Contents

1	Intro	oduction	1
	1.1	Objectives	1
	1.2	Plan of dissertation	2
	1.3	Overview on the resistive switching	4
		1.3.1 Bipolar and unipolar resistive switching	4
		1.3.2 Resistive switching mechanism	5
	1.4	Overview on the perovskite oxides	7
2	Expe	erimental methods	9
	2.1	Device fabrication methods	9
		2.1.1 RRAM device structure description	9
		2.1.2 Substrates preparation	11
		2.1.3 Pulsed laser deposition (PLD)	13
		2.1.4 DC sputtering	14
		2.1.5 Electron beam evaporation	16
		2.1.6 Photolithography process	16
		2.1.7 Ion Beam Etching	19
	2.2	RRAM device characterization methods	20
		2.2.1 Atomic force microscopy (AFM)	20
		2.2.2 X-ray diffraction (XRD)	21
		2.2.3 Scanning electron microscopy (SEM)	23
		2.2.4 Time-of-flight secondary ion mass spectroscopy	24
		(ToF-SIMS)	
		2.2.5 RRAM device measurement setup	25
3	Proc	ess development	29
	3.1	Thin film deposition: Laser fluence dependence	29
	3.2	Nano-imprint Lithography	33
		3.2.1 Introduction	33
		3.2.2 Mould design	35
		3.2.3 Sample preparation	36
	3.3	Resistive switching in Cross-point structure	40
4	Bipo	lar resistive switching with W and Pt top electrode	43
	4.1	Device fabrication	43
	4.2	Characteristics of bipolar resistive switching phenomenon	44
		4.2.1 Current-voltage (I-V) characteristics	44

	4.3	Reliability and switching characteristics of bipolar resistive	47		
		switching behavior	47		
		4.3.1 Pulse measurements	47		
		4.3.2 Retention	48		
		4.3.3 Readout disturbance	49		
	4.4	Mechanism of bipolar resistive switching and proposed model	51		
	4.5	Switching with asymmetric current compliance	56		
	4.6	Refreshment of RRAM devices	60		
	4.7	Pseudo Unipolar switching	62		
	4.8	Annealed Vs. as-prepared Pt/BST/SRO	63		
	4.9	Polarity change	65		
	4.10	Size dependence	69		
	4.11	R _{off} /R _{on} adjustment	71		
	4.12	Multilevel switching potential	73		
5	Bipo	ar and Unipolar resistive switching transition	77		
	5.1	Device fabrication	78		
	5.2	Characteristics of resistive switching phenomenon	78		
		5.2.1 Bipolar resistive switching behavior	78		
		5.2.2 Unipolar resistive switching behavior	80		
		5.2.3 Retention	82		
		5.2.4 Endurance	84		
		5.2.5 Temperature dependence	87		
	5.3	Proposed mechanism for bipolar to unipolar resistive switching	88		
		transition			
	5.4	Transition between bipolar and unipolar resistive switching	96		
6	Conc	lusions	103		
			405		
Re	References				