

TABLE OF CONTENTS

Abstract	1
Zusammenfassung	3
1 Introduction	5
1.1 Thin Films & Microelectromechanical Systems	5
1.2 Scope and Organization of the Thesis	7
2 Mechanical Properties of Thin Films	9
2.1 Elastic Parameters	9
2.2 Origin of Prestresses in Thin Films	12
2.3 Methods to Determine Mechanical Properties	17
2.4 The Bulge Test	25
3 Theory of Thin Plates	31
3.1 Plates with Large Deflection	32
3.1.1 Derivation of the Energy Terms	33
3.1.2 Derivation of the Plate Equation	36
3.2 Reduced Parameters	37
3.3 Boundary Conditions	39
3.4 Variational Calculations	40
3.5 Finite Element Analysis	43
3.6 Buckling	45
4 Fabrication & Experimental Setup	47
4.1 Design of Test Structures	47
4.2 Sample Fabrication	49
4.3 Experimental Procedure	52
5 Square Membranes	55
5.1 Symmetry Transitions of Square Membranes	55
5.2 Symmetry Decomposition	59
5.3 Weakly Prestressed Membranes	60
5.3.1 Finite Element Simulations	61

5.3.2	Variational Calculations	64
5.3.3	Numerical Results	70
5.3.4	Experimental Results	74
5.3.5	Comparison of Numerical and Experimental Results	74
5.4	Strongly Prestressed Membranes	77
5.4.1	Finite Element Simulations	79
5.4.2	Variational Calculations	83
5.4.3	Comparison of Numerical Results	89
5.4.4	Experimental Results	90
5.4.5	Comparison of Numerical and Experimental Results	94
6	Long Membranes	97
6.1	Introduction	97
6.2	Symmetry Decomposition	100
6.3	Experimental Procedure	101
6.4	Ripple Profiles	102
6.4.1	Variational Calculations	103
6.4.2	Comparison of Numerical and Experimental Results	109
6.5	Meander Profiles	110
6.5.1	Variational Calculations	112
6.5.2	Comparison of Numerical and Experimental Results	121
7	Surface Micromachined Test Structures	125
7.1	Design and Fabrication of the Annular Test Structures	126
7.2	Adaption of the Theory of Thin Plates	128
7.3	Finite Element Simulations	131
7.4	Experimental Results	133
8	Summary and Outlook	139
9	References	143
	Acknowledgements	157
	Curriculum Vitae	159
	Publications	161