

Table of Contents

Overview.	Characterization of ferroelectric films	
	by spectroscopic ellipsometry	1
	Summary of research performed	1
	Digital memory applications	2
	Infrared detector applications	4
	References	5
Chapter 1.	Microstructure	
	Characterizing material optical properties and	
	microstructure of ferroelectric SrBi₂Ta₂O₉ thin films	
	using multi-layer ellipsometry modeling	6
	Introduction	6
	Theory	8
	Experimental method	10
	Sample preparation	10
	Cross-sectional analysis	11
	Ellipsometric characterization	11
	Results and discussion	14
	Summary of optical results	14
	Bulk polycrystalline SBT	15
	PLD film on Si	16
	MOCVD film on Pt	18
	MOD film on Si	19
	Confirming the physical structure of a VASE model	20
	Summary	21

Acknowledgments	22
References	22
Figures	24
Chapter 2. Composition	
Using spectroscopic ellipsometry to detect second phase Bi_2O_3 and explain leakage current in SBT films	32
Introduction	32
Experimental method	33
Sample preparation	33
Optical characterization	34
Results and discussion	35
Tracing film quality to a key processing step	35
Comparing the optical properties of standard and defective SBT films	36
Optically identifying Bi_2O_3 as a second phase material	37
Estimating Bi_2O_3 content from optical dispersion	38
Correlating Bi_2O_3 content with leakage current	39
Reviewing grain size effects	41
Conclusions	42
Acknowledgments	42
References	43
Figures	44
Chapter 3. Substrate Interaction	
Using spectroscopic ellipsometry to identify a reaction layer between $\text{SrBi}_2\text{Ta}_2\text{O}_9$ films and Si substrates	51

Introduction	51
Experimental method	52
Results and discussion	54
Structure of the SiO ₂ layer from VASE	54
Structure of the SiO ₂ layer from TEM	55
Composition of the SiO ₂ layer from EDS	56
Refractive index of SBT films from VASE	57
Grain size in SBT films from SEM	58
Thickness of the SiO ₂ layer from capacitance	58
Conclusions	60
Acknowledgments	60
References	61
Figures	62
Appendix A. Analytical processes regarding void profiles	67
Appendix B. Supplementary information on the role of excess Bi₂O₃ in SBT films	71
Vita	80