

# Contents

<b>Zusammenfassung</b>	<b>iii</b>
<b>1 Introduction</b>	<b>1</b>
1.1 Motivation . . . . .	1
1.2 Outline . . . . .	2
1.3 Notation . . . . .	3
<b>2 Ferroelectric ceramics</b>	<b>5</b>
<b>3 Basic equations</b>	<b>11</b>
3.1 Motion and deformation . . . . .	11
3.2 Electrostatics . . . . .	15
3.3 Discontinuities . . . . .	23
3.4 Balance equations . . . . .	25
3.5 Piezoelectric constitutive law . . . . .	34
<b>4 Sharp interface approach</b>	<b>37</b>
4.1 Driving force and interface kinetics . . . . .	38
4.2 Numerical aspects . . . . .	41
4.3 Examples . . . . .	43
4.3.1 Electrode defect . . . . .	45
4.3.2 Side defect . . . . .	53
4.3.3 Polarization defect . . . . .	57
<b>5 Phase field approach</b>	<b>61</b>

5.1	Theory . . . . .	62
5.1.1	Thermodynamics . . . . .	63
5.1.2	Phase field potential . . . . .	65
5.1.3	Phase field parameters . . . . .	68
5.2	Numerical implementation . . . . .	72
5.3	Examples . . . . .	76
5.3.1	Introduction . . . . .	76
5.3.2	Parameter verification . . . . .	78
5.3.3	Domain wall pinning . . . . .	86
5.3.4	Microstructure evolution . . . . .	93
5.3.5	Bimodality . . . . .	96
5.3.6	Wedge formation . . . . .	100
<b>6</b>	<b>Effective material behavior</b>	<b>103</b>
6.1	Theory . . . . .	103
6.2	Multiaxial loading . . . . .	107
<b>7</b>	<b>Conclusion</b>	<b>113</b>
<b>Appendix</b>		<b>115</b>
A.1	Driving force acting on a $180^\circ$ interface . . . . .	115
A.2	Comparison of phase field models . . . . .	115
A.3	Alternative derivation of the evolution equation . . . . .	117
A.4	Parameters of the phase separation potential . . . . .	117
A.5	Element stiffness and damping matrix . . . . .	118
<b>Bibliography</b>		<b>121</b>