Multifunctional Polycrystalline Ferroelectric Materials

Processing and Properties
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Multifunctional Polycrystalline Ferroelectric Materials

Processing and Properties
Preface

Most of the recent efforts to produce books on ferroelectric materials have focused on issues such as the integration of ferroelectrics into different types of devices (Ferroelectric and Dynamic Random Access Memories; Piezoelectric Devices), mostly in thin film form, with intrusions into the realm of nanoscale phenomena. Although some attempts have been made to cover more fundamental topics, such as mechanical fatigue or phase transitions, which are essential to understand the performance of polycrystalline ferroelectrics in applications, an overview of the recent advances in processing and properties of both ferroelectric bulk ceramics and thin films is still lacking, despite its direct impact on the improvement or development of new applications. We think that this book can fill such gap. Here the reader will find in one book updated information on the preparation and properties of this technologically relevant range of materials – information that is currently scattered throughout a number of publications.

Basic concepts of polycrystalline ferroelectrics processing and properties are found, together with references to their multiple applications, in the introductory sections of the chapters. On the other hand, research topics that arose in the recent past and are nowadays the focus of intense activity are also addressed in this book. Such is the case for the environmentally friendly polycrystalline ferro-piezoelectric materials, seen from the point of view of elimination of hazardous components, such as the commonly used lead oxide, or the development of clean processing routes for lead-based ferroelectrics. The challenges in the processing and characterization of crystallographically oriented bulk ferroelectric ceramics and nanosized ferroelectrics are also analysed here. All chapters were written by leading authorities on the topics with reference to the basics and to recent advances.

C. Galassi (ISTEC, Faenza, Italy) has written Advances in Processing of Bulk Ferroelectric Materials, using both classical and non-conventional techniques. M. Kosec, D. Kuscer and J. Holc (Institute Jožef Stefan, Ljubljana, Slovenia) have written Processing of Ferroelectric Ceramic Thick Films, a topic at the first stage of the integration of ferroelectrics with other hybrid and microelectronic technolo-
gies. Following the integration steps that require even higher reduction of the dimensions of the ferroelectric material, some chapters are devoted to thin-film issues and nano-sized ferroelectrics. K. Kato (National Institute of Advanced Industrial Science and Technology (AIST), Nagoya, Japan) has written *Tailored Liquid Alkoxides for the Chemical Solution Processing of Pb-free Ferroelectric Thin Films*. M. L. Calzada (ICMM-CSIC, Madrid, Spain) has written *Ferroelectrics onto Substrates Prepared by Chemical Solution Deposition: From the Thin Film to the Self-Assembled Nano-sized Structures* and I. Bretos and M. L. Calzada (ICMM-CSIC, Madrid, Spain) have written *Approaches Towards the Minimization of Toxicity in Chemical Solution Deposition Processes of Lead-Based Ferroelectric Thin Films*.

Ferroelectricity and crystal structure are closely related, and the detailed analysis of this requires the use of singular and advanced techniques. L. E. Fuentes-Cobas (Centro de Investigación de Materiales Avanzados, Chihuahua, México) has written about *Synchrotron Radiation Diffraction and Scattering in Ferroelectrics*; M. E. Montero Cabrera (Centro de Investigación de Materiales Avanzados, Chihuahua, Mexico) – *X-Ray Absorption Fine Structure Applied to Ferroelectrics*; D. Chateigner (CRISMAT-ENSICAEN, Caen, France) and J. Ricote (ICMM-CSIC, Madrid, Spain) – *Quantitative Texture Analysis of Polycrystalline Ferroelectrics*; and V. V. Svartsman (Duisburg-Essen University, Duisburg, Germany); and A. L. Kholkin (Aveiro University, Aveiro, Portugal) – *Nanoscale Investigation of Polycrystalline Ferroelectric Materials Via Piezoresponse Force Microscopy*.

Frequently ferro-piezoelectric ceramic materials in devices are subjected to high mechanical loads and must present a high resistance to fatigue under electromechanical vibrations. D. Lupascu, J. Schröder (University of Duisburg-Essen, Essen, Germany), C. Lynch (UCLA, Los Angeles, USA), W. Kreher (University of Dresden, Dresden, Germany) and I. Westram (Darmstadt University of Technology, Darmstadt, Germany) have written about *Mechanical Properties of Ferro-Piezoceramics*. C. Chima-Okeke, W. L. Roberts, A. J. Bushby and M. J. Reece (Queen Mary College, University of London, UK) have written about *The Elastic Properties of Ferroelectric Thin Films Using Nanoindentation*.

A glimpse of the multifunctionality of ferro-piezoelectric ceramics, also mentioned in other chapters, is provided by R. Jiménez and B. Jiménez (ICMM-CSIC, Madrid, Spain), writing on *Pyroelectricity in Polycrystalline Ferroelectrics*. Special attention was given to issues related to the piezoelectric properties of polycrystalline ferroelectrics which are far from being fully explored, and nowadays face important challenges. L. Pardo (ICMM-CSIC, Madrid, Spain) and K. Brebøl (Limiel ApS, Langebæk, Denmark) cover *Properties of Ferro-Piezoelectric Ceramic Materials in the Linear Range: Determination from Impedance Measurements at Resonance* and J. Erhart (Technical University of Liberec, Liberec, Czech Republic) describes *Domain Engineered Piezoelectric Resonators*. A. Albareda and R. Pérez (Politechnic University of Catalonia, Barcelona, Spain) have written about *Non-linear Behaviour of Piezoelectric Ceramics*. Finally, also as a glimpse into the many possible applications of polycrystalline ferroelectrics, in particular in the field of ultrasonic transducers,
Y. Gómez-Ullate Ricón and F. Montero de Espinosa Freijo (Acoustics Institute, CSIC, Madrid, Spain) have written *Piezoelectric Transducers for Structural Health Monitoring: Modelling and Imaging*.

This book offers interesting content for the beginner from academia or industry who is curious about the possibilities of polycrystalline ferroelectric materials; they will find here a wide range of information. But, also, researchers involved in the study of ferroelectric materials or end-users of ferro-piezoelectric ceramics will find some recent developments in the field and some topics that are not commonly discussed in books devoted to ferroelectrics.

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