Electronic Supplementary Material (ESI) for Physical Chemistry Chemical Physics.

Tuneable reversible resistive switching behaviour of PVA-Zirconia nanocomposite films and validation of the trap-assisted switching mechanism by selective application external bias voltages

Table S1. Mechanical properties of PVA-ZrO_2 composite films.

Sample name	Tensile strength (MPa)	Young modulus (MPa)×10^3	Elongation at break (%)
PZ0.5	21.6	0.61 ± 0.027	44.24
PZ1	17.9	0.22 ± 0.009	54.71
PZ2	114.6	1.83 ± 0.026	43.87
PZ4	144.5	3.92 ± 0.078	30.31

Table S2. Determination of decomposition temperature and percentage of weight loss of PVA-ZrO_2 composite films during various phases of degradation from TGA analysis.

Sample name	1st degradation stage			2nd degradation stage			3rd degradation stage			Total mass loss (%)
	T_{In} (°C)	T_F (°C)	Mass loss (%)	T_{In} (°C)	T_F (°C)	Mass loss (%)	T_{In} (°C)	T_F (°C)	Mass loss (%)	
PZ0.5	83.2	194.5	10.33	261.2	406.4	73.81	408.7	494.4	13.63	97.77
PZ1	80.3	165.7	8.21	245.7	388.7	62.33	420.5	491.6	20.17	90.71
PZ2	82.4	160.4	7.68	247.4	390.5	61.97	421.2	491.2	23.06	92.72
PZ4	75.7	155.2	8.49	282.6	391.7	68.32	425.7	485.8	14.95	93.66

Table S3. Temperature dependent (303K an 403K) grain and grain-boundary capacitance for all the samples.

Temperature (K)	Sample name	Parameters				
		R_G (MΩ)	C_G (nF)	R_{GB} (MΩ)	C_{GB} (nF)	R_E (Ω)
303	PZ0.5	0.916	0.22	2.661	1.31	
	PZ1	0.424	0.18	1.347	4.97	
	PZ2	0.535	0.82	0.503	5.32	
	PZ4	0.098	4.32	0.214	7.72	
403	PZ0.5	0.2867	0.17	0.9874	8.58	
	PZ1	0.0082	1.34	0.1254	6.54	
	PZ2	0.0054	7.98	0.0114	9.47	654
	PZ4	0.0038	9.34	0.0086	27.82	442

Table S4. Grain, grain-boundary resistance and capacitance at the three different conditions (set, reset and zero bias) for PZ0.5 and PZ4 nanocomposites films.

Sample name	State of condition	R_G (MΩ)	C_G (nF)	R_{GB} (MΩ)	C_{GB} (nF)	R_E (Ω)
PZ0.5	Set	5.028	0.27	6.77	2.18	276
	0V bias	2.301	0.25	3.25	3.16	262
	Reset	1.193	0.92	2.898	43.52	234
PZ4	Set	0.825	0.99	1.434	3.37	1919
	0V bias	0.582	1.11	0.452	18.72	1665
	Reset	0.217	1.56	0.362	61.94	1629

Table S5: calculated $\Delta\varepsilon$, σ_{SP} and τ values for PZ4 composite films in a different condition.

Different external condition	$\Delta\varepsilon$	$\sigma_{SP} \times 10^{-9}$ (S/m)	τ (s^{-1})
SET	58.9	1.12	0.099
0V bias	86.1	3.69	0.057
RESET	112.7	19.62	0.056

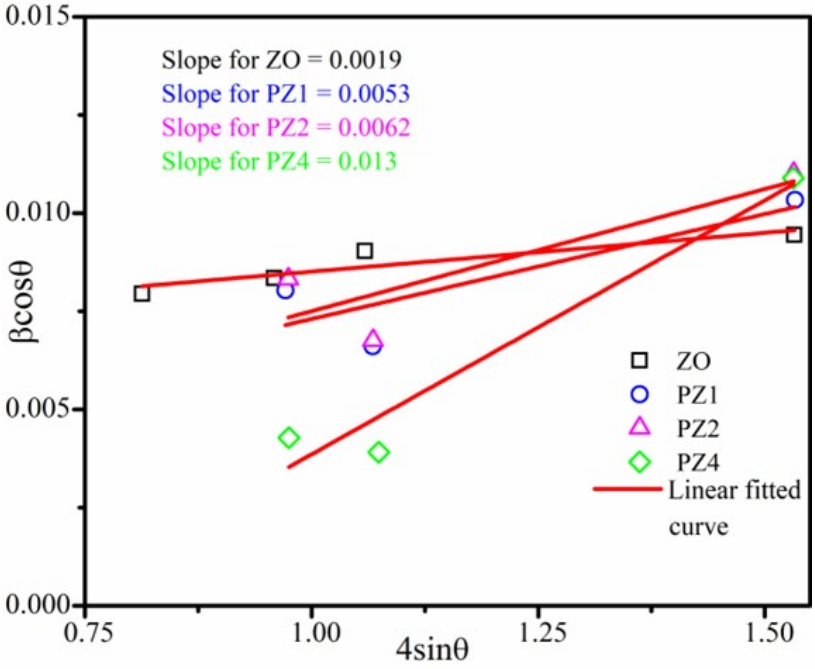

Figure S1. Williamson-Hall plot of ZO nanoparticles and PVA-ZO nanocomposites films.

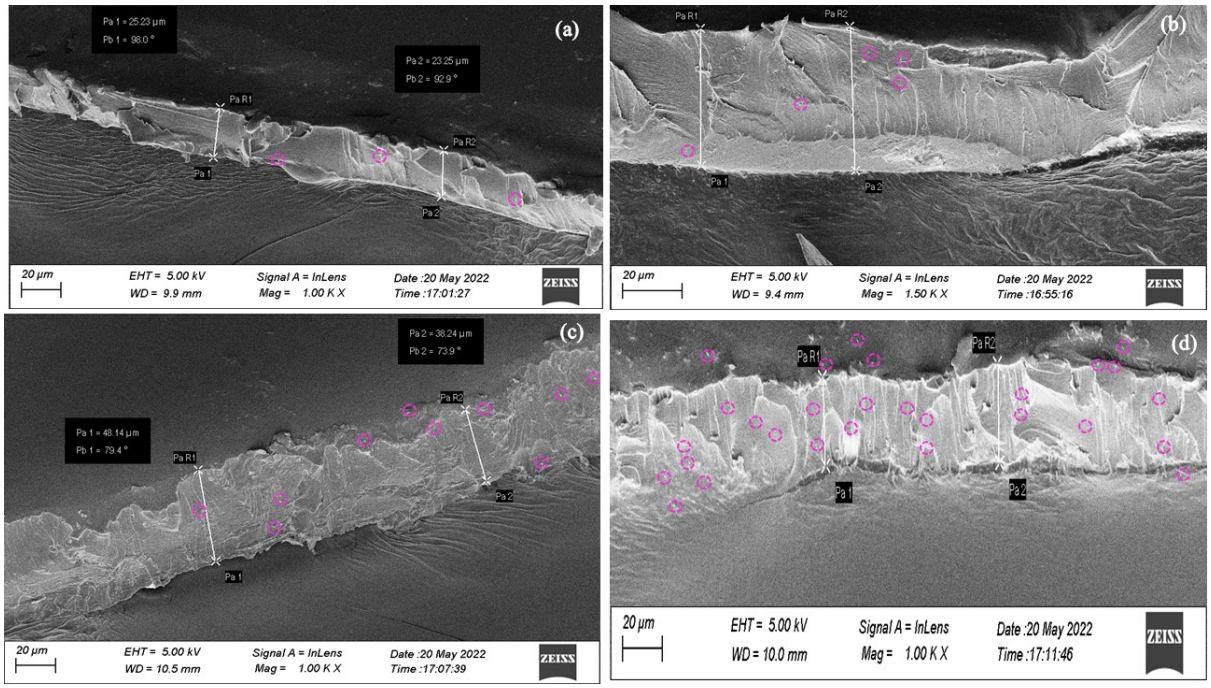

Figure S2. Cross-sectional FESEM images of PZ0.5, PZ1, PZ2 and PZ4 composites films.

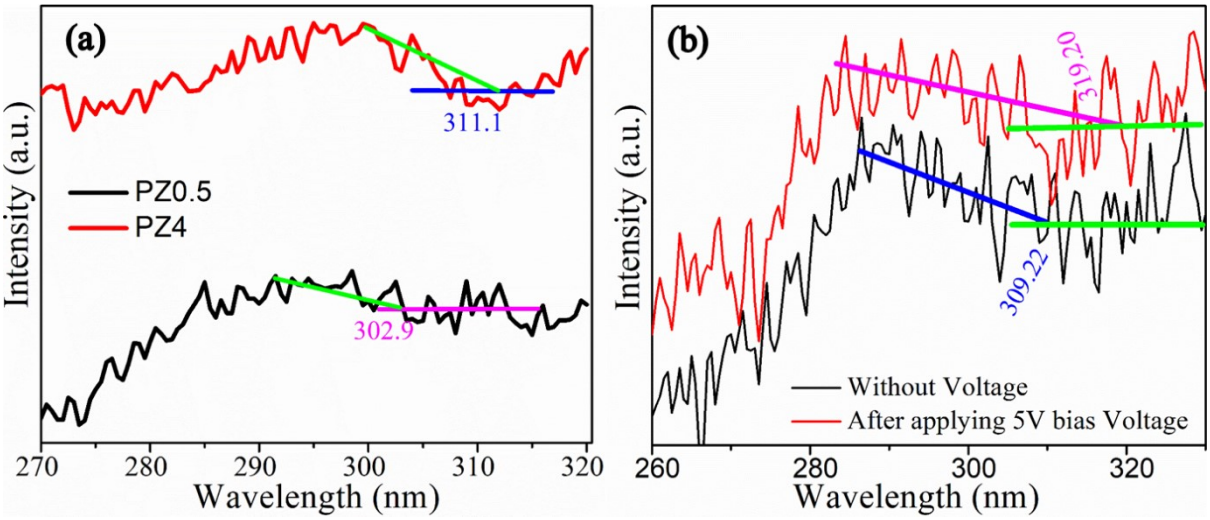

Figure S3. (a) Change in the optical absorbance band near the filler absorbance edge with the incorporation of ZO nanoparticles. (b) Modification of optical energy band near the ZO nanoparticles absorbance edge with the external biasing voltage.

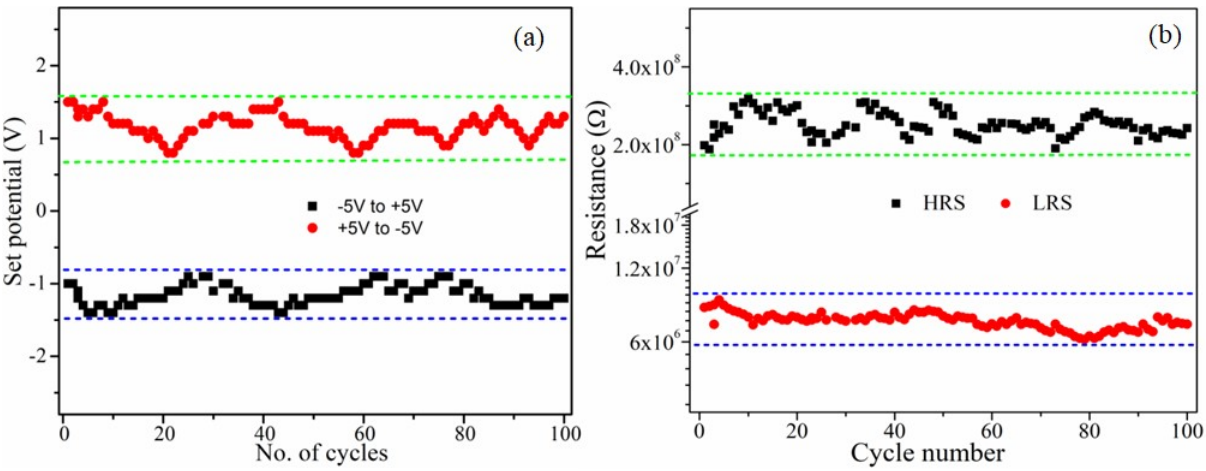

Figure S4. Investigation of the PZ4 sample's cyclic stability (100 cycles) performance using the SET (a) potential and (b) resistance.

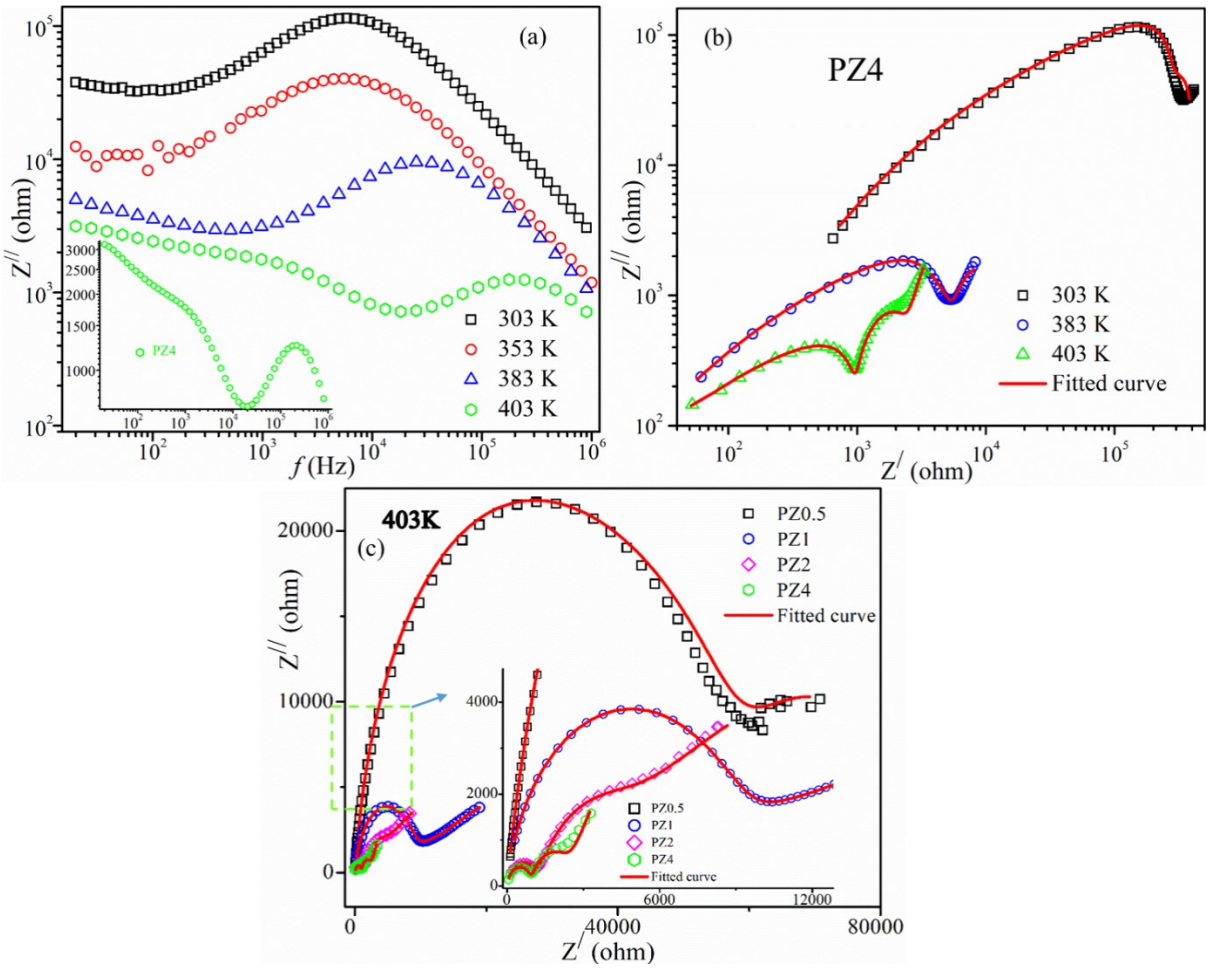

Figure S5. Analysis of the temperature-dependent relaxation mechanism using frequency dispersion (a) $Z^{//}$ and (b) Nyquist plot for PZ4 sample. (c) Investigation of the variation in the relaxation process for all samples using a Nyquist plot at a temperature of 403 K.

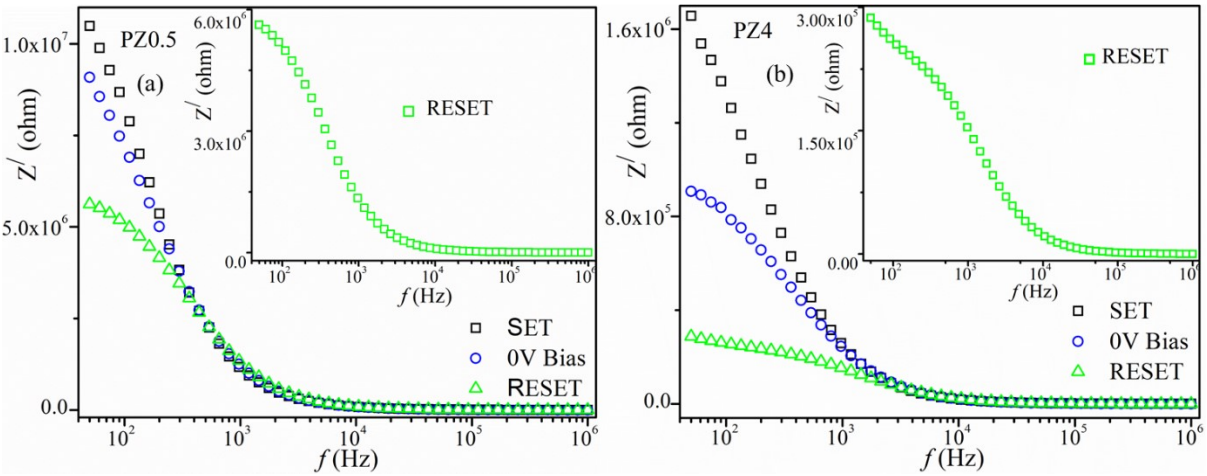

Figure S6. Frequency-dependent Z/ variation at SET, RESET and zero potential for (a) PZ0.5 and (b) PZ4 nanocomposite films.

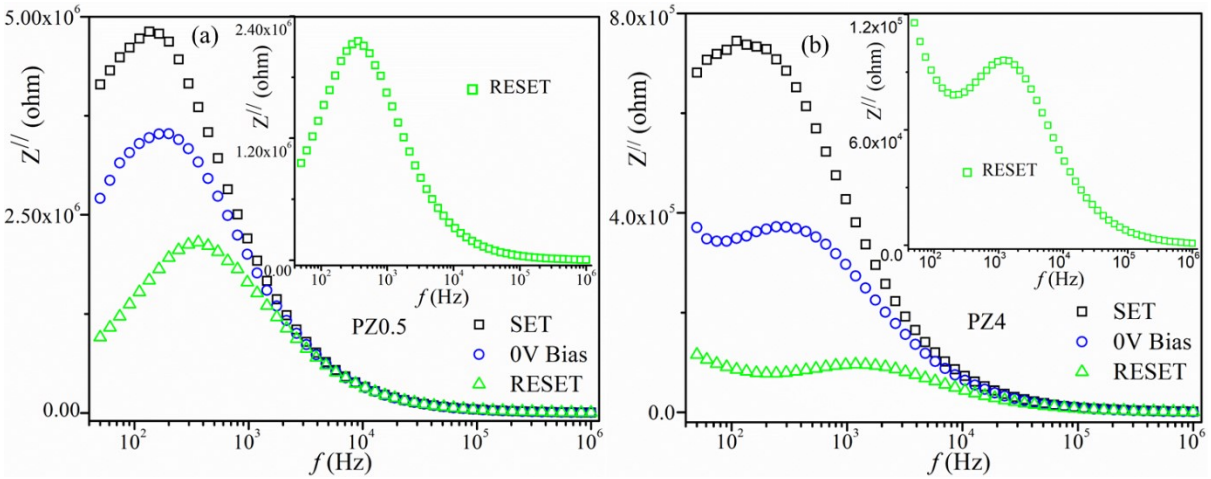

Figure S7. Frequency dispersion $Z^{//}$ modification of the (a) PZ0.5 and (b) PZ4 composite films at SET, RESET and zero voltage.

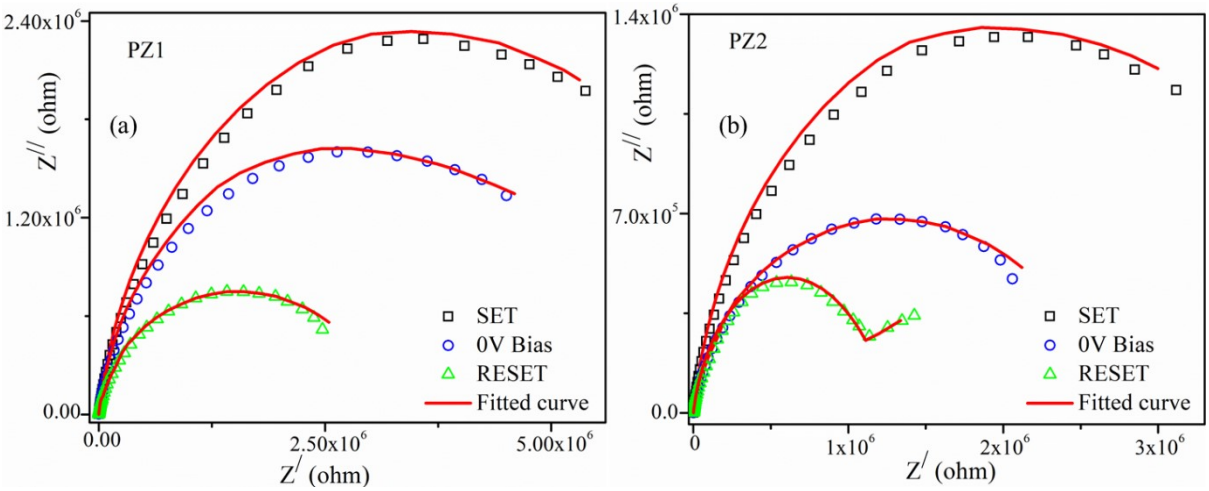

Figure S8. Nyquist plot at SET, RESET and zero potential for (a) PZ1 and (b) PZ2 composite films.

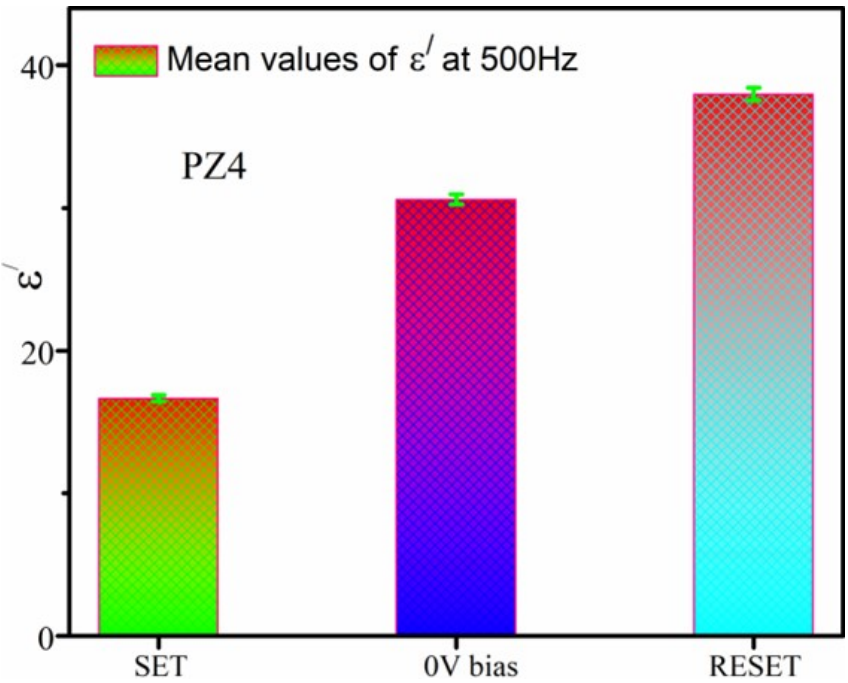

Figure S9. Variation of mean values of dielectric constant and error bar at SET, RESET and 0V bias condition of PZ4 composite films.