

图书基本信息

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前言

The functional ceramic materials (FCM) are potential for use in many electronic devices such as optical waveguides, non-volatile dynamic random access memories, micromotors, microactuators, thin film capacitors, and pyroelectric infrared detectors. FCM possesses unique properties like piezoelectricity, pyroelectricity, photoelectricity, photo-acoustic effect, photorefractive behavior, and non-linear optical activity that are closely depends closely on the common theme of composition-preparation-structure-property relationships in the solid state, especially microstructures (grain, grain boundary and domain structures, etc.) and their dynamic response to mechanical, electrical and optical loads at nanometer scale. Thus it is very important to understand the physical phenomenological behavior of ferroelectric structures and their dynamic evolution in nanoscale volumes. This is the context that motivated the publication of this book. The aim of this book is to present recent advances in the fabrication process of functional ceramic materials and their property study, particularly, in-depth observation/analysis of microstructures using the custom-built scanning electron acoustic microscopy (SEAM) , acoustic and piezoresponse mode scanning probe microscopy based on atomic force microscopy. Along with the generally accepted concepts and experimental results there are numerous applications of functional ceramics and devices in industry. We hope that this book will make the readers aware of tremendous developments in the field of microstructure characterization and functional ceramic preparations. The first two chapters address fundamentals of microstructures in the functional ceramics. Chapter 1 presents the formation mechanism of microstructures including grains, grain boundaries, pores, domain structures, and their correlations with properties and processing for some typical ceramics like PLZT (lead lanthanum zirconate titanate) ceramics, PTC (positive temperature coefficient) ceramics, piezoelectric ceramics, ferroelectric ceramics, and so on. Chapter 2 discusses grain boundary phenomena such as grain boundary segregation and migration in the functional ceramics.

内容概要

Microstructure, Property and Processing of Functional Ceramics describes the preparation, property and local structure microscopy of functional ceramics. It covers functional ceramic fabrication processing, grain boundary phenomena and micro-, nanoscale structures characterizations including scanning electron acoustic microscopy, scanning probe acoustic microscopy and piezoresponse force microscopy. This book is intended for advanced undergraduates, graduates and researchers in the field of materials science, microelectronics, optoelectronics and microscopy. Qingrui Yin and Binghe Zhu both are professors at the Shanghai Institute of Ceramics, Chinese Academy of Sciences; Dr. Huarong Zeng is an associate professor at the Shanghai Institute of Ceramics, Chinese Academy of Sciences.

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章节摘录

插图：According to Petzow, all phase regions and flaws contained in structures would be reflected in microstructures, which determine many properties of materials. According to Pask (1984), microstructures should include sizes and distribution of grains and pores, phase composition and distribution, nature of grain boundary and its defects and flaws, composition homogeneity as well as domain structures. Ceramics are materials derived from powdery raw materials through various processing, and possess specific microstructures and properties. Thus microstructures comprehensively reflect previous processing, and bring specific properties to materials. Microstructural analysis is also important for determining phase diagrams, providing bases for property analysis, instructing modification on formulation, processing improvement, production rationalization, and failure analysis. The following are several examples which further explain the importance of microstructure analysis.

Example 1: There was a newly built transformer substation in Shanghai. In a very hot summer the elevated temperature caused a dramatical rise of the oil pressure with a ceramic container, and gave a blast on it. Luckily, it happened during the trial run, otherwise it would probably have caused life threat and power shut down for a massive area. The microstructural analysis afterwards on that ceramic debris showed that the silica particle had sharp boundaries in the high-tension insulator ceramics, which provided evidences that silica particles did not fully melt and react with feldspar and other glass flits during sintering while the boundaries of silica particle of normal insulating ceramics are corroded with glass phases. The microstructure demonstrated that the ceramic body had not been fully sintered, thus it had low tensile strength and couldn't survive under high oil pressure.

Example 2: At a PTC heater manufacturer in Cixi city of Zhejiang province, the ceramic pieces were not broken after voltage test, but cracked in a large amount after packing and transportation, which caused a loss of hundreds of thousands of ceramic pieces (0.65 Yuan/piece at that time). In the analysis of microstructure of PTC ceramics, abnormally grown grains of large sizes were found. During the puncture testing, large grain would expand or contract along axis, which produced large residual stress and micro cracks. Thus the as sintered ceramic plates had normal strength, but became fragile and brittle after puncture testing because of micro cracks. After discovering the cause of problem, some additional additives were introduced to the composition to restrain the abnormal grain growth, and the problem was solved (Zhu, Yao, Zhao, et al, 2001).

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