Electronic supplementary information for the RSC Advances paper

Effect of insertion of low leakage polar layer on leakage current and multiferroic properties of $BiFeO_3/BaTiO_3$ multilayer structure

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Fig. S1 Schematic diagram of $BiFeO_3/BaTiO_3$ multilayers prepared on Silicon substrate

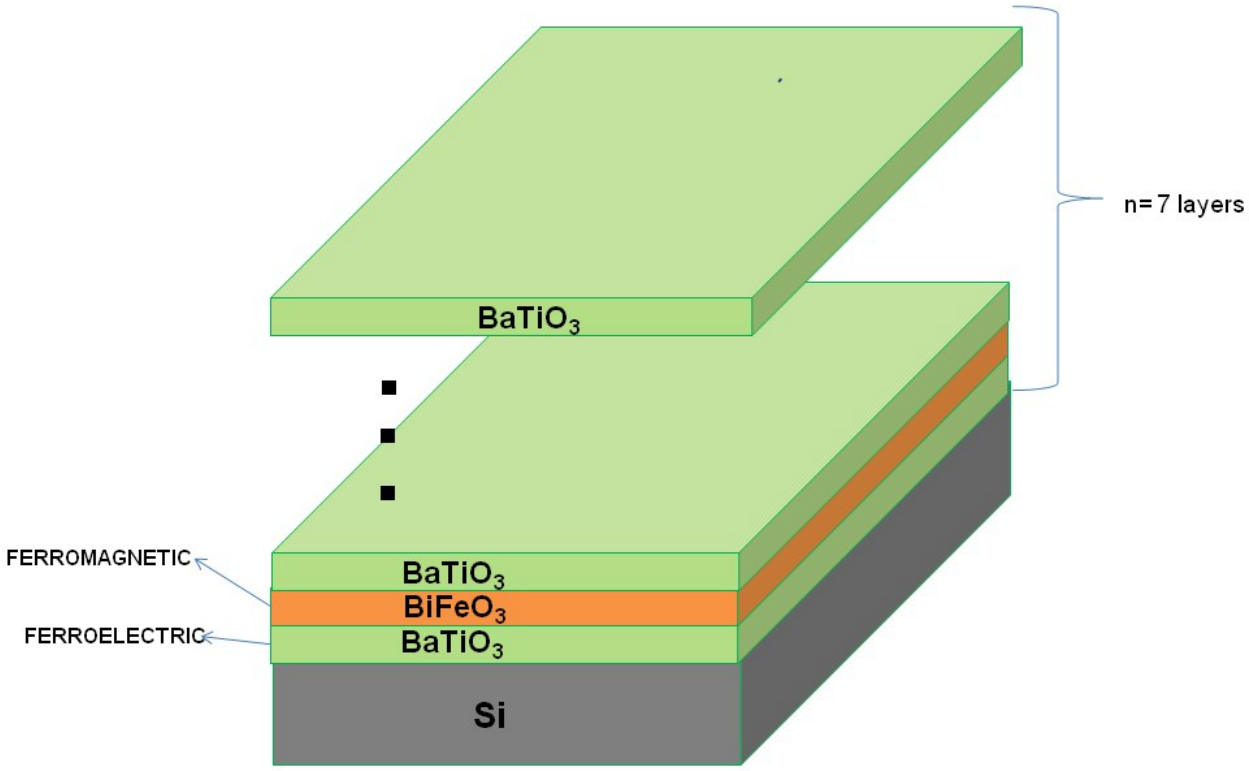

Fig. S2 C-V characteristics of $BiFeO_3/BaTiO_3$ multilayer structure having six stacking layers.

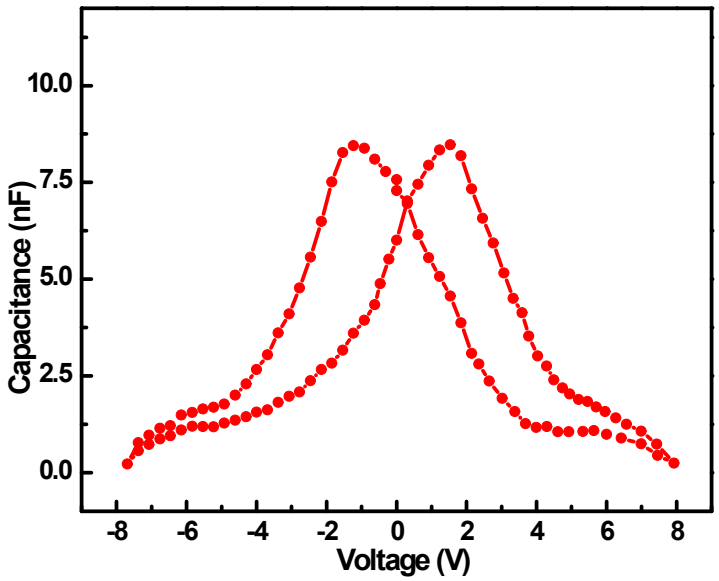

Fig. S2 represents the capacitance - voltage (C-V) characteristics of six layer $BiFeO_3/BaTiO_3$ structure. A little asymmetry was observed in the C-V curve due to the difference in the top (Au) and bottom (Pt) electrodes.

Table ST 1: Lattice parameters "a" and "c", c/a lattice distortion and stress modulus along c-axis in the $BaTiO_3$ and $BiFeO_3$ layers in $BiFeO_3/BaTiO_3$ multilayer structures.

	$BaTiO_3$				$BiFeO_3$			
	Lattice parameter		Stress modulus (%)	c/a distortion ratio	Lattice parameter		Stress modulus (%)	c/a distortion ratio
	a (Å)	c (Å)			a (Å)	c (Å)		
2 layers	3.985	4.024	0.223	1.0097	5.492	13.423	3.201	2.4437
3 layers	4.372	4.061	0.694	0.9288	5.495	13.419	3.230	2.4420
4 layers	4.369	4.058	0.619	0.9288	5.530	13.548	2.300	2.4499
5 layers	4.385	4.080	1.165	0.9304	5.535	13.530	2.430	2.4444
6 layers	**4.372**	**4.078**	**1.115**	**0.9327**	**5.424**	**13.315**	**3.980**	**2.4548**
7 layers	4.598	4.095	1.537	0.8906	5.420	13.321	3.937	2.4577
Bulk	3.999	4.033	---	1.0085	5.876	13.867	---	2.3599

The lattice parameters of $BiFeO_3$ and $BaTiO_3$ in multilayer thin film structures were calculated by Le-Bail fitting using Bruker Topas 3 software. The corresponding data reported for bulk $BaTiO_3$ and $BiFeO_3$ are also included in Table ST 1 for comparison. The values of lattice parameters a and c were estimated to be 4.372 Å and 4.078 Å for $BaTiO_3$ and 5.424 Å and 13.315 Å for $BiFeO_3$ respectively for the six layered $BiFeO_3$/ $BaTiO_3$ system (Table ST 1). These values are slightly lower than the corresponding bulk values for $BiFeO_3$ and slightly greater in case of $BaTiO_3$ [JCPDS card No. 01-072-0138 and 01-072-2035], indicating the presence of stress in the $BiFeO_3/BaTiO_3$ multilayer structures prepared by PLD. The stress modulus in the $BiFeO_3/BaTiO_3$ multilayer thin film is obtained using equation: Stress = $(c_o\text{-}c)/c_o$ in %, where "c" is the respective lattice constant of $BiFeO_3$ or $BaTiO_3$ in deposited multilayer structure and "c_o" is the corresponding bulk value.

Table ST 2: Ferroelectric, ferromagnetic parameters and leakage current of $BiFeO_3/BaTiO_3$ multilayer structures having different number of layers.

	P_r ($\mu C/cm^2$)	P_s ($\mu C/cm^2$)	$2E_c$ (kV/cm)	Leakage current (A)	M_r (emu/cm^3)	M_s (emu/cm^3)
2 layers	8.29	17.92	6.06	1.52×10^{-5}	10.33	28.29
3 layers	13.40	29.46	6.49	2.51×10^{-6}	13.45	37.67
4 layers	29.53	49.60	6.77	6.38×10^{-7}	21.26	56.42
5 layers	45.72	64.47	11.18	1.62×10^{-7}	32.98	86.88
6 layers	**72.14**	**99.80**	**10.25**	**3.18×10^{-8}**	**35.32**	**94.70**
7 layers	15.96	26.25	11.11	5.16×10^{-6}	15.79	42.36