Preface

The investigation of nanosized ferroelectric films and ferroelectric nanocrystals has attracted much attention during the past 15 years. There is interest in the fundamental and applied aspects. The theoretical basis is connected with the development of the Landau-Ginzburg-Devonshire (LGD) mean field and the first principles theories to the ultrathin ferroelectric films with thickness in the vicinity of critical size. Important potential applications are possible nanosize ferroelectric films in non-volatile memories, microelectronics, sensors, pyroelectric and electro-optic devices. This new area of research in ferroelectricity is still in development and far from completion. Many topics still need generalization. This book contains theory and experimental data for a wide range of ferroelectric materials and especially for polymeric ferroelectrics.

During the last 15 years Springer has published many excellent books on related topics: Scott [1], Ramesh [2], Alexe [3], Okuyama [4], Hong [5], Rabe et al. [6].

In this book we consider size effects, kinetics of switching and other fundamental properties of ultrathin ferroelectric films and nanocrystals in the vicinity of critical size. The concept of critical size has not only theoretical meaning. In spite of theoretical prediction of the critical size, the experiment in many cases does not find it. This does not mean that in all the cases the critical size is equal to zero and ferroelectricity exists in one elementary cell.

In 1993–1998, a revolutionary breakthrough occurred in the discovery of ferroelectric Langmuir–Blodgett (LB) films from polymeric materials. One impressive possibility of the LB method is the opportunity to vary the thickness of LB films to an accuracy of one monolayer, when the kind of molecules as well as orientation in a single monolayer can be controlled. It led to the discovery of ferroelectricity in one-two monolayer films by Bune et al. [7], and confirmed the assumption of Onsager [8] and Landau [9] about the existence of two-dimensional ferroelectricity and the absence of the crytical size. The existence of two-dimensional ferroelectricity in polymeric ferroelectrics (random copolymers of vinylidene fluoride and trifluorethylene) and, correspondingly, the absence of critical thickness in these ferroelectrics attracted attention to the question of the existence of the critical thickness in other (i.e., perovskite) ferroelectrics. Soon after, [7] the critical size in perovskites was evaluated theoretically by Junquera et al. [10].

The main task of this book is generalization of the size effect and physical properties of ferroelectrics in vicinity of the critical size and their possible applications.

One important preliminary comment has to be made. Speaking about the nanoscale, the authors bear in mind the films with thickness equal to the order of value to the size of the critical domain nucleus, which corresponds to the length scale of 1–10 nm [1].

The authors in no way consider this publication as a textbook or a comprehensive review. The book mainly reflects the authors' individual interests in the new region of ferroelectricity, which is developing so rapidly. Nevertheless, the authors hope that the book will be useful for a wide circle of students and researchers.

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http://www.springer.com/978-3-642-41006-2

Ferroelectricity at the Nanoscale
Basics and Applications
Fridkin, V.; Ducharme, S.
2014, XII, 122 p. 81 illus., 8 illus. in color., Hardcover
ISBN: 978-3-642-41006-2