

Ceramic Materials and Multilayer Electronic Devices

Edited by

K.M. Nair

A.S. Bhalla

S.-I. Hirano

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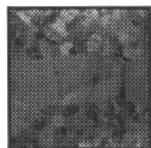
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*Proceedings of the High Strain Piezoelectric Materials, Devices, and Applications
and Advanced Dielectric Materials and Multilayer Electronic Devices Symposia
held at the 105th Annual Meeting of the American Ceramic Society, April 27–30,
2003 in Nashville, Tennessee.*

Edited by

K. M. Nair

E. I. duPont de Nemours & Co. Inc.

A. S. Bhalla

The Pennsylvania State University

S.-I. Hirano

Nagoya University

D. Suvorov

Jozef Stefan Institute

R. W. Schwartz

University of Missouri-Rolla

W. Zhu

Nanyang University

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Preface

The growth of materials research, development of technology, and product innovation has been extraordinary during the last century. Our understanding of science and technology behind dielectric materials played a major role in satisfying the social needs by developing electronic devices for automotive, telecommunications and medical applications. Dielectric technology development still has an enormous potential role to play in developing future materials for electronic applications. We will continue our growth efforts during this century to satisfy the increased demands of our society.

Materials societies like The American Ceramic Society (ACerS) understand their social responsibility. For the last many years, ACerS has organized several international symposia covering many aspects of the advanced electronic materials systems by bringing together leading researchers and practitioners of electronics and publishing proceedings of the conferences in the Ceramic Transaction series.

This volume contains a collection of selected papers from two symposia: Advanced Dielectric Materials and Multilayer Electronic Devices and High Strain Piezoelectric Materials, Devices and Applications that were held during the 105th Annual Meeting of The American Ceramic Society, April 27-30, 2003, Nashville, Tennessee. Major topics of the symposium were: fundamental and historical perspectives of dielectric materials; relaxor materials and devices; high strain piezoelectric devices; advanced aspects of powder preparation, characterization and properties; thin films; materials for low and high frequency applications; processing-structure-property-relationships; and potential areas of applications. Over fourteen invited and twenty-five contributed papers are peer-reviewed and included in this volume.

We, the editors, acknowledge and appreciate the contributions of the speakers, conference and session chairs, manuscript reviewers, and the ACerS staff for making this endeavor a successful one.

Finally, we dedicate this volume to the memory of professor W. D. Kingery and his contributions to modern ceramics.

K. M. Nair,
A.S. Bhalla
S-I. Hirano
D. Suvorov
W. Zhu
R. W. Schwartz

Design and Preparation of Materials

THE ROLE OF CRYSTAL CHEMISTRY IN THE DESIGN OF DIELECTRIC MATERIALS

William B. White
Materials Research Institute
The Pennsylvania State University
University Park, PA 16802

ABSTRACT

To a surprisingly accurate approximation, the crystal structure of a compound depends only on electrostatic forces holding ions together. On the order of 95% of the lattice energy can be ascribed to Coulomb forces. As a result, ions with the same size and charge can often be substituted interchangeably. A relatively small number of primary structures, with their distorted, ordered, and superstructure variants, account for a very large number of compounds. Phase transitions, structural and electronic ordering, and domain structures represent only a very small percentage of the total lattice energy but can sometimes be addressed by crystal chemical mapping.

INTRODUCTION

Crystal chemistry is concerned above all with the systematics of crystal structures. Although the emphasis is on structure, crystal chemistry is not crystallography. Crystal structures determined by the methods of x-ray, neutron, and electron diffraction are only the feedstock from which crystal chemical principles are sorted out.

When the experimental methods and underlying theory for extracting crystal structures from diffraction patterns were worked out in the early years of the 20th Century, there followed an outpouring of structure determinations. It was quickly recognized that some sets of compounds with quite different chemical composition had the same atomic arrangement. Thus NaCl, MgO, and MnS all have the same cation and anion positions within a face-centered cubic unit cell. The cell constants are different but these only serve to scale otherwise identical crystal structures. By the early 1920's a sufficient library of crystal structures had been built up that it was possible to search for systematic patterns. Crystal chemistry had been born.

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