## List of Figures

Figures	Title	page
1.1	Schematic of applications of multifunctional materials	2
2.1	Schematic representation of (a) Schematic of crystal structure and (b) Band diagram of ZnO	8
2.2	Energy levels of different point defects of ZnO	11
2.3	Schematic of ZnO structures and applications	21
2.4	Schematic of (a) Crystal structure of BFO and (b) Different multiferroic properties	24
2.5	Schematic of (a) Bipolar RRAM switching, (b) Unipolar RRAM switching (c) Filamentary switching and (d) Interface switching	35
2.6	Optical image of XRD system, IIT Jodhpur	37
2.7	Optical image of (a) SEM and (b) DC sputter coating system , IIT Jodhpur	38
2.8	Optical image of AFM system, IIT Jodhpur	39
2.9	Optical image of Cary 4000 UV- Vis spectrophotometer	40
2.10	Camera image of Raman Spectrometer with inbuilt PL spectrometer	41
2.11	Optical image of (a) SCS and (b) Electrochemical workstation, IIT Jodhpur	41
3.1	Schematic of gaps present in ZnO and BFO	44
4.1	Schematic of a double tube CVD system presented with respective growth temperature of different zones	49
4.2	XRD for (a) ZnO, (b) Zn:ZnO ; SEM and EDX images with orientations in insets for (c) ZnO and (d) Zn:ZnO films	51
4.3	AFM images of (a) ZnO and (b) Zn:ZnO	51
4.4	Raman spectra for (a) ZnO and (b) Zn:ZnO, (c) PL spectra for ZnO and Zn:ZnO  and (d) Color emission spectra for ZnO and Zn:ZnO	53
4.5	I-V response for (a) ZnO and (b) and Zn:ZnO ; C-V response for (c) ZnO and (d) Zn:ZnO	54
4.6	M-S graphs for (a) ZnO (a) and (b) Zn:ZnO; band gap graphs for (c) ZnO and Zn:ZnO and (d) Schematic diagram of B-M shift in Zn:ZnO thin films	55
5.1	Schematic representation of (a) ZnO gel preparation, (b) Spin coating, (c) Drying, (d) Dipping in growth solution, (e) Growth in oven and (f) Synthesized nanorods	60
5.2	(a) XRD graphs for ZnO, Zn <sub>0.98</sub> Li <sub>0.02</sub> O and Zn <sub>0.96</sub> Li <sub>0.02</sub> Ni <sub>0.02</sub> O nanorods on Si substrate and (b) Enlarged view of XRD between 34-35° for identifying any relative shift in (002) diffraction peak	61
5.3	Top surface SEM images of ZnO, $Zn_{0.98}Li_{0.02}O$ and $Zn_{0.96}Li_{0.02}Ni_{0.02}O$ nanorods and cross-sectional images of $ZnO/Zn_{0.08}Li_{0.02}O$ and $ZnO/Zn_{0.06}Li_{0.02}O$ nanorods and	62
5.4	(a) DRS absorption data of ZnO, $Zn_{0.98}Li_{0.02}O$ and $Zn_{0.96}Li_{0.02}Ni_{0.02}O$ with PL spectra in the inset and (b) Bandgap of ZnO, $Zn_{0.98}Li_{0.02}O$ and $Zn_{0.96}Li_{0.02}Ni_{0.02}O$ with zoomed region	63
5.5	Comparative Mott-Schottky plot for (a) Zn <sub>0.98</sub> Li <sub>0.02</sub> O, (b) Zn <sub>0.96</sub> Li <sub>0.02</sub> Ni <sub>0.02</sub> O with n- ZnO nanorods, (c) n-n contact current voltage characteristics and (d) p-n junction characteristics of Zn <sub>0.98</sub> Li <sub>0.02</sub> O and Zn <sub>0.96</sub> Li <sub>0.02</sub> Ni <sub>0.02</sub> O based p-n junction	64
5.6	(a) Linear fitted semilogrithim graph of n-ZnO/ p-Zn <sub>0.98</sub> Li <sub>0.02</sub> O diode, (b) Linear fitted semilogrithim graph of n-ZnO/ p-Zn <sub>0.96</sub> Li <sub>0.02</sub> Ni <sub>0.02</sub> O, (c) Current conduction mechanism of n-ZnO/ p-Zn <sub>0.98</sub> Li <sub>0.02</sub> O and (d) n-ZnO/ p-Zn <sub>0.96</sub> Li <sub>0.02</sub> Ni <sub>0.02</sub> O diodes in forward biased region	65
5.7	(a) Top view of SEM images of p-Zn <sub>0.98</sub> Li <sub>0.02</sub> O/n-ZnO and p-Zn <sub>0.96</sub> Li <sub>0.02</sub> Ni <sub>0.02</sub> O/n-ZnO homojunctions (b) I-V graph of p-Zn <sub>0.98</sub> Li <sub>0.02</sub> O/n-ZnO and p-Zn <sub>0.96</sub> Li <sub>0.02</sub> Ni <sub>0.02</sub> O/n-ZnO homojunctions with inset showing top p-p I-V charcateristics (c) Mott-Schottky analysis of p-Zn <sub>0.98</sub> Li <sub>0.02</sub> O/n-ZnO and p-Zn <sub>0.96</sub> Li <sub>0.02</sub> O/n-ZnO/Glass and p-Zn <sub>0.96</sub> Li <sub>0.02</sub> O/n-ZnO/Glass homojunctions with electrochemically fitted circuit in the inset	66
6.1	(a) XRD of ZnO nanorods and (b) Top view of ZnO nanorods with EDS data in inset	70
6.2	(a) AFM image of ZnO nanorods and (b) Calculated band gap of ZnO	71
6.3	(a) Photoluminescence of ZnO nanorods and (b) Color co-ordinates of nanorods	71

6.4	(a) I-V curve of heterojunction and (b) Emitted color of the junction under dark and UV	72
6.5	(a) Semilogrithmic curve of I-V and (b) log-log curve of I-V	73
7.1	(a) Schematic diagram of configuration of Ag/BiFeO₃/FTO RRAM device (b) XRD pattern of BFO, (c) Kubelka-Munk plot of BFO and (d) AFM image for BFO thin films	77
7.2	(a) First RRAM switching cycle, (b) Switching curve of 100 cycles, (c) Retention curve, and (d) Reliability of set and reset voltage	78
7.3	Logrithmic I-V curves for (a) Set and (b) Reset states; Schematic of (c) Filament formation and (d) Filament rupture	80
7.4	(a) I-V plot of RRAM device after 10 months for multiple cycles, (b) Retention graph, (c) Endurance curve for 1000 cycles and (d) Switching cycle after endurance.	81
8.1	(a) Mixing of precursors in 2-ME, (b) Formation of BFO gel, (c) Spin coating of BFO gel on FTO glass and (d) BFO thin film after deposition	84
8.2	(a) XRD pattern of BFO and (b) SEM and AFM images of BFO	85
8.3	(a) Tauc plot of BFO with absorption spectra in inset and (b) Raman spectra of BFO	86
8.4	(a) Bipolar current-voltage characteristics , (b) Multiple cycles, (c) Retention curve and (d) Probability curve of BFO RRAM	87
8.5	(a) Weibull's distribution curve of LRS and HRS @0.2 V (b) AC Endurance curve for 7000 cycles, (c) log I-log V curve of set state, (d) log I-log V curve of reset state	88
8.6	(a) Impedance curve fitting of HRS without R <sub>1</sub> and CPE, (b) Impedance cure fitting of HRS with R <sub>1</sub> and CPE, (c) Impedance curve fitting of LRS and (d) Schematic of filament formation mechanism	89