

Contents

1	Introduction to the integration of highly conductive electrodes	1
1.1	Dynamic Random Access Memory (DRAM)	4
1.1.1	Principle and limitation.....	4
1.1.2	High- κ materials processing	7
1.2	Neuroelectronic interfacing.....	10
1.3	Objectives of research work	14
2	Materials system.....	17
2.1	Electrodes	17
2.2	Diffusion barrier.....	18
2.2.1	Tantalum silicon nitride	21
2.3	Properties of high-permittivity dielectrics.....	22
2.3.1	Barium strontium titanate	24
3	Thin film deposition	29
3.1	Sputtering	30
3.2	Pulsed laser deposition	32
3.3	Electron beam evaporation.....	35
3.4	Chemical solution deposition	36
4	Thin film analysis: structural and electrical properties	41
4.1	Structure and morphology	41
4.1.1	X-ray diffraction	41
4.1.2	Atomic force microscopy.....	43
4.1.3	Scanning electron microscopy	46
4.1.4	Rutherford backscattering spectroscopy	47
4.1.5	X-ray fluorescence (XRF).....	50
4.2	Electrical characterization.....	52
4.2.1	Resistivity	52
4.2.2	Leakage current.....	53

4.2.3	Permittivity and loss tangent.....	55
4.2.4	Ferroelectric properties	57
5	Experimental results and discussion	59
5.1	Properties of tantalum silicon nitride thin films.....	59
5.1.1	Stoichiometry dependence on the deposition parameters.....	59
5.1.2	Resistivity	67
5.1.3	Influence of the substrate	70
5.2	Properties of thin film stack	79
5.2.1	Si/Pt/TaSiN/Pt.....	79
5.2.2	Si/Pt/TaSiN/Ta/Pt	86
5.2.3	Si/Pt/TaSiN/Ir	88
5.3	Structure and morphology of thin dielectric films	94
5.3.1	Si/Pt/TaSiN/BTO	94
5.3.2	Si/Pt/TaSiN/Pt/BST	96
5.3.3	Si/Pt/TaSiN/Ir/BST	99
5.4	Dielectric properties of capacitors.....	101
5.4.1	Electrical permittivity	101
5.4.2	Leakage current.....	106
5.4.3	Large signal hysteresis measurement.....	107
6	Summary and conclusions	111
6.1	Summary	111
6.2	Conclusions	113
Appendix	115	
A.1	Identification of phases from XRD diagram for different samples.....	115
A.2	Deposition parameters	123
A.3	Nerve cell – basic architecture and electrical excitability	125
References	129	