-x}/SrTiO_3$ structures for tunable microwave devices
C.H. Mueller et al

Growth and characterization of thin film dielectrics for microwave applications
H.M. O'Bryan and R.K. Watts

Fundamentals of biosensors and bioferroelectric sensors
V.S. Bystrov and A.N. Reshetilov

Modeling and theory

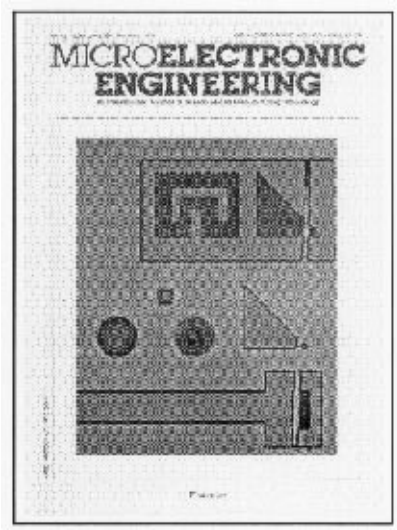
Model for switching in ferroelectric ceramics
G. Arlt

Fundamentals of the modified phase transition in random dipole ferroelectrics
J. Toulouse

-- continued on page 7

PROFESSIONAL JOURNAL

MICROELECTRONIC ENGINEERING
An International Journal of Semiconductor Manufacturing Technology



As mentioned in the Winter 1996 issue of the **Ferroelectricity Newsletter**, *the EMIF1 Proceedings have been published as a special volume of the journal* **Microelectronic Engineering**. *Here is some more information on this international journal of semiconductor manufacturing technology, which has been published since 1983.*

Microelectronic Engineering, an archival, peer-reviewed journal, brings together the results of European, American, and Japanese work in the rapidly expanding field of integrated microelectronic, optic, and optoelectronic devices, as well as nanotechnology. It publishes full research papers, short communications, and review articles. The scope of this journal includes materials, methods and designs for microfabrication, processing and inspection for microelectronic and optoelectronic elements from centimeters to nanometers.

Range of topics

- **Lithography** - optical lithography (submicron dimensions, deep UV lithography), electron optical methods and systems, ion beam methods and systems, X-ray optical methods and systems, resists
- **Pattern transfer** - ion implantation, dry etching
- **Materials** - metallization, microstructuring growth processes, silicon on insulators
- **Inspection and testing** - electron beam testers, laser probes, signal and image processing, metrology
- **Advanced processing** - process integration, three-dimensional integration, defect-free processes, manufacturing science, rapid thermal processing, process modelling, equipment modelling, laser assisted processing
- **Nanotechnology** - nanoscale fabrication and devices, atomic and nanoscale engineering
- **Fabrication aspects** - fabrication technology for microsystems and nanoscale systems

-- continued on page 7

PROFESSIONAL JOURNAL

MICROELECTRONIC ENGINEERING -- continued from page 6

- **Advanced devices** - nanometer structures, dimension-sensitive device properties, effects of small dimensions

Editors

USA - J. Kelly, Novellus Systems, Inc., 81 Vista Montana, San Jose, CA
Europe - M. Van Rossum, IMEC, Kapeldreef 75, B-3001 Leuven, Belgium
Japan - S. Namba, Faculty of Engineering Sciences, Osaka University, Toyonaka-shi, Osaka

Advisory editors

USA - A.R. Neureuther, Berkeley, CA; G. Owen, Palo Alto, CA; H. Pfeiffer, Hopewell Junction, NY; L. Swanson, Hillsborough, OR; L.F. Thompson, Murray Hill, NJ; E.D. Wolf, Ithaca, NY
Europe - H. Ahmed, Cambridge, UK; P. Balk, Delft, The Netherlands; G. Declerck, Louvain, Belgium; M. Gentili, Rome, Italy; A. Heuberger, Berlin, Germany; M.E. Jones, London, UK; R.A. Lawes, Didcot, UK; H.W. Lehmann, Zürich, Switzerland; B. Lischke, Munich, Germany; V. Mifsud, East Grindstead, UK; W.C. Nixon, Cambridge, UK; J. Perrocheau, Les Ulis, France; M. Pichot, Meylan, France; K.D. van der Mast, Eindhoven, The Netherlands; P. Vettiger, Rüschlikon, Switzerland; E. Wolfgang, Munich, Germany
Japan - M. Komuro, Tsukuba; S. Matsui, Tsukuba; T. Nishimura, Itami; Y. Shiraki, Tokyo; T. Takigawa, Kanagawa, N. Yokoyama, Kanagawa

Home page

http://www.elsevier.nl/locate/mee

Microelectronic Engineering is published by Elsevier Science B.V. To order or to request a free sample copy, contact the publisher at the following Elsevier Science Customer Service Departments:

New York
phone +(212) 633-3750
fax +(212) 633-3764
e-mail usinfo-f@elsevier.com

Amsterdam
phone +31 (20) 485-3757
fax +31 (20) 485-3432
e-mail nlinfo-f@elsevier.nl

Tokyo
phone +81 (3) 3836-0810
fax +81 (3) 3839-4344
e-mail forinfo-kyf04035@niftiserve.or.jp

□

ISIF 96 PAPERS

-- continued from page 6

Size effect in polarization switching in ferroelectric thin films
A.K. Tagantsev

Bulk screening effects in thin ferroelectrics
V.Y. Shur et al

Competition between order-disorder and displacive phase transition mechanisms
A. Bussmann-Holder

Feasibility of quartz-on-silicon pyro- and piezoelectric sensors
Y.M. Poplavko and L.P Pereverzeva

Polarization reversal in $SrBi_2Ta_2O_9$ thin films: Analysis of switching current data
V.Y. Shur et al

High dielectric permittivity ionic materials for DRAMs designed by computer simulation
R. Kulver and R.A. Guenther

Origin of the voltage dependence of interfacial capacitance and leakage currents in high dielectric constant thin films
P. Alluri, S.K. Dey, I.R. Zuleeg

Analysis of current-voltage and capacitance-voltage data of BST thin films fabricated with enhanced metal organic decomposition process
V. Joshi et al

Applications and devices (nonvolatile memories)

Fabrication and characterization of metal-ferroelectrics semiconductor field effect transistors using epitaxial $BaMgF_4$ films grown on

-- continued on page 8

ISIF 96 PAPERS

-- continued from page 7

Si(III) substrates
K. Aizawa et al

Applications and devices (optical and pyroelectrical)

Some additional possibilities of the use of ferroelectric films for information storage and processing
V.I. Petrovsky and A.S. Sigov

The phase diagrams of $H_xLi_{1-x}NbO_3$ and $H_xLi_{1-x}TaO_3$ optical waveguides
Y.N. Korkishko and V.A. Fedorov

Mixed ferroelectric crystals for room temperature pyroelectric detection
G. Arunmozhi et al

Growth and ferroelectric characterization of pure and doped triglycine sulphate crystals
S. Aravazhi et al

Optical waveguide losses of PZT thin films with various Zr/Ti stoichiometries
G. Teowee et al

Device integration issues and testing

Integration of ferroelectric capacitors using multilayered electrodes
I. Chung et al

Integrated polycrystalline ferroelectric capacitors on Si with conducting barrier layers for high density memory applications
A.M. Dhote et al

A reactive ion etch study for producing patterned platinum structures
C.E. Farrell et al

-- continued on page 9

READERSHIP

FERROELECTRICITY NEWSLETTER *READERSHIP STATISTICS*

Please see the editorial on page 1 for a description of Figures 1 to 4.

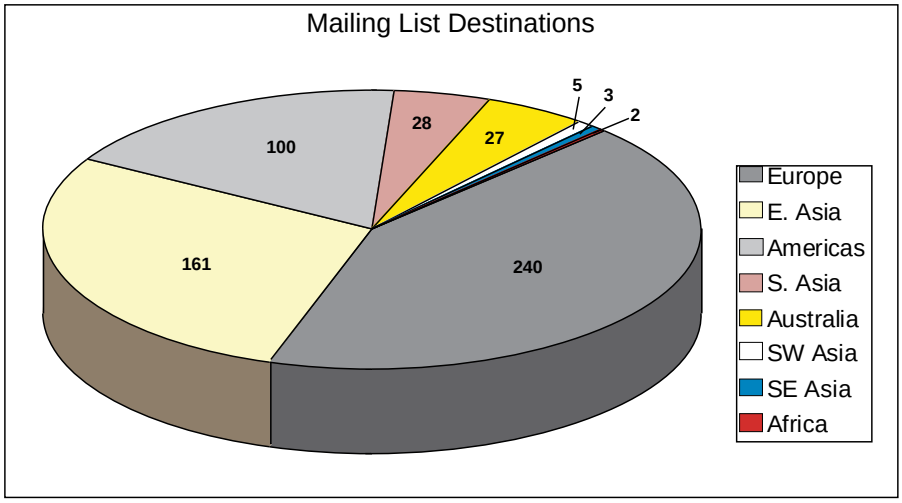


FIGURE 1. Mailing list, destinations

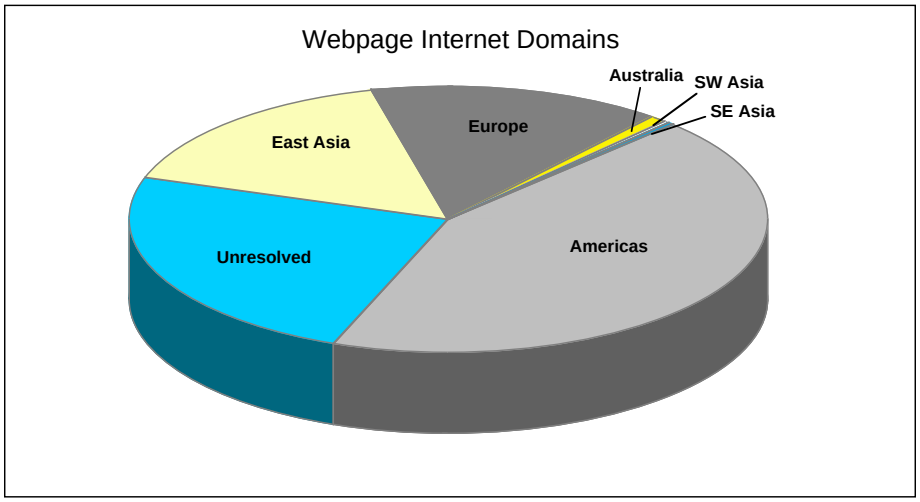


FIGURE 2. Webpage Internet domains

-- continued on page 9

READERSHIP

FERROELECTRICITY NEWSLETTER
READERSHIP STATISTICS -- continued from page 8

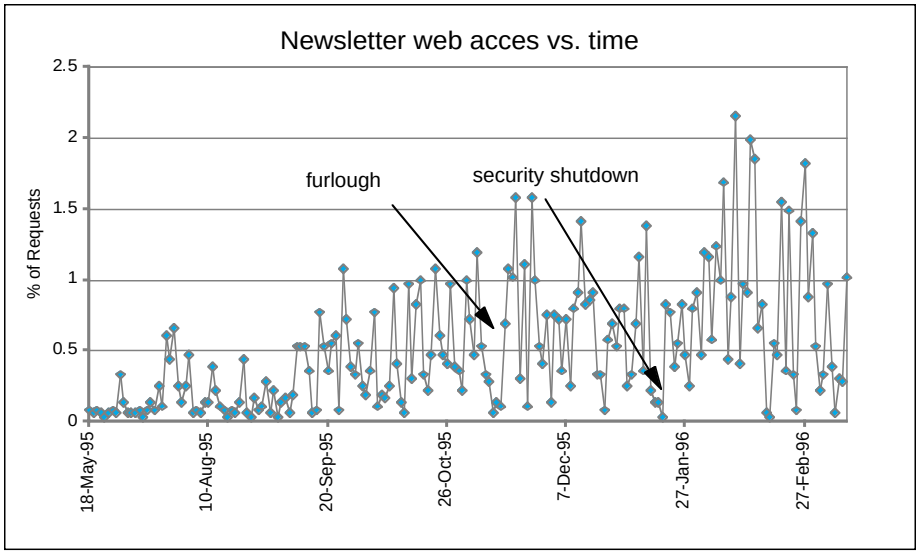


FIGURE 3. Newsletter web access versus time

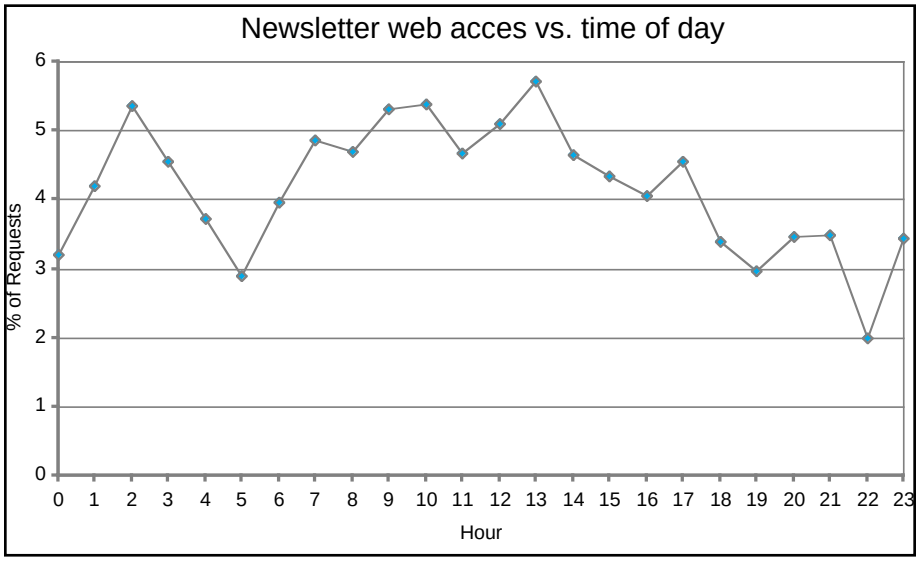


FIGURE 4. Newsletter web access versus time of day

□

ISIF 96 PAPERS
-- continued from page 5

Fabrication and comparison of ferroelectric capacitor structures for memory applications
C. Chung et al

Etching effects to PZT capacitors on RuO_x/Pt electrode by inductively coupled plasma
C.J. Kim et al

Interdiffusion Phenomena in strontium bismuth tantalate films
P.N. Johnston et al

Effects of top electrode annealing on the PZT thin films
E.-G. Lee et al

Reactive ion beam etching of ferroelectric materials using an RF inductively coupled ion beam source
K. Williams et al

TiO_2 diffusion barrier layer in the ferroelectric random access memory cell
B. Yang and R. Ramesh

Characterization (Electrical)

Scanning force microscopy studies of domain structure in the vicinity of fatigued and nonfatigued ferroelectric capacitors
O. Auciello et al

Characterizations of $SrBi_2Ta_2O_9$, $SrBi_2(Ta,Nb)O_9$ $CaBi_2Ta_2O_9$ thin films fabricated by the RF magnetron sputtering deposition technique
J.-K. Lee et al

Sr content dependence of ferroelectric properties in $SrBi_2Ta_2O_9$ thin films
T. Hase et al

-- continued on page 10

ISIF 96 PAPERS

-- continued from page 9

Growth and electrical properties of $Ba_{1-x}Sr_xTiO_3$ thin films on Pt/RuO_2 hybrid electrodes by RF sputtering and metalorganic chemical vapor deposition
D.C. Kim et al

Phenomenology of the dielectric response of CVD $(Ba,Sr)TiO_3$ thin films
S.K. Streiffer et al

Electrical properties of ferroelectric-capacitor-gate Si MOS transistors using P(L)ZT films
E. Tokumitsu et al

Investigation of the electrical characteristics of transition metal oxide composites of barium strontium titanate thin films
S. Sengupta

A systematic study of substituted elements in the barium strontium titanate system
J.H. Thiesen et al

Statistical investigation of dielectric breakdown of strontium bismuth tantalate thin film capacitors
B.M. Melnick et al

Pb and Ti displacements in $Pb(Zr,Ti)_3$ perovskites
W.L. Warren et al

Retention and imprint properties of ferroelectric thin films
J.J. Lee et al

Imprint induced failure modes in ferroelectric nonvolatile memories
J.M. Benedetto

-- continued on page 11

NEW PUBLICATIONS

RESULTS OF 25 YEARS OF RESEARCH IN DIELECTRIC SPECTROSCOPY OF FERROELECTRICS

The Fall 1994 issue of the **Ferroelectricity Newsletter** *(pp. 8-10) brought an article by Prof. Jonas Grigas entitled* ***"Microwave dielectric spectroscopy of ferroelectrics: History and present status"*** *in which he presented some of the topics discussed in detail in his new book.*

Jonas P. Grigas, ***Microwave dielectric spectroscopy of ferroelectrics and related materials***, Volume 9, Ferroelectricity and Related Phenomena series, 416 pp, cloth ISBN 2-88449-190-2

Recent technological advances affecting the size and useful frequency range of electronic elements depend heavily on the discovery of materials suitable for applications in the development of new radar systems, satellite broadcasting, and multichannel terrestrial and cosmic communications via the use of microwaves. Ferroelectrics and related materials have become increasingly important for the utilization of microwave techniques.

In this monograph, the author summarizes the results of his 25 years of work in the field of microwave dielectric spectroscopy of ferroelectrics and related materials. The book provides a comprehensive review of methods available for microwave dielectric measurements and designated ferroelectric families.

This volume is an indispensable reference for researchers, engineers, and graduate students of the physics of structural phase transitions, superionic conductors, ferroelectrics, and related materials.

Contents

Introduction • Dielectric dispersion • Microwave dielectric spectroscopy • Low-dimensional semiconductors • Semiconductive ferroelectrics • Quasi-one-dimensional H-bonded ferroelectrics • Other order-disorder ferroelectrics • Protonic conductors

To order contact

University of Toronto Press, 340 Nagel Drive, Buffalo, NY 14225-4731, USA, phone (800) 565-9523, fax (716) 683-4557
or
International Publishers Distributor, c/o PO Box 90, Reading, Berkshire RG1 8JL, UK, phone +44 (0) 1734 568316, fax +44 (0) 1734 568211
or
International Publishers Distributor, Kent Ridge, PO Box 1180, Singapore 911106, phone +65 741 6933, fax +65 741 6922

□

NEW PUBLICATIONS

NEW MRS PUBLICATIONS

June 1995 *MRS Bulletin* explores organic thin films

The recent surge of interest and effort in the area of organic thin films is due in large part to the many promising applications for which these films can be used. It is also due, however, to the emergence of new preparation and characterization methods for thin film research. Self-assembled monolayers, for example, are an excellent model for studying interfacial phenomena, such as adhesion and friction, which in turn have potential applications in corrosion prevention, wear protection, and biosensing.

The June 1995 issue of ***MRS Bulletin*** outlines the diversity and complexity of organic thin films; features new applications, such as molecular recognition and biomimetic chemistry; surveys methods of preparation and types of materials, such as evaporated organic films, self-absorbed monolayers, Langmuir-Blodgett films, and lipid bilayers. Guest editors for the issue are Tisato Kajiyama and Toyoki Kunitake (Kyushu University) and David G. Whitten (University of Rochester).

Articles include:

Chemistry of self-assembling bilayers and related molecular layers
Toyoki Kunitake (Kyushu University)

Novel concepts of the aggregation structure of organic monolayers on the surface of water
Tisato Kajiyama (Kyushu University)

Structural evaluation and molecular control of vacuum-evaporated organic thin films
Kazumi Matsushige (Kyoto University)

Supramolecular assemblies of chromophores in L-B films and related media
Huijan Chen, Catie Weiss Farahat, Mohammad S. Farahat, H. Cristina Geiger, Uwe W. Leinhos, Kangning Liang, Xuedong Song, and Thomas L. Penner (National Science Foundation Center for Photoinduced Charge Transfer); Abraham Ulman (Polytechnic University); Jerry Perlstein, Kock-Yee Law, and David G. Whitten (National Science Foundation for Photoinduced Charge Transfer)

Surface adsorption of monolayers
Abraham Ulman (Polytechnic University)

The quartz-crystal-microbalance study of protein binding on lipid monolayers at the air-water interface
Yoshio Okahata, Y. Ebara, and T. Sato (Tokyo Institute of Technology)

-- continued on page 12

ISIF 96 PAPERS

-- continued from page 10

Characterization and optimization $A_{m-1}Bi_2(Ta_{1-x}Nb_x)mO_{3m+3}$ layered perovskites using Rayleigh's analysis
C.A. Paz de Araujo et al

A qualitative model for the fatigue-free behavior of $SrBi_2Ta_2O_9$
H.N. Al-Shareef et al

Dielectric analysis of integrated ceramic thin film capacitors
R. Waser

Reliability study on BST capacitors for GaAs MMIC
A. Noma and D. Ueda

The capacitance of PVPLT/Pt structures
T.M. Shaw et al

Elucidation of the switching processes in tetragonal PZT films by impedance analysis
D.J. Wouters et al

Dielectric breakdown strength in sol-gel derived PZT thick films
H.D. Chen et al

Dielectric properties of sol-gel derived BST thin films
D.M. Tahan et al

Ti thickness effects in Pt/Ti bottom electrode on properties of $(Ba,Sr)TiO_3$ thin film
S.Y. Cha et al

Stability of reactive DC-sputtered Ir and IrO_2 thin films in various ambients
T.-S. Chen et al

Modeling ferroelectric capacitor switching using a parallel elements model
B. Jiang and J.C. Lee

-- continued on page 12

ISIF 96 PAPERS

-- continued from page 11

Dielectric properties of ECR-sputtered $(Ba,Sr)TiO_3$ films under DC-bias stresses
S.-I. Ohfuji et al

Charge transport in bismuth layer ferroelectrics
A.C. Palanduz and D.M. Smyth

The use of voltage to accelerate the endurance degradation of PZT capacitors
T.D. Hadnady et al

Electrical characteristics of Pt-bismuth strontium tantalate-P-Si with zirconium oxide buffer layer
M. Lim and T.S. Kalkur

Materials Processing (CVD)

Domain structure of epitaxial PZT thin films grown on MgO(001) by RF magnetron sputtering
K.S. Lee, Y.M. Kang and S. Baik

Pulsed laser ablation synthesis and characterization of strontium bismuth tantalate thin films and integration into capacitors for near fatigue-free nonvolatile memories
D. Thomas et al

Epitaxial growth of c- and a-oriented $Bi_2SrTa_2O_9$ thin films on conducting YBCO thin film electrodes
A. Ignatiev et al

Lead content control of PLZT thin films prepared by RF magnetron sputtering
K. Suu et al

Systematic variations in the electronic properties of epitaxial

-- continued on page 13

NEW PUBLICATIONS

NEW MRS PUBLICATIONS

-- continued from page 11

NEW PUBLICATIONS IN THE MRS SYMPOSIUM PROCEEDINGS SERIES

Evolution of thin film and surface structure and morphology

This volume draws together researchers working in the areas of surface structure, dynamics and growth characterization to identify common interest areas and to promote interdisciplinary interaction.

Topics include thin films - nucleation and growth; surface structural rearrangements, defects; *in situ* studies of surface structure; thin films - structure/morphology; surface roughness/wear/tribology; interfacial reactions; and thin films - general.

Volume 355 in the MRS Symposium Proceedings Series; 103 papers (668 pages) from the 1994 MRS Fall Meeting in Boston, MA.

Edited by B.G. Demczyk (University of Michigan), E. Garfunkel (Rutgers University), B.M. Clemens (Stanford University), E.D. Williams (University of Maryland), and J.J. Cuomo (North Carolina State University).

Hardcover or microfiche $69 (MRS members), $77 (US list), $82 (non-US list).

Thin films: Stresses and mechanical properties V

Thin films have become an integral part of the technological changes currently sweeping the commercial marketplace. Applications range from tooling surfaces to microelectronic components. Performance, however, is often limited by the mechanical properties of both the films and the structures to which they are attached. This volume focuses on the latest research developments related to mechanical properties and performance in thin film materials.

Topics include effects of stress on diffusion, microstructure, and surface morphology; relationships between deposition parameters, microstructure, and stresses; structure, stresses, and mechanical properties in epitaxial thin films; structure, stresses, and mechanical properties in multilayered thin films; electromigration, structure, stresses, and mechanical properties in interconnect and passivation materials; mechanical properties of polymer coatings; advances in measurment techniques; submicron indentation - experiments, theory, and technique; and fracture, adhesion, and wear of thin films.

Volume 356 in the MRS Symposium Proceedings Series; 137 papers (901 pages) from the 1994 MRS Fall Meeting in Boston, MA.

Edited by Shefford P. Baker (Max-Planck-Institut für Metallforschung), Caroline A. Ross (Komag Incorporated), Paul H. Townsend (Dow Chemical Company), Cynthia A. Volkert (AT&T Bell Laboratories), and Peter Børgesen (Universal Instruments Corporation).

Hardcover or microfiche $67 (MRS members), $75 (US list), $80 (non-US list).

-- continued on page 13

NEW PUBLICATIONS

NEW MRS PUBLICATIONS -- continued from page 12

Ferroelectric thin films IV

Representing the latest technical information from academia, government organizations, and industry, this volume highlights topics of four major categories: the first public technical disclosure of the materials processing and characterization of the much acclaimed "Y1" nonvolatile memory material; enhanced understanding of the role of electronic and ionic defects in ferroelectric thin film degradation; extensive technical progress in metalorganic chemical vapor deposition of ferroelectric thin films; and the development of enhanced process integration techniques for ferroelectric thin films with semiconductor technology. In addition, improved process technologies that bring the optical properties of these complex, multicomponent oxide films to the verge of commercial viability are discussed.

Topics include layered structure ferroelectrics; characterization; photonic phenomena; process integration issues; DRAM thin film technology; chemical vapor deposition; solution deposition; vapor deposition, pulsed laser deposition; and piezoelectric and IR thin film technology.

Volume 361 in the MRS Symposium Proceedings Series; 91 papers (623 pages) from the 1994 Fall Meeting in Boston, MA.

Edited by Bruce A. Tuttle (Sandia National Laboratories), Seshu B. Desu (Virginia Tech), R. Ramesh (Bellcore), and T. Shiosaki (Kyoto University).

Hardcover or microfiche $59 (MRS members), $69 (US list), $74 (non-US list).

Structure and properties of multilayered thin films

Layered thin film structures often have unusual properties which make them appealing in a wide range of applictions. Fabrication of submicron and nanometer multilayers can produce metastable phases that may not be predicted from bulk equilibrium phase diagrams. Understanding the growth, structure, stability, and properties of multilayers, and controlling their microstructure through processing, are important in many applications.

Topics include phase transformation and reaction kinetics; processing and growth, structural characterization, magnetic, electronic, and optical properties; mechanical properties; X-ray optics; and thin film interfaces.

Volume 382 in the MRS Symposium Proceedings Series; 75 papers (496 pages) from the 1995 MRS Spring Meeting in San Francisco, CA.

Edited by Tai D. Nguyen (Lawrence Berkeley Laboratory), Bruce M. Lairson (Rice University), Bruce M. Clemens (Stanford University), Sung-Chul Shin (Korea Advanced Institute of Science and Technology), and Katsuaki Sato (Tokyo University of Agriculture and Technology).

Hardcover or microfiche $74 (MRS members), $85 (US list), $98 (non-US list).

Modeling and simulation of thin film processing

Diverse materials science communities review the extraordinary progress made in the development of computer simulation and modeling techniques for the prediction of film morphology, microstructure, composition, profile,

--continued on page 14

ISIF 96 PAPERS

-- continued from page 12

$Pb(Zr_x,Ti_{1-x})O_3$ thin films by MOCVD
C.M. Foster et al

Effects on La and Nb modification on electrical properties of $Pb(Zr,Ti)O_3$ thin films by MOCVD
H. Fujisawa et al

Formation of circular-shaped crystalline phases embedded in amorphous $PbTiO_3$ thin films grown by MOCVD
S.S. Yom et al

Preparation of $(Pb,La)TiO_3$ films by metalorganic chemical vapor deposition with new lanthanum precursors
D.A. Neumayer et al

On the origin of topography-dependent composition in vapor-deposited films
T.S. Cale and S.K. Dey

Chemical vapor deposition of $(Ba,Sr)TiO_3$ thin films for application in gigabit-scale dynamic random access memories
K. Eguchi

Characteristics of ferroelectric $Bi_2SrTa_2O_9$ thin films grown by "flash" MOCVD
C. Isobe et al

$BaTiO_3$ epitaxial structure and electrical properties as a thin film ferroelectric on silicon
R.A. McKee et al

Electrical properties of $SrTiO_3$ thin films by plasma-enhanced metal-organic chemical vapor deposition
N-K. Kim et al

-- continued on page 14

ISIF 96 PAPERS

-- continued from page 13

Electrical and microstructural properties of $SrTiO_3$ thin films deposited by metalorganic chemical vapor deposition
H.J. Cho et al

DRAMs

A review of perovskite-type dielectrics for DRAMs
D.E. Kotecki

Applications and devices (piezoelectric sensors and actuators)

Integrated ferroelectric monomorph transducers for acoustic imaging
J. Bernstein et al

Thin film characterization by acoustic microscopy
T. Kundu

Piezoelectric and dielectric aging in $Pb(Zr,Ti)O_3$ thin films and bulk ceramics
A.L. Kholkin et al

Antiferroelectric to ferroelectric phase switching thin films in lead circonate and lead hafnate based compositions
C.J. Gaskey et al

Integrated ferroelectric MEMS: Technology issues and device applications
D.L. Polla

Piezoelectric and electrostrictive bimorph actuators and sensors for smart microsystems
P. Gaucher et al

Device characteristics of piezoelectric cantilever beam accelerometer

-- continued on page 15

NEW PUBLICATIONS

NEW MRS PUBLICATIONS

-- continued from page 13

and structure. These techniques are rapidly moving out of the area of academic research and into technological and production design areas of thin film based industries.

Topics include deposition and growth modeling; film morphology and topology; film microstructure; failure mechanisms; etching; process modeling and control; and reactor-scale modeling.

Volume 389 in the MRS Symposium Proceedings Series; 51 papers (382 pages) from the 1995 MRS Spring Meeting in San Francisco, CA.

Hardcover or microfiche $66 (MRS members), $77 (US list), $88 (non-US list).

Thin films for integrated optics applications

The combination of electrooptic thin films with silicon integrated circuits provides a promising approach to creating optoelectronic integrated circuits (OEICs) capable of sending information at data rates greater than 1 Gbit/second with low power consumption. These devices are of two basic types - very highly parallel (64K channels or greater) or very high speed (Gbits/second/channel). Electrooptic materials featured in this volume include organic polymers and/or multilayers, liquid crystals, and inorganic thin films. Materials design, processing, and device issues are addressed.

Topics include nonlinear organics, liquid crystals for integrated optics; ferroelectric thin films; Er-doped inorganic thin films; and inorganic thin film waveguides.

Edited by Bruce W. Wessels (Northwestern University), Seth R. Marder (California Institute of Technology), and David M. Walba (University of Colorado).

Volume 392 in the MRS Symposium Proceedings Series; 34 papers (290 pages) from the 1995 MRS Spring Meeting in San Francisco, CA.

Hardcover or microfiche $64 (MRS members), $74 (US list), $85 (non-US list).

Epitaxial oxide thin films II

Our understanding and control of epitaxial oxide heterostructures has progressed along multiple frontiers, including magnetic, dielectric, ferroelectric, and superconducting oxide materials. This has resulted in both independent rediscovery and the successful borrowing of ideas from ceramic science, solid-state physics, and semiconductor epitaxy. A new field of materials science has now emerged which aims at the use of the intrinsic properties of various oxide materials in single crystal thin film form. Exploiting the potential of these materials, however, will only be possible if many fundamental and engineering questions can be answered. This volume represents continued progress toward fulfilling that promise.

Topics include dielectrics; ferroelectrics, optics, superconductors, magnetics; and magnetoresistance.

Edited by James S. Speck (University of California), David K. Fork (Xerox Palo Alto Research Center), Ronald W. Wolf (Philips Research

-- continued on page 15

NEW PUBLICATIONS

NEW MRS PUBLICATIONS -- continued from page 14

Laboratories), and Tadashi Shiosaki (Kyoto University).

Volume 401 in the MRS Symposium Proceedings Series; 77 papers (562 pages) from the 1995 MRS Fall Meeting in Boston, MA.

Hardcover or microfiche $64 (MRS members), $70 (US list), $75 (non-US list).

Silicide thin films—fabrication, properties, and applications

Tremendous advances have been made in the use of silicides as contacts and interconnects in microelectronic devices and as active layers in sensors. A flourish of novel fabrication concepts and characterization techniques has led to high quality silicide devices and a better understanding of the electronic and micrometallurgical properties of their interfaces. The shrinking physical dimensions of ULSI devices, beyond the deep submicron regime, now poses new and serious materials challenges for the development of manufacturable silicide processes. Scientists and engineers from materials science, physics, chemistry, device, processing, and other disciplines examine in this volume the current issues facing silicide thin film applications.

Topics include silicide fundamentals—energetics and kinetics; processing of silicide thin films; ULSI issues; CVD silicides; semiconducting silicides; processing of germano silicide thin films; silicides and analogs for IR detection; interfaces, surfaces, and epitacy; novel structures and techniques; and properties of silicide thin films.

Edited by Ray Tung (AT&T Bell Laboratories), Karen Maex (IMEC), Paul W. Pellegrini (Hanscom Air Force Base), and Leslie H. Allen (University of Illinois—Urbana).

Volume 402 in the MRS Symposium Proceedings Series; 93 papers (648 pages) from the 1995 MRS Fall Meeting in Boston, MA.

Harcover or microfiche $67 (MRS members), $73 (US list), $78 (non-US list).

1996 MRS Publications Catalog

This 80-page catalog contains information on more than 400 books, plus videotapes, databases, journals, the *Handbook of Modern Ion Beam Materials Analysis*, as well as a list of 67 new proceedings volumes.

The catalog is organized by topical categories, including biomedical materials; catalysts; ceramics and composites; computational methods, electronic materials and processing; education; glasses and insulators; materials characterization; metals and alloys; novel processing/application; nuclear waste management; polymers; and sensors. A title index and a series index listing all proceedings from MRS-sponsored symposia since Fall 1988 are also included.

To order any publication or to receive the free catalog, please contact the Materials Research Society, 9800 McKnight Road, Pittsburgh, PA 15237; phone +(412) 367-3012; fax +(412) 367-4373
For general information regarding MRS, e-mail your request to

□

ISIF 96 PAPERS

-- continued from page 14

using surface micromachining process
J-H. Kim et al

Materials processing (PVD)

Effect of $SrTiO_3$ deposition temperature on the dielectric properties of $SrTiO_3/YBa_2Cu_{7-o}/LaAlO_3$ structures
F.A. Miranda et al

Jet vapor deposition TM of ferroelectric thin films for general applications
T. Tamagawa et al

Preparation of Bi,Ti_3O_{12} thin films by pulsed laser deposition and their anomalous imprint characteristics
B.H. Park et al

Deposition of self-polarized PZT films by planar multitarget sputtering
R. Bruchhaus et al

Influence of the substrate material, substrate temperature, and sputtered lead flux on the in-situ perovskite pulse formation
B. Jaber et al

Dependence of the dielectric constant on the Ba/Sr ratio for sputter-deposited $(Ba,Sr)TiO_3$ thin films
T. Kuroiwa et al

Process integration studies for a reliable high Demsotu PZT-based FRAM technology
R. Ramesh and A. Shote

High reliable PZT growth using conventional reactive sputtering and

-- continued on page 16

ISIF 96 PAPERS

-- continued from page 15

rapid thermal annealing
S. Yamauchi and M. Yoshimaru

Structural characterization of $Ba_{0.5}Sr_{0.5}TiO_3$ on crystalline RuO_2 prepared by pulsed laser deposition
Q.X. Jia et al

Microwave and biomedical

Bioferroelectricity in the biomembranes ion channels
V.S. Bystrow and H.R. Leuchtag

Strontium barium titanate thin films for electrically tunable and adaptive microwave devices
A.T. Findikoglu et al

Deposition of ferroelectric oxide composites by the MOCVD process
S. Ramanathan et al

Dielectric properties of doped $SrTiO_3$ thin films for active microwave applications
L.A. Knauss et al

Chemically derived microwave dielectric thin films
T. Zhang and P.P. Phule

Fabrication and characterization of ferroelectric composite ceramics
L.S. Sengupta et al

Materials processing (MOD)

New low temperature processing of condensed MOD-$SrBi_2Ta_2O_9$ thin films
Y. Ito et al

Optimized c-axis oriented strontium bismuth tantalate grown from metal-organic deposition (MOD) solutions
M. Azuma et al

-- continued on page 17

UPCOMING MEETINGS

Third Pacific Rim Conference on Ferroelectric Applications
27 - 29 May 1996
International Session of Ferroelectric Materials and Their Application (FMA-13)
29 May 1996 afternoon
Coop-Inn, Kyoto, Japan

Chairmen

Prof. J.F. Scott, Melbourne, Ausstralia
Prof. S.I. Woo, Taejon, Korea
Prof. T. Shiosaki, Kyoto, Japan
Prof. C.P. Araujo, Colorado Springs, USA

FMA is a Japanese domestic meeting. FMA-13 will be held 29 May - 1 June. Presentations and abstracts are mainly in Japanese. Proceedings are published in English in a special issue of the *Japanese Journal of Applied Physics.*
Participants of the Pacific Rim Conference may stay during FMA-13 as free observers with no presentation or paid active prticipant with presentation.

Contact

Prof. T. Shiosaki, Department of Electronics, Faculty of Engineering, Kyoto Univ., Kyoto 606-01, Japan; phone +81 75 753-5309; fax +81 75 753-5749; e-mail tshiosak@kuee.kyoto-u.ac.jp

Ferroelectrics and Their Applications
An intensive 5-day short course
23 - 28 June 1996
School of Industrial and Manufacturing Science
Cranfield University, Cranfield, England

Ferroelectric materials permeate a vast range of industrial, military, commercial, and domestic applications, including piezoelectric gas ignitors, sounders, microphones, hydrophones, accelerometers (e.g., in air bags), RF and microwave filters in radio and TV, IR detectors for burglar alarms and light switches, and the multilayer capacitors which are indispensable components in electronic equipment. They impinge on everyone's life in many ways but are nevertheless a poorly understood group of materials.

A new set of engineering applications of these materials is emerging, such as in "smart" materials which are beginning to be used in the control of vibration and noise in helicopters, as the active materials in a new range of uncooled thermal imagers (e.g., for military and firefighting applications), as the actuators for low-cost ink-jet printers, "smart" automotive suspensions, and video recorder heads. In thin film form they will be used for the next generation of static and dynamic silicon memories and the sensing and actuation elements in the emerging field of silicon microsystems.

-- continued on page 17

UPCOMING MEETINGS

Short Course at Cranfield -- continued from page 16

This course has been set up to give engineers and scientists using or wishing to use these materials the opportunity to develop their knowledge under the tuition of some of the world's leading figures in this technology.

Aims of the program

- To provide an understanding of how ferroelectrics can be used in a wide range of applications, and to relate the requirements of these applications to the basic structures and properties of materials.
- To provide a firm grounding in the basic properties of the materials and how these relate to crystal structure and materials forms.
- To review the properties of, and fabrication techniques for, single crystal, polymeric, and especially ceramic and thin film ferroelectrics with reference to specific materials examples.
- To survey major current emerging applications for ferroelectrics and relate them to specific examples.
- To discuss the rationale for selecting particular materials.
- To provide a forum to discuss future trends in the application of ferroelectrics and major materials issues affected.

Course synopsis

- Introduction to ferroelectrics
- Tensor properties of materials
- Ferroelectric structures
- Ferroelectric ceramics
- Ferroelectric polymers and ceramic/polymers composites
- Ferroelectric oxide thin films
- Dielectric applications
- Piezoelectric applications
- Pyroelectric applications
- Electrooptic applications
- Future trends and summary
- Examples and practical classes
  Example classes will be used to teach
  - tensors
  - characterization of materials' properties (piezoelectric, dielectric, pyroelectric, electrooptic)
  - piezoelectric devices - characteristics and design

Written Assignment

A post-course written assignment will be set on a topic to be selected by each student from a given list.

Total course duration

40 hours teaching, consisting of 24 hours of lectures, 6 hours of example classes, plus 10 hours of practical classes. The course will start on Sunday evening and finish on the following Friday afternoon.

-- continued on page 18

ISIF 96 PAPERS

-- continued from page 16

$SrBi_2Ta_2O_9$ (SBT) thin films prepared by electrostatic spray
J. Gu et al

Conformal LSMCD deposition of $SrBi_2(Ta_{1-x}Nb_x)_2O_9$
N. Solayappan et al

Characterization of $SrBi_2Ta_2O_9$ thin film capacitors on Pt/TiOx electrodes by misted deposition technique
S. Hayashi et al

Characterization: Physical and chemical

Structure-property characteriation of $Pb(Ar,Ti)O_3$ thin films for microsensor applications
B.A. Tuttle et al

Characterization of $Pb(Zr,Ti)O_3$ thin films by MOCVD using the total reflection X-ray diffraction method
M. Shimizu et al

Infrared spectroscopic, X-ray, and nanoscale characterization of strontium titanate thin films
J.D. Webb et al

Studies of oxygen incorporation during growth of $Pb(Zr_x,Ti_{1-x})O_3$ and $SrBi_2Ta_2O_9$ films via in-situ, real-time pulsed ion beam surface analysis
O. Auciello et al

Effect of barium and strontium contamination on silicon surfaces during thermal processing
S. Yamamichi et al

Nucleation and orientation of sol-gel PZT films on Pt bottom electrodes
G. Willems et al

-- continued on page 19

UPCOMING MEETINGS

Short Course at Cranfield -- continued from page 17

Course tutors

Professor L. Eric Cross
Evan Pugh Professor of Electrical Engineering, Pennsylvania State University, USA
Dr. David A. Hall
Lecturer in Materials Science (Ceramics), University of Manchester Materials Science Centre
Dr. Caroline Millar
Electroceramics Group Leader, GEC Marconi, Materials Technology, Caswell
Dr. Jas S. Obhi
Research Scientist, GEC Marconi Materials Technology, Caswell
Dr. Anil Patel
Research Scientist, GEC Marconi Materials Technology, Caswell
Professor Roger W. Whatmore (Course director)
Royal Academy of Engineering Professor of Engineering Nanotechnology, Cranfield University

Contact

Mrs. Marion Walls, Promotions Manager, Building 42, The Manufacturing Management Centre, School of Industrial and Manufacturing Science, Cranfield University, Cranfield, Bedfordshire MK43 0AL, England; phone +44 1234 754043; fax +44 1234 751572

1996 IEEE International Symposium on the Applications of Ferroelectrics (ISAF '96)
18 - 21 August 1996
Rutgers University, held at Brunswick Hilton and Towers, East Brunswick, New Jersey

This biennial meeting will address recent issues pertaining to the application of ferroelectric, piezoelectric, dielectric, and electrooptical materials in the form of single crystals, bulk ceramics, and thick and thin films.

Topics

- Wireless communications - microwave resonators, HF capacitors, SAW devices, phase shifters, thin film resonators, and microstrip filters
- Memory applications - DRAM, FRAM, holographic storage, and integrated capacitors
- Ultrasonic imaging - biomedical imaging, NDE, acoustic microscopy, underwater imaging, and hydrophones
- Electrooptic devices - modulators, Bragg reflectors, frequency doublers, photorefractive crystals, and holographic storage
- Electromechanical control - sensors, actuators, MEMs, motors, piezoelectric printing technology, and photo-strictors
- Energy storage - thick and thin films, MLCs, and integrated capacitors
- Infrared imaging - pyroelectrics, uncooled IR detectors, and novel IR detectors
- Displays - ferroelectric liquid crystals, piezoelectric transformers, and flat-panel displays
- Sensors - PTC thermistors, chemical sensors, chemistry on chips, and varistors

Contact

Prof. A. Safari, Department of Ceramic Engineering and Center for Ceramic Research, Rutgers, The State University of New Jersey, Brett and Bowser Roads, PO Box 909, Piscataway, NJ 08855-0909; phone +(908)445-4367; fax +(908) 445-3258 or +(908) 445-5595; e-mail safari@safari.rutgers.edu

UPCOMING MEETINGS

International Conference on Electronic Ceramics & Applications
Electroceramics V
2 - 4 September 1996
University of Aveiro, Portugal

This conference, held under the auspices of the European Ceramic Society, will address the advances and development of materials for electronic ceramics, state of the art applications, and prospective components or devices.

Plenary sessions will consist of presentations by invited speakers known worldwide for their expertise. All other contributions, arranged according to topics, will be presented orally at parallel sessions. They will also be shown as posters during the conference.

Topics

Presentations may address dielectrics, ferroelectrics, grain boundary controlled materials, electronic and ionic conductors, superconductors, magnetic ceramics, integrated functions, and processing. Special emphasis will be given to the following subjects:

- Packaging and assembling
- Electrical and mechanical reliability
- Microwave ceramics and devices
- Thin film sensors and devices
- Diamond films: deposition, electrical properties, and devices
- Multilayer devices
- Bulk and intergranular structure of electroceramics

Organization

P.H. Duvigneaud, Brussels, Belgium
J.L. Baptista, Aveiro, Portugal
R. Brook, Oxford, UK

Contact

Prof. Dr. Rainer Waser, Institut für Werkstoffe der Elektrotechnik II, RWTH Aachen, Sommerfeldstrasse 24, D-52074 Aachen, Germany
phone +49-241-80 78 12, fax +49-241--88 88 300

The 1996 MRS Publications Catalog Supplement containing 62 new books is now available.
To receive a free copy of the 24-page catalog, please contact the Materials Research Society
9800 McKnight Road, Pittsburgh, PA 15237
phone +(412) 367-3012, fax +(412) 367-4373

MAILBOX .....

This space is reserved for inquiries and comments of our readers to colleagues in the field. It is designed as an additional vehicle to facilitate the exchange of information and answers to specific questions. Our sponsors mandate that all contributions must be ***noncommercial.***

The monograph *Principles and applications of ferroelectrics and related materials* by A.M. Glass and M.E. Lines is an important resource for researchers in ferroelectricity.

Alex R. Freeman
PO Box 19023
Dept. of Mech. & Aerospace Engr.
University of Texas at Arlington
Arlington, TX 76019
phone +(817) 273-2086
e-mail reddy@mecad.uta.edu

Gordon and Breach is planning the publication of the following book in the latter part of 1996:
The ferroelectric thin films: Synthesis and basic properties,
by James. F. Scott, Carlos A. Paz de Araujo, and George W. Taylor.

ISIF 96 PAPERS

-- continued from page 17

Memory Devices and Characterization

Thin film characteristics by acoustic microscopy
T. Kunio

Transparent all-thin-film ferroelectric field effect transistor
M.W.J. Prins et al

	CALENDAR OF EVENTS 1996
May 21-23 •	International Seminar on Relaxor Ferroelectrics, Dubna, Russia (see *Ferroelectricity Newsletter* Vol. 4, No. 1, p. 15)
25-29	• International Symposium on Ferroic Domains and Mesoscopic Structures, Vienna, Austria (see *Ferroelectricity Newsletter* Vol. 4, No. 1, p. 15)
27-29	• 3rd Pacific Rim Conference on Applications of Ferroelectrics, Coop-Inn Kyoto, Japan (see p. 16)
May 29-**Jun** 1	• 13th Meeting on Ferroelectric Materials and Their Applications (FMA-13), Coop-Inn Kyoto, Japan. For information contact Prof. T. Shiosaki, Department of Electronics, Kyoto University, Kyoto 606-01, Japan, phone +81 75 753-5309, fax +81 75 753-5749, e-mail tshiosak@kuee.kyoto-u.ac,jp
Jun 23-28	• Ferroelectrics and Their Applications, Short Course, Cranfield University, Cranfield, England (see p. 16)
Aug 4-9	• 10th American Conference on Crystal Growth, in conjunction with the 9th International Conference on Vapor Growth and Epitaxy, Vail, Colorado (see *Ferroelectricity Newsletter* Vol. 4, No. 1, p. 15)
18-21	• IEEE International Symposium on the Application of Ferroelectrics (ISAF '96), Brunswick Hilton and Tower, East Brunswick, NJ/Rutgers University (see p. 18)
26-29	• 3rd European Conference on Applications of Polar Dielectrics (ECAPD-3), Bled, Slovenia (see *Ferroelectricity Newsletter*, Vol. 3, No. 4, p. 13)
Sep 2-4	• Electroceramics V, University of Aveiro, Portugal (see p. 19)
25-27 30	• 9th International Symposium on Electrets (ISE 9), Shanghai, China • Workshop at ISE 9: The Future of Electrets and Surveys on Ongoing Electret Research (see *Ferroelectricity Newsletter*, Vol. 3, No. 4, p. 14)
Dec 2-6	• MRS Fall Meeting, Boston, Massachusetts. For information contact Werner Lutze, University of New Mexico, phone (505) 277-7964, fax (505) 277-5433, e-mail brbl@unmb.unm.edu

SPACE SYSTEMS ACADEMIC GROUP
CODE SP
NAVAL POSTGRADUATE SCHOOL
MONTEREY, CA 93943