The fourth International Meeting on Ferroelectricity

Leningrad, September 18-23, 1977

Sponsors:

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International Union of Crystallography

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The International Advisory Committee met during the Conference and it was decided that the next International Meeting on Ferroelectricity (IMF-5) would be held in the USA in 1981.

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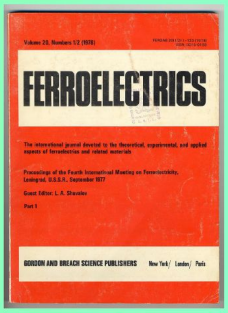

Introductory Speech

Dear Friends, Ladies and Gentlemen,

The first decades of our century mark a turning point in the history of mankind. In October 1917 in this city where our conference is taking place, the Great October Socialist Revolution began, and with it, the creation of a new society founded upon a classless social structure. The October Revolution has radically influenced the fate of hundreds of millions of people both here in our country and far beyond its borders. Sixty years later, the consequences of this revolution continue to play a deciding influence on the entire course of social development.

Great revolutionary changes occurred during the first third of our century in science, and particularly in physics. The theory of relativity radically changed our long-established conceptions of time and space; quantum mechanics showed the limits of the apparently universal and unchanging classical laws of mechanical movement, and formulated new laws which were applicable to the realm of micro-phenomena as well. Against the background of these mighty events, the work of Anderson and Valasek were almost unnoticed. I am referring to their investigations nearly sixty years ago in the United States of the dielectric properties of Rochelle Salt which gave rise to the Russian terminology of "seignette electric" materials.

In English scientific literature, these substances are called "ferroelectrics" as if to underline, by this not entirely natural combination of two words, the formal similarity between the electrical properties of ferroelectrics and the magnetic ones of ferromagnetics.

Although the phenomenon of ferroelectricity became known several thousand years later than that of ferromagnetism, it still did not attract much immediate attention. Only in the early 1930's here in Leningrad at the Physico-Technical Institute did Kurchatov and Kobeko carry out the multifaceted and rather complete experiments on Rochelle Salt and its isomorphic compounds that became the foundation for a new branch of solid state physics—Ferroelectricity. The results of this work were made known in Kurchatov's monograph, *Segnetoelektrik*, published in 1933.

The investigations of Rochelle Salt made possible the demonstration of the full symmetry between the electrical and magnetic properties of a substance; but it could not elevate the practical significance of ferroelectrics to the level which ferromagnetism had attained in technology. This was connected to the fact that Rochelle Salt because of some of its other properties—low mechanical stability, high hydroscopicity and a limited temperature range in which spontaneous polarization was secure—was only minimally useful for technological applications.

As a consequence of this, the study of ferroelectricity attracted little attention from other researchers. After Kurchatov's work, one notes only the discovery in Switzerland in 1935 of the ferroelectric properties of potassium dihydrogen phosphate which were of even less practical use than those of Rochelle Salt.

The turning point in the physics and technology of ferroelectrics came in 1944 in Moscow at the Physics Institute of the Soviet Academy of Sciences with the discovery of the ferroelectric properties of barium titanate. Prepared by a process long and well established in the production of ceramics, polycrystalline barium titanate can be polarized in an electrical field just as ferromagnetic substances are magnetized in a magnetic field.

The thermodynamic theory of the new ferroelectrics was developed at the Physics Institute of the Soviet Academy of Sciences in 1945. The theory's basic assumption, which was later verified experimentally, holds that the recurrence and the anomalies of ferroelectric properties are connected with phase transitions.

Barium titanate and related materials began to be studied, produced, and employed practically in the more highly industrialized countries. One may note that in the early years of developing barium titanate, the US and Soviet governments worked together in this field. Before ferroelectric properties were established in barium titanate it was thought that a hydroxyl group H—O was a necessary condition for ferroelectricity in crystals. It turned out, however, that this was not essential, and that in actuality, crystals of a rather simple composition and structure can be ferroelectric. This discovery inspired many researchers in various countries to search for new ferroelectric substances and their efforts were crowned with success.

In the Soviet Union, broad and fruitful research on ferroelectrics continues to be carried out at the Physico-Technical Institute in Leningrad, at the Institute of Crystallography of the Soviet Academy of Sciences, and the L. Ya. Karpov Physico-Chemistry Institute in Moscow, as well as at the several advanced institutes of the Academy of Sciences and in the Universities of Rostov, Dnepropetrovsk, Riga, Lvov, Voronezh, Kalinin and elsewhere.

Along with widely known investigations, research is developing in new directions, notably in the synthesis and study of substances possessing a combination of properties such as ferroelectric and ferromagnetic, or ferroelectric and semi-conductive, particularly photo-electrical properties. The successful work at the Institute of Crystallography and the Physico-Technical Institute of the Soviet Academy of Sciences deserves mention in this regard. Thus we can say that in a short time, ferroelectricity in all its multifariousness has become the subject of scientific and technological attention on a par with its older cousin ferromagnetism.

Itself the product of new technology of the past decades, ferroelectricity is becoming a useful and vital component of the latest technology—microelectronics and quantum electronics. In the first case, thanks to the large value of its absolute dielectric constant (permitivity), and in the second, because of the use of its non-linear optical properties for the multiplication of optical frequencies and the deflection and modulation of laser and other light.

Allow me to express my firm belief that our conference will serve the further strengthening of scientific ties among scientists of various countries, united by work on common problems of ferroelectricity, and that our common labour will lead to new successes in science and technology for the good of all humanity. I thank you for your attention and offer your my very best wishes.

B. M. WUL

Guest Editorial

The increasingly rapid growth of the significance of science in the life of mankind on a global, regional and local level is increasingly accompanied by the ever more decisive effect on the development of science by forces external to it. Still, the role of internal forces, i.e. the role of scientists' independent efforts, is in no sense excluded. In particular, the organization of various international scientific conferences, symposia, colloquia and so on is essentially the result of these scientists' initiatives and the fruit of their disinterested and indeed sometimes thankless labour.

It is difficult to overestimate the importance of such international scientific forums. They insure immediate and as usual most effective exchange of scientific information; they facilitate the coordination and co-operation of research; finally, and this is very important, they aid in the creation and strengthening of friendly working relations among scientists. That is, in the last analysis, they improve the general atmosphere in the world.

The history of the International Meetings on Ferroelectricity serves as a clear example. The first International Meeting on Ferroelectricity organized in 1966 in Prague through the initiative of Dr. Jan Fousek, established the study of ferroelectricity in the international arena as an important independent branch of solid state physics. Then came the second IMF in Kyoto, and the third IMF in Edinburgh, followed by the European Meetings on Ferroelectricity and other international symposia. The journal *Ferroelectrics* was born in 1970, and gradually there arose an international community of specialists in ferroelectricity, working in an atmosphere of mutual respect and good will. The organizers of the fourth IMF have endeavored to uphold their efforts to maintain and develop these traditions.

The fourth IMF took place in Leningrad, a city gifted by history, a city having many of the features of war than any other on earth. And the very atmosphere of Leningrad harmonized with that spirit of mutual respect and conviviality which according to many of the participants from various countries reigned at the conference. We may hope that this spirit will be maintained in the future, and will contribute to the strengthening of friendship and collaboration among scientists throughout the world, and to the improvement of relations among all peoples of the world.

The fourth IMF demonstrated the rapid growth of fundamental and applied achievements in ferroelectric science, its successful peaceful extension into related sciences, and the further increase in the number of organizations and specialists occupied with fundamental problems of ferroelectricity and its practical uses. The large number of young names among the authors of the papers stands as a guarantee of future successes in the science of ferroelectrics.

More than 80% of the papers read at the conference—particularly all of those submitted to the organizing committee during the conference and accepted shortly thereafter—are published in these proceedings. It was deemed advantageous in organizing the material not to hold to strictly to the order of the conference program, but rather to group the papers in sections by topic for the reader's greater convenience.

Refereeing of the papers by the chairmen of the plenary and section sessions together with a number of specialists have rendered a great service in the preparation of the manuscripts for publication. N. M. Sebagria and Dr. G. G. Kessenikh, colleagues at the Institute of Crystallography of the USSR Academy of Sciences, played a particularly important role in these preparations. As always, Dr. G. W. Taylor's help has been invaluable in initiating the work and speeding it to completion.

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FOURTH INTERNATIONAL MEETING ON FERROELECTRICITY

List of Participants

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CUBA
M. A. Garcia

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B. Brezina, J. Fousek, M. Glogarova, V. Janovec, J. Kaulich, C. Kosak, J. Krompa, J. Petzelt, F. Smutny, J. Zelenka

FINLAND
R. Laiho

FRANCE
P. Bastie, D. Bernard, G. Chanussot, A. Delabarre, G. Fernandes, G. Godefroy, L. Godefroy, P. Gonnard, A. Hadni, B. Khelifa, R. Le Bihan, F. Michel-Calendini, F. Micheron, J. Raves, C. Ridou, J. Sapriel, J. Schneck, J. C. Toledano, P. Toledano, M. Trocha

GERMANY (EAST)
H. Blumberg, H. Brauer, D. Bäbling, R. Danz, H. Dessmann, E. Hegenbarth, G. Helke, H. D. Kürsten, F. Pröhen, J. Schreiber, G. Schmidt, G. Sorge, W. Windisch

GERMANY (WEST)
J. Albers, D. Rinaldi, H. Böhm, K. H. Ehses, W. Gebhardt, U. Heister, E. Kratzig, H. Kurz, K. H. Michel, R. Migoni, R. Munser, J. Petersen, H. Schmitt, P. Seidel, H. Thomann, H. G. Unruh, D. Van der Linde, W. Wersing

GREECE
F. Milia

HUNGARY
B. Pelyi

INDIA
P. S. Narayanan

ITALY
M. Grandolfo, M. Vadacchino, P. Vecchia

JAPAN
R. Abe, K. Ema, K. Hamano, J. Hatano, S. Hirotsu, T. Hosokawa, M. Hosoya, K. Iiie, Y. Ishibashi, W. Kinase, J. Kobayashi, S. Kojima, M. Matsuoka, M. Midorikawa, T. Nagamoto, T. Nakamura, K. Okazaki, S. Saito, T. Saito, K. Sakata, S. Sawada, H. Shimizu, M. Takagi, Y. Takagi, T. Takenaka, H. Tamura, Y. Tominaga, K. Toyoda, Y. Ueno

MOROCCO
B. Elouadi

NETHERLANDS
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NORWAY
R. Holt

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SWEDEN
R. Limanga, C. Sajas

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U.S.S.R.
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