Ferroelectricity Newsletter

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

Volume 2, Number 1 Winter 1994

LOOKING BACK AND LOOKING AHEAD

In the Roman pantheon, Janus, artistically represented with two faces, was the god identified with all beginnings. With this issue we begin the second year of publication of the ***Ferroelectricity Newsletter***, and Janus, with one face looking back and the other directed to the future, seems to be an appropriate symbol for Volume 2, Number 1. Here is why:

Professor Eric Cross, whom some of you have had the pleasure to hear speak at conferences, has graciously set time aside from his busy schedule to delight us with one of his extraordinarily vivid accounts of the early years of ferroelectricity. In general, his articles, as his talks, have only one flaw: they end too soon. Professor Cross, however, mentioned that he may write more short articles telling the rest of the story of ferroelectricity as he experienced it during his 45 years of involvement in the field.

If the account of the early years of ferroelectricity represents Janus's face looking back to the past, the news release by Professor Araujo stands for Janus's face looking ahead to the future.

The 30 January 1992 issue of ***Electronics Times*** (European edition) reported a breakthrough in ferroelectric materials for use with nonvolatile memories, to be announced at the ISIF 92 in Monterey, California. At that time one could hear skeptical voices who said it was too early to term the findings a breakthrough. But research and experimentation went on, sometimes under difficult circumstances, and now, two years later, there is no shadow of a doubt: it was a breakthrough judging by the results it produced. On page 2 of this issue you find a list of achievements so far. We can be sure that this list will be continued in the future.

Indeed, 1994, being the centennial of the observation of the first dielectric anomaly with temperature in Rochelle Salt, promises to be a year when we find out about the roots as well as the future of ferroelectricity. It will be an exciting year.

Rudolf Panholzer
Editor-in-Chief

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EMF-7 PROCEEDINGS

The Proceedings of the Seventh European Meeting on Ferroelectricity (EMF-7), which took place from 8 - 12 July 1991 in Dijon, France, have been published in ***Ferroelectrics*** Volumes 124 - 128 (1991 and 1992).

Volume 124
Section 1: Theoretical Aspects of Ferroelectricity

Tricritical Point Behavior and Quadrupole Interactions in Ferroelectrics
R. Ramírez, M. Fé Lapeña, and J. A. Gonzalo

Thermal Fluctuations of the Domain Wall Position in Impure Crystal
N. I. Lebedev and A. S. Sigov

Nucleation on a Moving Twin Boundary
A. A. Bulbich and P. E. Pumpyan

Quantum Mechanics of a Proton or Deuteron on a Single H-Bond: Fluctuating Potential and Friction Term
A. Becker and R. Siems

Interacting Protons in Two Double Minimum Potentials: Quantum Mechanical Calculations
H. Blaurock and R. Siems

Sound Absorption in Quantum Hydrogenous Ferroelectrics
A. I. Morosov and A. S. Sigov

Theoretical Model for the Modulated Phases of the Dielectric A_2BX_4 Family and BCCD
M. B. Walker and Z. Y. Chen

Models for the Phase Diagrams of A_2BX_4 and Similar Compounds
T. Janssen

On the Phenomenological Theory of phase Transitions in Betain Calcium Chloride Dihydrate
D. G. Sannikov

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LATE BREAKING NEWS

COOPERATION BETWEEN MATSUSHITA AND SYMETRIX PRODUCES NEW FERROELECTRIC DEVICES

On 14 December 1993, Carlos Paz de Araujo, professor at the Electrical Engineering Department of the University of Colorado at Colorado Springs, where he heads the Microelectronics Laboratories, and Chairman of the Board of Symetrix Corporation at Colorado Springs, issued the following corporate press release:

• **Matsushita Electronics Corporation** increased production of **ferroelectric (BST) based microwave monolythic integrated circuits (MMICs)** using GaAs/$Ba_{.7}Sr_{.3}TiO_3$ **barium strontium titanate capacitors**. Production now is 100,000 devices per month. Cellular phones using these devices are sold in Europe and Japan under several brands, including Panasonic.

• The first demonstration of **ferroelectric thin films in a VLSI chip** occurred recently at **Matsushita**. A COMB filter - a CCD device which is used in VCRs and video cameras was developed and is being put in a pilot production line. These devices will reach production of about 300,000 per month by April 1994. A BST ($Ba_{.7}Sr_{.3}TiO_3$) capacitor on chip is used.

• For the last six years, no ferroelectric device has been shown at the International Solid State Circuits Conference (ISSCC). The last device was a 256 bits 4T/4C device using PZT made by Ramtron. On 18 February 1994 -- on the eve of the seventh year -- **a 256 kilobit 1T/1C memory operating at only 3 volts for read/write and 100 nsec** (with a very large cell) will be shown by the **Matsushita/Symetrix** team. This device shows no fatigue tested up to $5x10^{12}$. It is the lowest power ferroelectric memory to date and also the only successful implementation of a 1T/1C (DRAM-like) architecture. The material used is Symetrix's proprietary Y-1.

• At the ISSCC, **Micron Semiconductor** of Boise, Idaho, will review an invited paper with results of BST and Y-1. The paper stresses renewed interest in ferroelectrics as thin film capacitor reliability is increased.

• **Symetrix** announces that their room temperature LSCVD equipment achieved **BST with leakage below 10^{-10}A/cm^2, dielectric density over 30 fF/μ^2 with high breakdown voltage at 400A.** High profile step coverage has been achieved. Symetrix holds several patents on this technique known as Liquid Source CVD. The company has developed 6-inch reactors and will introduce results with 8-inch reactors at the ISIF 94.

Papers introducing the **new Matsushita/Symetrix memory** at the **ISSCC 1994** on 18 February at the San Francisco Marriott:

16.1 Memory Applications of Integrated Ferroelectric Technology
W. Kinney and F. Gealy **(10:45 am)**
Micron Semiconductor Inc., Boise, ID

16.2 A 256 kb Nonvolatile Ferroelectric Memory at 3V and 100ns
T. Sumi, N. Moriwaki, G. Nakane, T. Nakakuma , **(11:15 am)**
Y. Judai, Y. Uemoto, Y. Nagano, S. Hayashi, M. Azuma, E. Fujii, S. Katsu, T. Otsuki, and G. Kano (Matsushita Electronics Corp., Kyoto)
L. McMillan &C. Paz de Araujo (Symetrix Corp., Colorado Springs, CO)

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CONFERENCE REPORTS

SECOND INTERNATIONAL CONFERENCE ON MAGNETOELECTRICS

The Second International Conference on Magnetoelectrics, chaired by Professor Hans Schmid from the University of Geneva, was held from 12 to 17 September 1993 at Ascona, Switzerland.

Magnetoelectrics are materials that are ordered both electrically and magnetically. The most interesting are those which are simultaneously ferroelectric and ferromagnetic, although all four combinations of ferroelectricity and antiferroelectricity with ferromagnetism and antiferromagnetism receive attention. The history of investigations of phenomena arising from these ordered states and their mutual interaction is long and colorful, beginning with Pierre Curie, taking some embarrassing wrong turns in the 1920s before application of group theory in solid state physics was done carefully, but blossoming twenty years ago with specific theoretical predictions by Dzyaloshinskii and experimental discoveries by Astrov and coworkers. About the same time Borovik-Romanov discovered experimentally the related phenomenon of piezomagnetism.

The first international conference on magnetoelectrics was run in 1973 in the USA at a time when many of the principal contributors—predominantly in the USSR—were unable to attend. An excellent conference proceedings was edited by Freeman. And for roughly twenty years plans were delayed for a sequel. In September it finally happened, complete with almost all the original contributors—Dzyaloshinskii (now at U.C. Irvine), Borovik-Romanov, and Astrov included, but G. Rado absent due to ill health.

This conference was not merely a fraternal reunion of important but aging pioneers. It was marked by qualitative and exciting new discoveries. From this reviewer's perspective the most important and elegant results were those of R. Pisarev (Ioffe Institute, St. Petersburg) on nonreciprocal optical reflections from magnetoelectrics. Applications of the pertinent theories to high-T_C superconductors were also suggested (I. Dzyaloshinskii, Irvine; P. Toledano, Amiens), though in most cases prior to experimental results. Other new directions including the theory of toroidal ordering and possible examples in nature. Some excellent tutorial reviews (e.g., Borovik-Romanov, Moscow) were interspersed with new results, sometimes unpublished, which gave the conference nice balance and mix.

This aspect of ferroelectricity research never reached the commercial level of success anticipated for it in 1975 (as fast, high speed computer memory devices); that dream stimulated much of the beautiful physics of boracite-family ferroelectrics (largely at Battelle Institute) in the 1970s. At present the results are likely to interest primarily the "pure" end of ferroelectrics research but with possible impact in the areas of nonlinear optics and superconductivity.

The conference was notable for its excellent food and fine accommodation (Monte Veritas is a superb conference center) and the outstanding attention to detail by Prof. Schmid and especially Dr. Ye and Dr. Rivera. A

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EMF-7 PROCEEDINGS

cont.

Section 2: Crystal Growth and Structure

Correlation Between the Dielectric Properties and Crystallographic Structure of D-Serine Admixtured TGS Crystals
J. Stankowska. Z. Bochynski, A. Czarnecka, and L. Dejneka

$K_2(NbO)_2SiO_{12}$: A New Material for Non-Linear Optics
M. P. Crosnier, D. Guyomard, A. Verbaere, Y. Piffard, and N. Tournoux

Crystal Growth of $K(Ta_{1-x}Nb_x)O_3$ Solid Solutions
B. Hellermann, F. Baller, B. Gather, H. Hesse, and R. Pankrath

Crystallographic and Dielectric Properties of New Ferroelectric Oxyfluorides Related to $KNbO_3$
L. Benziada, Z. Ladjeroud, and J. Ravez

Growth of $PbZr_{1-x}Sn_xO_3$ Single Crystals and Their Phase T,x-Diagram
B. S. Toubou, V. G. Smotrakov, and O. E. Fesenko

$Pb_2A\ Nb_5O_{15}$(A = Li,Na,K) Ferroelectrics: Novel Data on Their Structure and Phase Transitions
E. Gagarina, V. Filipiev, T. Ivanova, V. Sakhnenko, V. Eremkin , and V. Smotrakov

X-Ray Diffraction Study of $RbLiCrO_4$
I. P. Makarova, I. A. Verin, and K. S. Aleksandrov

DTA and X-Ray Studies of - $LiNH_4SeO_4$ Single Crystals
B. Hilczer, A. Pietraszko, P. Piskunowicz, L. Szczepanska, and J. Stepien-Damm

Influence of Water Vapor Pressure and Mechanical Treatments on Phase Stability in $MHXO_4$ and MH_2PO_4 Salts (M = K, Rb Cs, NH_4; X = S, Se)
A. Lunden, B. Baranowski, and M. Friesel

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EMF-7 PROCEEDINGS

cont.

Size Effect in a Nucleation and Growth Transformation
O. Delcourt, M. Descamps, and H. J. Hilhorst

Crystal Growth and Vibrational Spectra of Lithium Hydrogen Malate $LiH_3(C_4H_4O_5)_2$
M. Kemiche, P. Becker, C. Carabatos-Nedelec, F. Brehat, and B. Wyncke

Neutron Diffraction Study of the Electric Field Influence on $Sr_xBa_{1-x}Nb_2O_6$ Mixed Crystals
F. Prokert, A. M. Balagurov, D. Sangaa, and B. N. Savenko

Textured Bi-System Crystalline Structure Obtained by the Czochralski Method
M. B. Kosmyna, A. B. Levin, A. I. Mashkov, and V. P. Seminozhenko

Section 3: Phases Transitions (including Incommensurate and Ferroelastic)

Optical Study of the Transition of Doped Potassium Tantalate
G. P. Banfi, P. Camagni, E. Giulotto, G. Samoggia, and U. T. Höchli

The Order-Disorder Phase Transition in KSCN
O. Blaschko, W. Schwarz, W. Schranz, and A. Fuith

Birefringence Behavior at the N-IC Phase Transitions in One-Dimensionally Modulated Crystals: K_2SeO_4 and BCCD
J. Kroupa

Comparative Study of Critical Behavior in Several One-Dimensionally Modulated Incommensurate Phases by Quadrupolar Perturbed NMR
R. Walisch, J. Petersson, D. Schüssler, S. Kluthe, A. Trampert, and K.-P. Holzer

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CONFERENCE REPORTS

MAGNETOELECTRICS CONFERENCE

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high degree of informal interaction occurred; the conference banquet and outing were notable successes. A third conference on magnetoelectrics is planned for Russia in three years.

INTERNATIONAL CONFERENCE ON ULTRASONIC ATTENUATION AND INTERNAL FRICTION

This conferene, held in Rome from 5 to 9 September 1993, is one in a distinguished and long-running series, dating back some fifty years or so. This year's version was held in the main La Sapienza campus of the University of Rome in September, when Rome is at its best. September sunshine, pines, fountains, and pasta. The venue for the conference is the campus where both Marconi and Fermi labored and is certainly distinguished in the annals of physics.

The conference emphasized metal physics, including "warm" superconductors. Of interest to the ferroelectrics community, however, were several papers on loss mechanisms in ferroelectric oxides. There was a session devoted to thin films. And of course there is considerable overlap of interest in oxide perovskites from the superconductivity community and the ferroelectrics community. Of the review keynote talks that of Fossheim (Trondheim) was notable in its attempt to show evidence for subtle phase transitions, possibly related to ferroelectricity, in the $YBa_2Cu_3O_7$ family. Prof. Wang (Nanjing) also discussed related problems in other (ferroelectric) oxides.

This conference was marked by the high quality of its informal "hallway" discussions. A dominant theme was the following: Ultrasonic attenuation is perhaps the most sensitive of all spectroscopic techniques for the discovery of structural phase transitions. It has repeatedly uncovered many subtle displacements (e.g., $BaMnF_4$) years before X-ray or neutron scattering has confirmed the existence of a transition via conventional Bragg scattering. However, the ultrasonic results give almost no direct structural information. Therefore, while often stimulating, they invariably raise more questions than they answer. Lead-strontium titanate ceramics are ferroelectrics of interest in which a half dozen highly reproducible ultrasonic attenuation anomalies between 25 and 100K have been observed (Hegenbarth, 1977; Venevtsev et al., *Ferroelectrics* 130, 245 (1992); but it is by no means obvious that these are due to structural phase transitions. The ferroelectricity community would benefit from greater use of ultrasonic attenuation and internal friction techniques, particularly if we are able to integrate them with methods (NMR, light scattering, XRD) that give greater structural detail.

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Melbourne, Australia

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HISTORY

FERROELECTRICITY: The Early Years

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The proper history of ferroelectricity has been documented in several resent papers [1,2,3] and the important roles of a number of the key players recognized by appropriate tributes in *Ferroelectrics* and other journals. [4,5] The following is not intended to compete at all in this arena, but rather to give a more lighthearted set of personal reminiscences about some of the events, people, and programs which have contributed most strongly to my own involvement and continuing personal interest in this whole subject area. If our editor, Hannah Liebmann, has sufficient patience and tolerance, this may be the first of two or three short articles, covering the 45 years of my involvement in the field during which I had the privilege and pleasure to meet with many of its most eminent practitioners.

Contrary to the belief of many of my students, I was not around at the origination of the term ferroelectrics by J. Valasek in 1920 to describe the hysteretic nonlinearity in the polarization response in Rochelle Salt. I was even too young to appreciate the relief in the community on the discovery of the similar phenomenon at low temperature in potassium dihydrogen phosphate (KDP) by Busch and Scherrer in 1935, with the simpler structure and much more stable properties. My initiation to ferroelectricity followed quite closely on the end of World War II. After a stint in the British Admiralty I returned to Leeds University to take a B. Sc. in Physics. Following the B.Sc. I was fishing around for a Ph. D. topic and was discussing my options with Dr. Richard Whiddington, the then head of department in Leeds who had recently returned from Washington, D.C., where he worked as a scientific attaché in ONR. Whiddington gave me a whole stack of research reports from the National Lead Company. Work by Wainer and Saloman, who had been under contract to ONR to find ceramic dielectric substitutes for mica, which had run into short supply during the war due to U-boat activity. These National Lead Reports covered a fantastically broad material synthesis program and were a cornucopia of data on a wide range of new double oxides with the simple perovskite structure and fascinating ferroelectric-like dielectric properties.

This set me off reading parallel studies, early reports from the Laboratory for Insulation Research at MIT etc., but it was certainly the work of Wainer and Saloman which set me off on a "love affair" with the perovskites which has lasted more than half a lifetime. Professor Stoner, the great band theory magnetician in Physics at Leeds, was rather miffed that I did not join his group and I well remember his comment, "So, Cross, you are going to waste your time researching this trivial lattice phenomenon!"

Since Whiddington was also a magnetics man, we started to look for Barkhausen pulses in the charging current of $BaTiO_3$ capacitors and much to

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EMF-7 PROCEEDINGS
cont.

Pseudo Spin-Phonon Coupling Model of the Normal-Incommensurate Phase Transition of C_2O_4D ND_4, $1/2D_2O$
M. Krauzman, A. Colline, M. Debeau, D. Kirin, F. Moussa, R. M. Pick, M. Quilichini, and N. Toupry

Study of -Incommensurate-ß Transitions in Quartz by White Beam Synchrotron Radiation Laue Method
V. Soula, G. Dolino, B. Capelle, and Y. L. Zheng

A Study of Long Time Correlations in Finite ^{4}-Systems (d = 1,2) by Use of Molecular Dynamics
S. Flach, J. Siewert, R. Siems, and J. Schreiber

Molecular Dynamics of a Ferroelectric Exhibiting Two Phase Transitions
R. Hemmerling, K. H. Weyrich, and R. Siems

Order Parameter Saturation at Low Temperatures--Numerical Results for Displacive and O/D Systems
E. Salje, B. Wruck, and S. Marais

Defects and Ferroelectric Phase Transitions
B. A. Strukov, S. A. Taraskin, and A. B. Suvkhanov

222K Structural Phase Transition of Hexagonal $BaTiO_3$ Under Uniaxial Pressure
H. Yamaguchi, H. Uwe, and T. Sakudo

Existence of Two Time Scales in the Phase Transitions of $BaTiO_3$
K. Laabidi, M. Fontana, and B. Jannot

The Phase Transition Dynamics in $Na_{1/2}Bi_{1/2}TiO_3$
I. G. Siny, T. A. Smirnova, and T. V. Kruzina

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EMF-7 PROCEEDINGS
cont.

Peculiarities of Structure and Phase Transitions in Lead-Containing Ferroelectric Perovskites
M. Kupriyanov and V. Kogan

Time Dependent Properties of $PbZr_xTi_{1-x}O_3$ Crystals
K. Roleder, D. Grzywacz, and J. Wolak

On the Phenomenology of Diffuse Phase Transitions in PLZT
H. Schmitt and B. Kirsch

Ferroelectric Phase Transitions and Domain Relaxation in $KTa_{1-x}Nb_xO_3$
D. Sommer, D. Friese, W. Kleemann, and D. Rytz

Dipolar Freezing of Glassy $K_{1-x}Li_xTaO_3$, x = 0.011
F. Wickenhöfer, W. Kleemann, and D. Rytz

Variations of the Second Harmonic Intensity at the Low Temperature Phase Transition in $K_{1-x}Li_xTaO_3$ Under Electric Field
P. Voigt and S. Kapphan

Phase Transitions in $Li_xNa_{1-x}NbO_3$ Solid Solution for $0 < x < 0.1$
C. Kus, W. S. Ptak, and W. Smiga

NMR Investigation of Crystals with Diffused Phase Transitions
M. D. Glinchuk, I. P. Bykov, and V. V. Laguta

Order-Disorder Aspects in $PbIn_{0.5}Ta_{0.5}O_3$ Crystals
A. Kania and M. Pawelczyk

Dielectric Properties for Differently Quenched $PbIn_{0.5}Nb_{0.5}O_3$ Crystals
A. Kania and E. Rówinski

Investigation of Phase Transitions in $Pb(In_{0.5}Ta_{0.5})O_3$ Crystals
A. A. Bokov, I. P. Rayevsky, V. V. Neptrin, and V. G. Smotrakov

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HISTORY

EARLY YEARS OF FERROELECTRICITY
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the boss's joy found lots of spikes in charging our rather poorly prepared ceramics. These pulses probably had nothing to do with the domain switching we imagined to be taking place! Fortunately at just about this time Bernt Matthias and Walter Merz published a recipe for growing $BaTiO_3$ single crystals, so like true physicists we could get away from the messy ceramics.

At that time I was working with Arthur Dennison, a geoscience graduate student. Our total budget for the year was £100 ($400 at the then rate of exchange) but using crystal grown in a borrowed platinum crucible, examined on a loaned polarizing microscope, we published our first results on domains in $BaTiO_3$ in that prestigious journal *The Proceedings of the Leeds Philosophical and Literary Society!*[6] This was followed by two short notes to *Nature*, which were, much to our surprise, accepted for publication.

The research was low key, very low pressure. Professor Whiddington always took the long summer break at his cottage on the Norfold Broads so there was a lot of time to read, think, and experiment. That fall was unusually cold in Leeds, and I well remember turning off the heat in the lab, opening all the windows and with the microscope balanced on the window ledge making some early optical observations of the low temperature phase near 0˚C in our crystals.

England was not a strong hub for ferroelectric work but about this time, following the *Nature* articles, we had our first prestigious foreign visitor, Dr. Forsberg from MIT, resplendent in full Navy uniform. He was returning the compliment as US Navy representative at the new ONR office in London. He made us aware of the gorgeous square net domain patterns in $BaTiO_3$ crystal grown with impurity gradients, a structure we have come to call Forsberg patterns.

I believe, perhaps fortunately, Dr. Dennison and I were probably the world's worst crystal growers so in spite of all our best efforts we finished up with minuscule 1/2 mm square ultra thin samples almost ideal for selecting simple domain patterns, easy to interpret in the polarizing microscope. To make electrical measurements, we had to miniaturize our electroding methods using masking and evaporation; primitive in the extreme compared to modern lithographic methods but adequate to get down to 0.2 mm diameter electrodes.

Our tiny crystals showed square hysteresis loops with Pr - 25 $\mu c/m^2$, well above the then accepted 16 $\mu c/cm^2$ for $BaTiO_3$, clear first order change at the Curie point T_c and double hysteresis above T_c. The behavior was just as predicted in A.F. Devonshire's elegant phenomenology, but not at all what referees expected. It was a great relief when Walter Merz published his much more detailed evaluation of Joe Remeikas lovely 'c' domain crystal, and we were finally able to get our results published.

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HISTORY

EARLY HISTORY OF FERROELECTRICTY

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Following the $BaTiO_3$ work I was offered an Imperial Chemical Industries fellowship at Leeds in Physics with the princely salary of £600 per year. This enabled a start on the Sodium Niobate ($NaNbO_3$) work with Basil Nicholson. Bernt Matthias had classified $NaNbO_3$ as ferroelectric and Ray Pepinsky was firmly in that court. Bertie Kay and his student Vousden, at Bristol University, however, had made very careful X-ray measurements and found clear antipolar displacements of the Nb ions and a multiple unit cell suggesting antiferroelectricity. This looked just like the sort of problem which might be resolved by incompetent crystal growers producing tiny crystals with simple twin patterns. In fact, it proved much more difficult to get the simple crystal because of the lower room temperature orthorhombic symmetry, and Basil and I spent many long nights searching through thousands of crystals for just the right twinning and orientations. However, again using miniature electrodes, we were able to demonstrate clear double hysteresis and antiferroelectricity, so the controversy was resolved.

Now, however, using the luxury of homemade heating and cooling stages, we were able to explore a whole raft of new high temperature phase changes and one very exciting new low temperature phase change, opening the subject for many years of future X-ray studies.

During the time of the $NaNbO_3$ work, the British Physical Society held a provincial meeting in Leeds which brought both Helen Megaw and A.F. Devonshire to the laboratory. As a crass rather callow young post doc I remember with real joy their interest and enthusiasm for the $NaNbO_3$ work we were doing and the helpful discussions which went on well into the night after the meeting. Megaw was enthusiastic to take up X-ray studies of our crystals, and this early meeting lead on to a long period of cooperation. At this time also following Kittel's earlier phenomenology, I was embarking on a three-dimensional phenomenology for the $NaNbO_3$ antiferroelectric, and the help from Devonshire was vital for me to muster the confidence to publish that more ambitious study.

Looking back at the very informal magnanimous manner in which these two great people generously gave of their time, I am very much saddened to see how our current highly competitive "dog eat dog" scramble for research funding and survival militates against such help for the present generation of graduate assistants.

My period at Leeds ended with a major meeting on ferroelectrics called by the British Ministry of Defense at Christ Church in Dorset. I was an invited speaker on the $NaNbO_3$ work and Bernt Matthias was the keynote speaker. In view of my findings on antiferroelectricity I was in fear of some possible interaction from the Great Man, but all went well. At the meeting I was recruited by the electrical Research Association and began new studies of bismuth strontium titanate, a dielectric which was of high interest to Erie company, then a member of the Association.

Before leaving Leeds just one personal story about the shortage of housing for faculty at that time. Since our first landlady was an alcoholic,

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EMF-7 PROCEEDINGS

cont.

Optical and Electric Investigations of the Phase Transitions in Pyrochlore $Cd_2Nb_2O_7$
Z. G. Ye, N. N. Kolpakova, J. -P. Rivera, and H. Schmid

Optical and Dielectric Studies on Ferroelectric Oxyfluoride $K_3MoO_3F_3$ Single Crystals
Z. G. Ye, J. Ravez, J. -P. Rivera, J. -P. Chaminade, and H. Schmid

X-Ray Diffraction Study of the Phase Transitions in the Ferroelectric $Pb_5(Cr_{1-x}Al_x)_3F_{19}$ System
V. Andriamampianina, J. Ravez, J. Ihringer, and S. C. Abrahams

R_{25} and M_3 Soft Mode Competition Near the Structural Phase Transition in $KCaF_3$
C. Ridou, M. Rousseau, P. Daniel, J. Nouet, and B. Hennion

Phase Transitions in $Rb_{1-x}K_xCaF_3$ Studied by EPR
A. M. Minorel, G. Silly, and J. Y. Buzaré

Critical Behavior of [110]-Stressed $RbCaF_3$
J. Y. Buzaré, W. Berlinger, and K. A. Muller

Effect of B^{3+} Ion Size on the Phase Transitions in $Rb_2Kb^{3+}F_6$ Elpasolites Series
I. N. Flerov, A. Tressaud, K. S. Aleksandrov, M. Couzi, M. V. Gorev, J. Grannec, S. V. Melnikova, J. P. Chaminade, S.V. Misyul,, and V.N. Voronov

Phase Transitions in $K_{1-x}Rb_xAlF_4$: I—X-Ray Scattering Study
F. Brunet, A. Gibaud, C. Ridou, and J. Nouet

Phase Transitions in $K_{1-x}Rb_xAlF_4$: II—Brillouin and Ultrasonic Studies
F. Ganot, M. Papin, A. Bulou, and P. Moch

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EMF-7 PROCEEDINGS
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Phase Transitions in $K_{1-x}Rb_xAlF_4$: III—Birefringence Measurements
R. Farhi, D. Sommer, and W. Kleemann

EPR Study of $[Mg(H_2O)_6]SiF_6$: Mn^{2+} in the Incommensurate Phase
R. Hrabanski

Interpretation of the Difference Between the KCN and RbCN Elastically Ordered Structural Phase on the Basis of a Pseudo-Oriented Dipole Potential Mode
P. Bourson and D. Durand

Phase Front and Dielectric Measurements in KD_2PO_4
J. Bornarel and R. Cach

Neutron-Diffraction Studies of the Heavy-Atom Structure H-Ordering Materials
M. I. McMahon, R. J. Nelmes, R. O. Piltz, W. F. Kuhs, and N. G. Wright

High-Pressure Neutron-Diffraction Studies of KH_2PO_4-Type Phase Transitions as T_c Tends to 0K
R. J. Nelmes, M. I. McMahon, R. O. Piltz, and N. G. Wright

Nonlinear Dielectric Properties of CsH_2PO_4
V. Müller, G. Sorge, and L. A. Shuvalov

Structural Studies of Potassium Titanyl Phosphate(KTP) Under High Pressure
D. R. Allan, J. S. Loveday, R. J. Nelmes, and P. A. Thomas

Raman Scattering and Phase Transitions in Titanylorthophosphates: A Comparative Study
M. Serhane, C. Dugautier, R. Farhi, P. Moch, and R. V. Pisarev

Crystallographic, Ferroelectric and Nonlinear Optical Properties of the $K(Ti_{1-x}Sb_x)O(P_{1-x}Si_x)O_4$ Compounds
J. Ravez, A. Simon, B. Boulanger, M. P. Crosnier, and Y. Piffard

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HISTORY

EARLY HISTORY OF FERROELECTRICITY
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and my wife was expecting our first child, we had to move. The university was buying up old properties in the vicinity of the lab and we were offered a basement and first floor of one of these old Victorian houses, complete with stables at the back for the carriage horses. I bundled the wife into a taxi for a first look at our new home and gave the address to the taxi driver. I got a very queer look from the driver.

"Are you sure of the address, sir?"

"Yes," I said.

"You taking the young lady?" he asked.

"Yes," I said again, "she is my wife."

"Well, if you must, sir."

It turned out that our new Victorian style abode had been a very well known house of ill repute (brothel) before the University bought it, and the cabby was doing his best to protect me from possible folly!

The ERA in Perivale (later moved to Leatherhead) in Surry was a typical British invention with its programs to be paid for between industry and government. Of course each thought that the other should pick up the whole tab, so it was already short of money. The pace of work was, however, modest, with lots of coffee and tea breaks for group discusisons. The lab had been responsible under Whitehead for some of the fundamental advances in dielectric breakdown studies and was a most interesting group to work with.

My immediate companion was a Dr. Vera Daniel, an expert on dielectric relaxation and a great help to me since the topic of study $Bi_{2/3x}Sr_{1-x}TiO_3$ was a Skanovi dielectric with unusual low temperature relaxation properties. Bismuth strontium titanate lead inevitably to later studies of the lead magnesium niobates relaxor ferroelectrics, an involvement which goes on to this day.

The Research Association was a civilized group giving lots of freedom for ancillary studies. I was able to finish the $NaNbO_3$ phenomenology, and the work which I had started in Leeds on the $NaNbO_3$:$KNbO_3$ solid solution system. Leatherhead being close to London, it was possbile to attend many of the Physical Society Crystallography Association and IEEE meetings.

Speakers who made a deep impression during that period included: Dr. Hans Jaffe discussing the major advances in piezoelectric ceramics effected by the work at Clevite Corporation; Helen Megaw with the first outlines of a covalent bonding model for the perovskite oxides, a model shown now to be at the whole base of the behavior; Chalmers Fraser on the basic structure and the difficulty of pinning down precise titanium ion displacements in $BaTiO_3$ by X-ray methods.

Over this period, the excellent little book by Megaw on ferroelectric crystals appeared. Our attention was frequently directed to Penn State where Ray Pepinsky was building the outstanding ferroelectric group with Gen Shirane, Franko Jona, Vedam, Barsch, Mitsui, and a host of other visitors from Japan. Bell Labs was a comparable power house in the field with Bernt Matthias, Walter Merz, Bob Miller, Elizabeth Wood, and a crew of exceptional physicists and crystallographers.

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UPCOMING MEETINGS

EARLY HISTORY OF FERROELECTRICITY

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In those late 1950s one could still read *Physical Review* for fun, and each issue seemed to bring a new ferroelectric, TGS, $LiNbO_3$, $Bi_4Ti_3O_{12}$, and a host of others.

Perhaps the most critical event in my career was the "toss of a coin" decision to go to the International Union Meeting on Crystallography, which in 1960 was in Cambridge. It was at that meeting that my old tutor from Leeds, George Brindley, one of the world's most eminent clay mineralogists, met me with an invitation to come to Penn State. He was then head of the Ceramics Department at Penn State and after much personal heart searching we decided to move our family, now with three sons, to the USA.

I realize now what a fantastic opportunity that simple invitation afforded to come in at the onset of the whole evolving materials research at Penn State. Truly a critical turning point or phase transition.

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4. Von Hippel Festschrift. *Mater. Res. Bull.* 6, 882 (1971).
5. Lang, S. Conversation with Professor W.G. Cady. *Ferroelectrics* 9 (3/4), 141-149 (1975).
6. Cross, L.E., A.T. Dennison, M.M. Nicholson, and R. Whiddington. *Proc. Leeds Phil. Lit. Soc.*, Part 3, 199-206 (1948).

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UPCOMING MEETINGS

Symposium on Silicon Nitride and Silicon Dioxide Thin Insulating Films
San Francisco, 22 - 27 May 1994

The objective of this symposium, sponsored by the Electrochemical Society at its Spring meeting, is to link material studies and technological applications to allow for clearer design and design processing considerations for the fabrication of devices and integrated circuits (VLSI/ULSI) which incorporate these thin insulating films. **Contact**: V.J. Kapoor, Dept. of Electrical Engineering and Computer Science, ML 30, University of Cincinnati, Cincinnati, OH 45221-0030, Phone (513) 556-1769; or W.D. Brown, Beca 3217, University of Arkansas, Fayetteville, AK 72701, Phone (501) 575-3009.

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EMF-7 PROCEEDINGS
cont.

Electrical and Thermal Studies of the High Temperature Phase Transitions of $(NH_4)_2SO_4$ Crystals
A. El-Korashy and G. A. Mohamed

Effect of Radiation Damage in $NaNH_4SO_4{\cdot}2H_2O$ Single Crystals
B. Hilczer, H. G. Darwish, and J. Wolak

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Symmetry Analysis of the Ferroelastic Phase in $LiKSO_4$
M. S. S. Dantas, G. J. Perpetuo, R. A. Nogueira, and M. A. Pimenta

Damping of the Elastic Waves in $LiKSO_4$ Single Crystals Near the Phase Transition at 190K
M. Czajkowski, M. Drozdowski, and M. Kozielski

Brillouin Scattering and Dispersion of the Sound Velocity in $Rb_3H(SeO_4)_2$
S. G. Lushnikov and L. A. Shuvalov

Reexamination of the Influence of Hydrostatic Pressure on Phase Transition in NH_4HSeO_4 Crystals
R. Poprawski

Dielectric and Thermal Studies of the Phase Transitions in Cr-Cl Boracite
Z. G. Ye, J. -P. Rivera, P. Tissot, and H. Schmid

□

EMF-7 Proceedings
published in
Volumes 125 - 128 of
Ferroelectrics
will be indexed in subsequent
isuues of the
Ferroelectricity Newsletter

UPCOMING MEETINGS

Third Asian Regional Seminar on Microelectronics and Information Technology (TARSMIT '94)
Bangkok, 9 - 11 August 1994

Keynote speakers from Indonesia, Malaysia, Phillipines, Singapore, Thailand, and Australia will discuss microelectronics, fabrication technology, sensors, and computer technology. Chairman: P. Thajchayapong, National Electronics and Computer Center (NECTEC), Ministry of Science and Technology, Rama VI Rd., Rajvithe, Bangkok 10400, Thailand.

International Symposium on Ferro- and Piezoelectric Materials and Their Application '94
Moscow, 29 August - 2 September 1994

This meeting is scheduled to follow the Russian-Japan biannual ferroelectricity meeting. **Contact:** Dr. V.V. Gagulin and Dr. S.K. Korchagina, Karpov Institute of Physical Chemistry, Ulitsa Obukha 10, Moscow 103064, Fax +095-975-2450.

International Exhibition on Ferro- and Piezotechnics '94
Moscow, 20 August - 10 September 1994

Chairman: Prof. Dr. Skorikov, Kurnakov Institute of Chemistry. **Contact** secretaries of the preceding conference for details; this is a commercial and industrial exposition.

8th International Symposium on Electrets (ISE 8)
Paris, 7 - 9 September 1994

Held every three years, the ISE will review the state of the art in the field of electrets from the point of view of both physical phenomena and applications. **Topics** include charging and polarization phenomena; charge storage and transport (trapping, injection, mobility, etc.); thermally stimulated effect; radiation effects and dosimetry; photoelectrets; ferro-, piezo-, and pyroelectricity; thin polymeric layers; nonlinear properties; molecular electronics; surface and contact phenomena; new experimental techniques; and applications. **Contact** Prof. J. Lewiner, Ecole Supérieure de Physique et de Chimie Industrielles (E.S.P.C.I.), 10, rue Vauquelin, 75005 Paris, France, Phone +33 1 40 79 45 31, Fax +33 1 47 07 91 75.

2nd Pacific Rim Workshop on Ferroelectric Applications
Royal Melbourne Institute of Technology
Melbourne, Victoria, Australia, 21 - 24 November 1994

Co-chairs are Prof. T. Shiosaki (Kyoto), Prof. Seong Ihl Woo (KAIST, Taejon), and Prof. J.F. Scott (RMIT). This follows a successful first meeting in Taejon in 1993. A 1995 sequel is planned in Japan. Conference proceedings will appear in ***Integrated Ferroelectrics***. Contact Prof. Scott at Faculty of Applied Sciences, RMIT, GPO 2476V, Melbourne, Vic. 3001, Australia. □

Conference Organizers

If you want current or back issues of the **Ferroelectricity Newsletter** *to distribute at your event, contact*
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1. Rank the following sections with number 1 being the most important and number 5 the least important to you:

Upcoming Meetings	1	2	3	4	5
Conference Reports	1	2	3	4	5
Index of Scientific Papers	1	2	3	4	5
Late Breaking News	1	2	3	4	5
Special Reports:					
Patent Survey	1	2	3	4	5
Professional Societies	1	2	3	4	5
Journals on ferroelectrics by Gordon and Breach	1	2	3	4	5
Ferroelectrics' "von Hippel" issue	1	2	3	4	5
Ferroelectricity: The Early Years	1	2	3	4	5
Calendar of Events	1	2	3	4	5

2. What else would you like to read about in the ***Ferroelectricity Newsletter***?

3. Do you find the newsletter easy to read?

4. Suggestions for improvement:

5. Would you like to become a contributor to the ***Ferroelectricity Newsletter***?

If yes, in which field would you like to contribute?

CALENDAR OF EVENTS 1994

Jan 29	• Abstract deadline for ISAF-94
Feb 6-9	• Third Williamsburg Workshop on First-Principles Calculations for Ferroelectricity, Williamsburg, VA (see *F. Newsletter* Vol. 1, No. 4, p.6)
Mar 1 14 - 16	• Abstract deadline for Electroceramics IV (see *F. Newsletter* Vol. 1, No. 4, p. 9) • ISIF 6 Monterey, CA (see *F. Newsletter*, Vol. 1, No. 3, p. 11)
Apr 4-8 24 - 28	• MRS 1994 Spring Meeting, San Francisco, CA (see *F. Newsletter* Vol. 1, No. 4, p. 6) • American Ceramics Society Meeting, Indianapolis, IN
May 22-27	• Symposium on Silicon Nitride and Silicon Dioxide Thin Insulating Films, San Francisco (see p. 9)
Aug 7-10 9-11 29-2 **Sep** 20-10 **Sep**	• 9th IEEE Internat. Symposium on the Applications of Ferroelectrics, University Park, PA (see *F. Newsletter* Vol. 1, No. 4, p. 8) • 3rd Asian Regional Seminar on Microelectronics and Information Technology, Bangkok (see p. 10) • Internat. Symposium on Ferro- and Piezoelectric Materials and Their Application '94, Moscow (see p. 10) • International Exhibition on Ferro- and Piezotechnics '94, Moscow (see p. 10)
Sep 5-7 6-9 7-9	• Electroceramics IV, Aachen, Germany (see *F. Newsletter* Vol. 1, No. 4, p. 9) • 3rd International Symposium on Domain Structure of Ferroelectrics and Related Materials (ISFD-3), Zakopane, Poland (see *F. Newsletter* Vol. 1, No. 4, p. 10) • 8th International Symposium on Electrets (ISE 8), Paris (see p. 10)
Nov 21-24	• 2nd Pacific Rim Workshop on Ferroelectric Applications, Melbourne, Australia (see p.10)
	1995
Jul 4-8	• 8th European Meeting on Ferroelectricity, University of Nijmegen, The Netherlands. For information contact Mrs. Rina Vos, Secretariat EMF8, Institute for Theoretical Physics, University of Nijmegen, Toernooiveld, 6525 ED Nijmegen, The Netherlands

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