**Supplementary information**

# Very High Commutation Quality Factor and Dielectric Tunability in Nanocomposite $SrTiO_3$ Thin films with $T_c$ Enhanced to >300 °C

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The highly vertically strained, heteroepitaxial growth of $SrTiO_3$ in $SrTiO_3$-$Sm_2O_3$ nanocomposite films on *(001)* $SrTiO_3$ substrates is clearly seen from the X-ray diffractogram of Fig. S1(a), where only *(00l)*-type peaks were seen. The $Sm_2O_3$ phase also grew heteroepitaxially, with 45° in-plane rotation compared to the $SrTiO_3$ substrate, as seen from the X-ray phi-scans shown in Fig. S1(b).

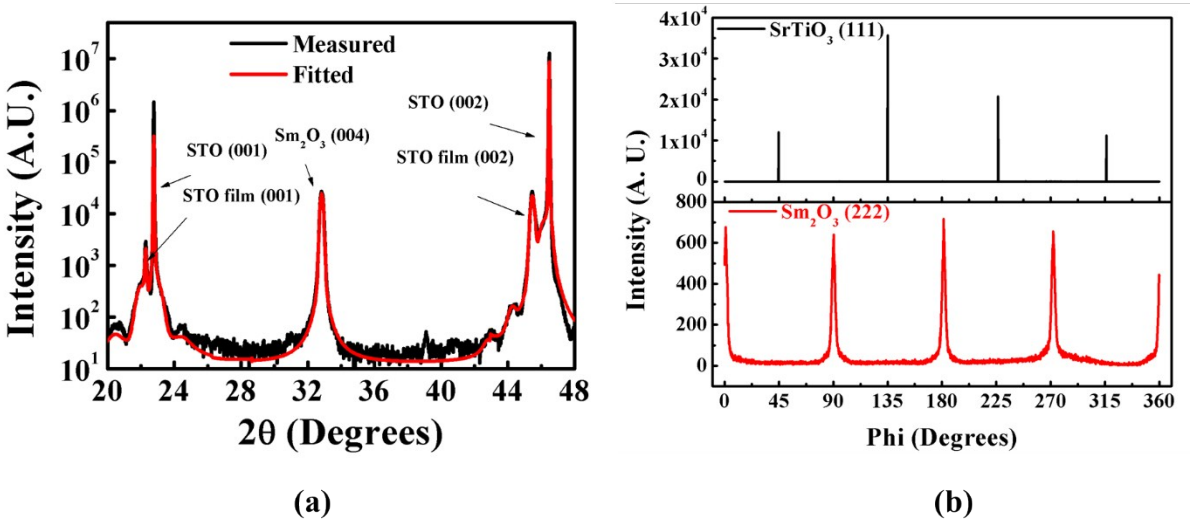


**Fig. S1** (a) Out-of-plane symmetric 2θ-ω X-ray diffraction scan of $SrTiO_3$-$Sm_2O_3$ film, (b) phi scan around $SrTiO_3$ (111) and $Sm_2O_3$ (222) peaks showing the in-plane epitaxial relationship between the $SrTiO_3$ substrate and the $Sm_2O_3$ filmTo determine the Curie temperature, polarisation vs. electric (PE) loops were measured as the sample was heated. These results are presented in Fig. S2(a). Fig. S2(b) shows the capacitance (and dielectric loss (tan δ) vs. d.c. electric field measurements performed at room temperature and 1 MHz, up to electric fields of 1000 kV/cm in either direction.

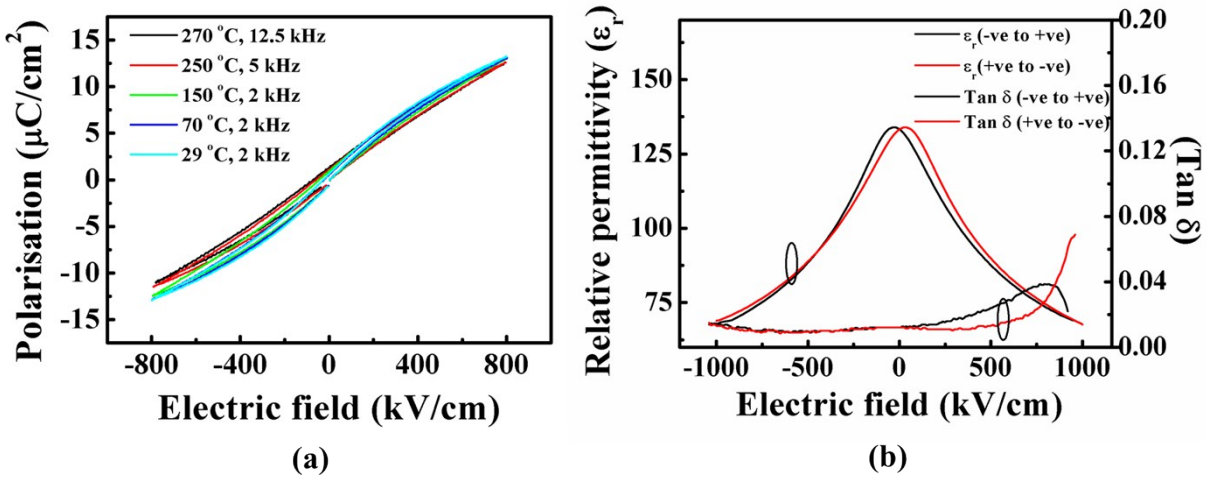


**Fig. S2** (a) Polarisation vs. electric field (PE) loops from room temperature to 270°C, and (b) Relative permittivity ($\varepsilon_r$) and Tan δ vs. electric field measurements for a 250 nm thick

$SrTiO_3$-$Sm_2O_3$ (60 wt.% $Sm_2O_3$) nanocomposite film grown on Nb-doped $SrTiO_3$ (001) single crystal substrate.

From Fig. S2(a), we can clearly see that the film has retained ferroelectric character at least to 270 °C. Beyond this temperature the loops became quite lossy to conclude their ferroelectric or paraelectric nature. The tunability as calculated from the capacitance vs. electric field measurements shown in Fig. S2(b) was found to be ~49% with a K-factor of 2800.

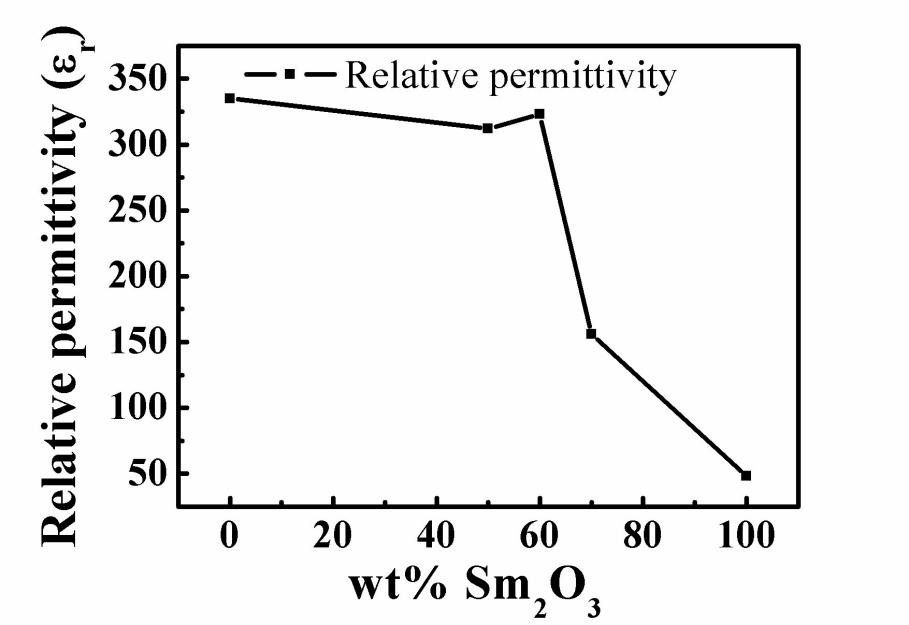


**Fig. S3** Variation of the relative permittivity of the columnar composite films at zero DC bias as the $Sm_2O_3$ content is varied.

From Fig. S3 we see that the relative permittivity ($\varepsilon_r$) of the films decreases with increasing $Sm_2O_3$ content. This is explained by the lower relative permittivity of $Sm_2O_3$.