## **Contents**

1	Prei	iminary Knowledge and Continuum Thermodynamics	Ţ
	1.1	Background	1
	1.2	Foundations of Classical Electrodynamics	2
	1.3	Some Preliminary Knowledge in Electroelasticity	9
	1.4	Classical Thermodynamics	13
	1.5	Continuum Thermodynamics and Irreversible Processes	15
	1.6	Physical Variational Principle (PVP)	20
	1.7	Some Extensions in Continuum Thermodynamics	22
	1.8	The SI System (International System of Units)	30
	Refe	erences	30
2	Phy	sical Variational Principle and Governing Equations	33
	2.1	Electric Gibbs Free Energy Variational Principle	
		in Piezoelectric Materials	33
	2.2	Alternative Forms of the Physical Variational Principles	40
	2.3	General Variational Principle	46
	2.4	Variational Principle in Piezoelectric Materials Under Finite	
		Deformation	49
	2.5	Internal Energy Variational Principle in Piezoelectric	
		Materials	54
	2.6	Constitutive Equations in Electroelasticity	60
	2.7	Variational Principle in Pyroelectric Materials	
		and Its Governing Equations	62
	2.8	Variational Principle and Governing Equations in Pyroelectric	
		Materials with Diffusion	68
	2.9	Conservation Integrals in Piezoelectric Materials	74
	Refe	erences	84
3	Gen	eralized Two-Dimensional Electroelastic Problem	87
	3.1	Generalized Two-Dimensional Linear Electroelastic Problem	87
	3.2	Generalized Displacement Method in the Piezoelectric	
		Materials	89

vii

viii Contents

	3.3 3.4	Stress Function Method	99
		Piezoelectric Material	104
	3.5	Rigid Elliptic Inclusion in Transversely Piezoelectric Material	116
	3.6	Singularity	121
	3.7	Interaction of an Elliptic Inclusion with a Singularity	127
	3.8	Asymptotic Fields near a Line Inclusion Tip in a Homogeneous Material	135
	Refe	rences	139
4		ear Inclusion and Related Problems	141
	4.1	Vector Riemann-Hilbert Boundary-Value Problem	
		in the z Plane	141
	4.2	Interface Cracks in Piezoelectric Bimaterials	146
	4.3	Other Line Inclusions	155
	4.4	Short Discussions on Some Special Problems	163
	4.5	Interaction of Collinear Inclusions with Singularity	173
	4.6	Interaction of an Elliptic Hole and a Vice-Crack	182
	4.7	Strip Electric Saturation Model of an Impermeable	
		Crack in a Homogeneous Material	190
	4.8	Strip Electric Saturation Model of a Mode-III Interface	
		Crack in a Bimaterial	194
	4.9	Mode-III Problem for a Circular Inclusion	
		with Interface Cracks	200
	Refe	erences	208
5	Som	e Problems in More Complex Materials with Defects	211
	5.1	Isotropic Electrostrictive Material	211
	5.2	Cracked Infinite Electrostrictive Plate with Local Saturation	
		Electric Field	223
	5.3	Asymptotic Analysis of a Crack Subjected to Electric	
		Loading	230
	5.4	Pyroelectric Material	235
	5.5	Interface Crack in Dissimilar Pyroelectric Material	242
	5.6	Point Heat Source and Interaction with Cracks	248
	5.7	Functionally Graded Piezoelectric Material	254
	Refe	erences	262
6	Electroelastic Wave		
	6.1	Electroelastic Waves in Piezoelectric Materials	265
	6.2	Surface Wave	270
	6.3	Fundamental Theory of Layered Structure with Generalized	
		Biasing Stresses	273
	6.4	Love Wave in ZnO/SiO <sub>2</sub> /Si Structure with Initial Stresses	277
	6.5	Other Surface Waves	286
	6.6	Waves in Pyroelectrics	294

Contents

	6.7	Reflection and Transmission of Waves in Pyroelectric	
	<i>(</i> 0	and Piezoelectric Materials	303
	6.8	Coupling Problem of Elastic and Electromagnetic Waves	200
	<i>(</i> 0	in Piezoelectric Material	309
	6.9	Transverse Wave Scattering from a Semi-infinite	312
	6 10	Conducting Crack	
	6.10	Transient Response of a Mode-I Crack	321
	6.11	On the General Dynamic Analyses of Interface Cracks	328
	кете	rences	335
7	Thre	ee-Dimensional and Applied Electroelastic Problems	339
	7.1	Potential Function Methods in Transversely Isotropic	
		Piezoelectric Materials	339
	7.2	A Penny-Shaped Crack in Transversely Isotropic Material	345
	7.3	Ellipsoidal Inclusion and Inhomogeneity	355
	7.4	Some Simpler Practical Problems	364
	7.5	Laminated Piezoelectric Plates	367
	7.6	The First-Order Approximate Theory of an	
		Electro-magneto-elastic Thin Plate	379
	7.7	Piezoelectric Composite Shells	384
	Refe	rences	392
8	Failure Theories of Piezoelectric Materials		
	8.1	Experimental Studies	395
	8.2	Some Practical Failure Criterions	399
	8.3	The Local Energy Release Rate Theory	404
	8.4	Failure Criterion of Conductive Cracks with Charge-Free	
		Zone Model	408
	8.5	Modal Strain Energy Density Factor Theory	413
	8.6	Electric Breakdown of Solid Dielectrics	420
	Refe	rences	424
т.	.1		400