Supporting information for

Piezoelectric and Dielectric Properties of Multilayered $BaTiO_3/(Ba,Ca)TiO_3/CaTiO_3$ Thin Films

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Table S1 The bulk lattice constant of every composition layer and substrate.

Compositions	a (Å)	b (Å)	c (Å)
$BaTiO_3$	3.997	3.997	4.037
$CaTiO_3$	5.387	5.439	7.646
(Orthohombic)	(3.809 in cubic)	(3.846 in cubic)	(3.823 in cubic)
$(Ba_{0.85}Ca_{0.15})TiO_3$	3.972	3.972	4.019
$(Ba_{0.75}Ca_{0.25})TiO_3$	3.959	3.959	4.003
$Nb:SrTiO_3$	3.905	3.905	3.905

According to Bragg equation：

$$2d_{hkl}\sin\theta = K\lambda \tag{S1}$$

The d_{002} of peak1, Peak2, and Peak3 can be calculated，and d_{001} ($d_{001}=2d_{002}$) corresponds to the out of plane constant $c_{measured}$. Based on the unchanged volume of each layer, the in plane constant a_{film} can be calculated from equation S2:

$$a_{bulk}\times b_{bulk}\times c_{bulk}=a_{film}\times b_{film}\times c_{measured} \tag{S2}$$

Where the a_{bulk}, b_{bulk} and c_{bulk} of each layer can be obtained from Table S1, the Cmeasured is the calculated d_{001}, thus we can get the in plane constant of each layer $a_{film}=b_{film}$.

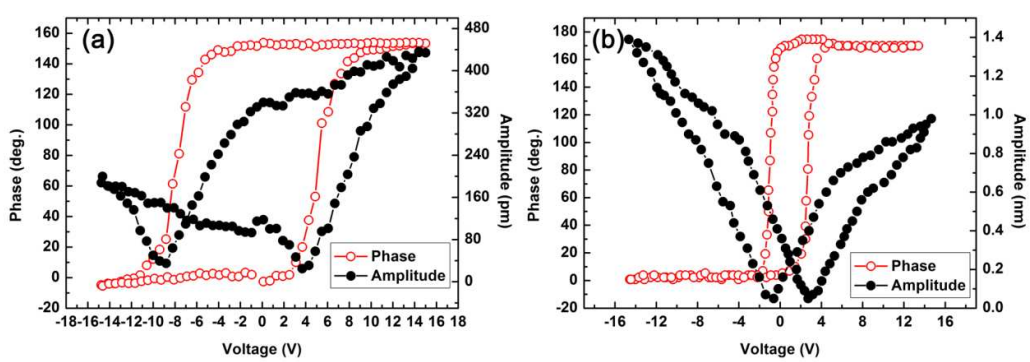

Figure S1. Comparison of SS-PFM (a) and conventional PFM (b) of amplitude-voltage butterfly loops and phase-voltage hysteresis loops for $CT^{(1)}/BCT15^{(1)}/BT^{(1)}$ sample.

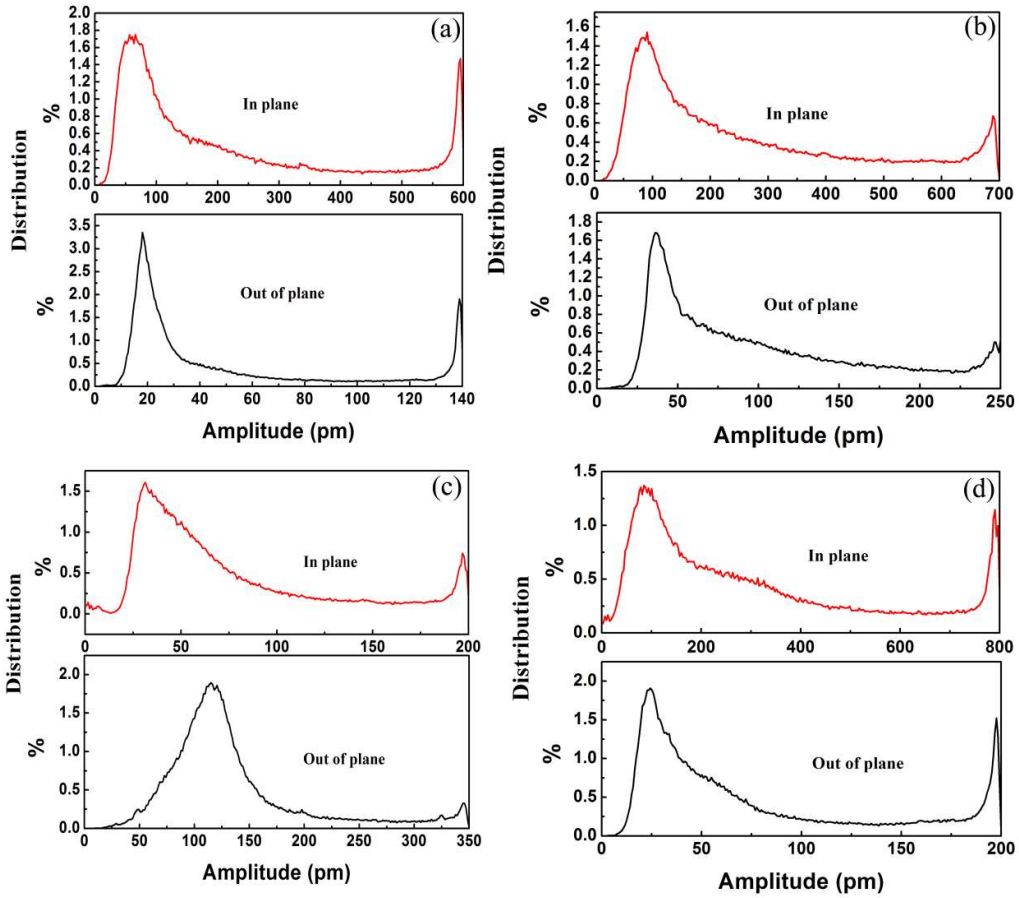

Figure S2. Distribution of amplitude in Figure 3 and Figure 4 for (a)S1: $CT^{(1)}/BCT15^{(1)}/BT^{(1)}$ (b)S2: $CT^{(1)}/BCT15^{(1)}/BT^{(2)}$ (c) S3: $CT^{(1)}/BCT25^{(1)}/BT^{(1)}$ (d)S4: $CT^{(1)}/BCT25^{(1)}/BT^{(2)}$.

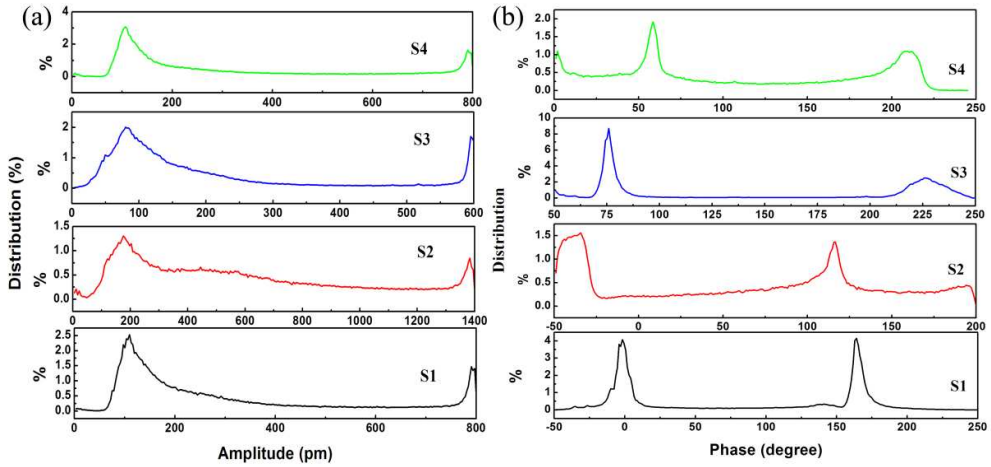

Figure S3. Distribution (a) of amplitude (b) and phase contrast in Figure 5.