Preface

The idea of this book germinated in 2008 following a discussion with Michel Bruel about the work on materials of the perovskite family carried out at CEA LETI Minatec in Grenoble. It quickly came to our mind to bring together in one document the studies that we have undertaken in this area since the early 2000s. Thus several people have come to lend a hand in the writing of this book by taking charge of a section or a chapter corresponding to their area of expertise. Twenty-one people have contributed to this project, which was eventually split into two volumes: the first, *Piezoelectric Materials Integrated on Silicon*, published by ISTE in 2011 and dedicated to the study of thin piezoelectric films and the second volume on dielectrics with very high permittivity and ferroelectrics.

In this book, following the same vein as the piezoelectricity book, I wanted to repeat the basic thermodynamic concepts in order to lay down a solid foundation. However, it will be noted that this book is much more focused on technological aspects with nine chapters on this thematic out of twelve in total. Chapter 1 is dedicated to the general theory of thermodynamics, which works very well to explain most of the properties of these materials. Chapter 2 deals with the specific property of thin films on a substrate and the radical change that it induces on the mathematical formulation of this subject. Chapter 3 covers the techniques of deposition and shaping of these specific dielectric layers. Chapter 4 is exclusively dedicated to X-ray diffraction techniques that are fundamental to gauge the structural properties of these layers. Chapter 5 is a more general approach to the physicochemical characterization usually associated with these layers. Chapter 6 tackles a completely different field yet fundamental to the radio-frequency applications of these layers: the radio-frequency characterization. Chapter 7 is an embodiment of high permittivity capacitors of $Pb(Zr,Ti)O_3$ and includes an in-depth treatment of the leakage currents of these materials in thin films. Chapter 8 presents several examples of capacitors integrated on silicon. Chapter 9 deals with the reliability of these high permittivity capacitors, a field that is not often addressed and yet one that is crucial for the integration. Chapter 10 covers the field of tunable ferroelectric capacitors and Chapter 11 describes the implementation of ferroelectric memories.

To complete, I would like to thank those who participated in the elaboration of this book. I would start by Michel Bruel, an emblematic figure of LETI, and Marc Aïd, head of the radio frequencies components laboratory, who have been a constant support throughout these years of work. Then I want to thank Pierre Eymeric Janolin of Ecole Centrale de Paris, who agreed to work on Chapter 2 relating to the influence of substrate on thin films, Chrystel Deguet, who worked on layers transfer (Chapter 3), Bertrand Vilquin, who described the Molecular Beam Epitaxy (MBE) technique (Chapter 3), Gwenael Le Rhun, one of my closest colleagues who greatly contributed to Chapter 3 and almost exclusively to Chapter 5 on the techniques for physicochemical characterization, Patrice Gergaud, who took charge of Chapter 4 on X-ray diffraction, Brahim Dkhil and Pascale Gemeiner, who described the Raman technique in Chapter 5, and Thierry Lacrevaz, who took charge of Chapter 6 on radio-frequency characterization. A special mention goes to Emilien Bouyssou, who wrote all of Chapters 7 and 9 on leakage currents and the reliability of PZT capacitors in thin films, Benoit Guigues, who wrote the overwhelming majority of Chapter 10 in its, and Christopher Muller, who took charge of Chapter 11 on ferroelectric memories. I would finally like to thank Xiaohong Zhu, who wrote the last chapter on multiferroic materials.

Finally, my thoughts go to my wife and two daughters for their everlasting support.

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