Supplementary Information

Well-saturated ferroelectric polarization in $PbTiO_3$-$SmFeO_3$ thin films

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Experimental section

Tetra-n-butyl titanate, lead acetate trihydrate, iron nitrate nonahydrate and samarium trinitrate were used to prepare the precursor solution, with 2-Methoxyethanol and glacial acetic acid as solvent and stabilizer, respectively. All experimental reagents are analytical reagent (AR) except tetra-n-butyl titanate is chemically pure (CP). The starting materials were dissolved in 2-Methoxyethanol sequentially to synthesize the 0.2 mol/L PTSF10 precursor solution. 10% excess lead acetate trihydrate was added to compensate the lead loss during the rapid thermal process. 4% glacial acetic acid in volume ratio was added at last. At the same time, stirring was operated on appropriate speed. Then, the mixed solution was bottled and aged for over 24 h to form the precursor. The precursor solution was filtrated with a 0.2 μm syringe filter and deposited onto $Pt/Ti/SiO_2/Si$ substrate at a spinning rate of 4000 rpm for 30s. Subsequently, the film was pyrolyzed at 300°C for 10min and annealed at 600 °C for 1 min to crystalize. $LaNiO_3$ used to buff Si substrate was synthesized by sol-gel process, too. Lanthanum nitrate ($La(NO_3)_3 \cdot 6H_2O$) and nickel acetate tetrahydrate ($Ni(CH_3COO)_2 \cdot 4H_2O$) were dissolved in 2-Methoxyethanol, with consistent stirring applied. In the same way as the deposition of PTSF10 thin film, $LaNiO_3$ precursor solution was spin-coated onto the Si substrate. After annealed at 650 °C, the $LaNiO_3$ buffed Si substrate was used to support the PTSF10 thin films.

Supporting figures

The room temperature magnetization-magnetic field (*M-H*) curves is shown in the Fig.S1. A weak saturated magnetization (M_S) ~3 emu/cc at a magnetic field of 10kOe (equal to 1 Tesla) is detected by PPMS. Besides, the low coercive field (H_c) means the thin film is soft magnetic, which is more applicable in many devices.

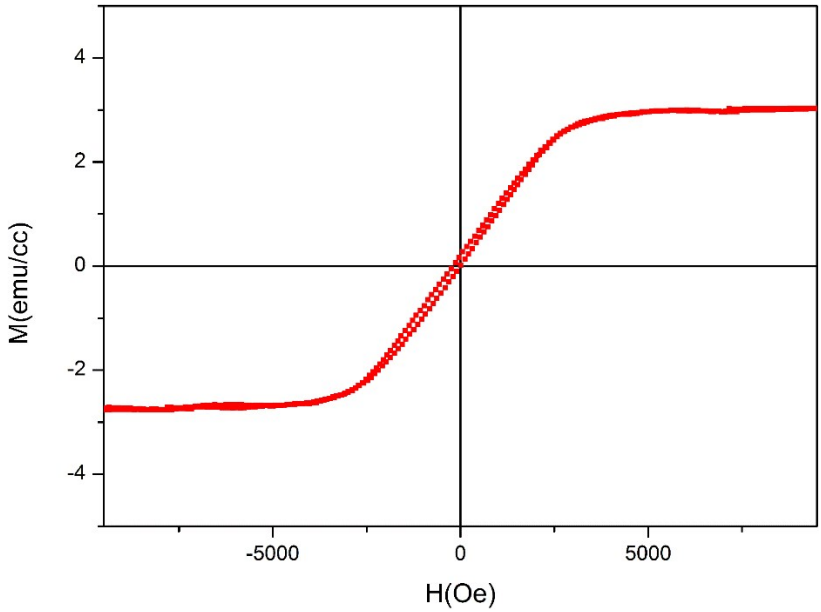

Fig.S1 *M-H* hysteresis loop of the PTSF10 thin film.

The XRD result of PTSF10 with $LaNiO_3$ bottom electrode is shown in Fig.S2. The label P in the image represent PTSF10 while L stands for $LaNiO_3$. PTSF10 on $LaNiO_3$ could be determined to be tetragonal perovskite structure, with a highly orientation in (100) direction. The $I_{(100)}/I_{(110)}$ is calculated to be 4.5, similar with the PTSF10 thin films on $Pt/Ti/SiO_2/Si$ substrate.

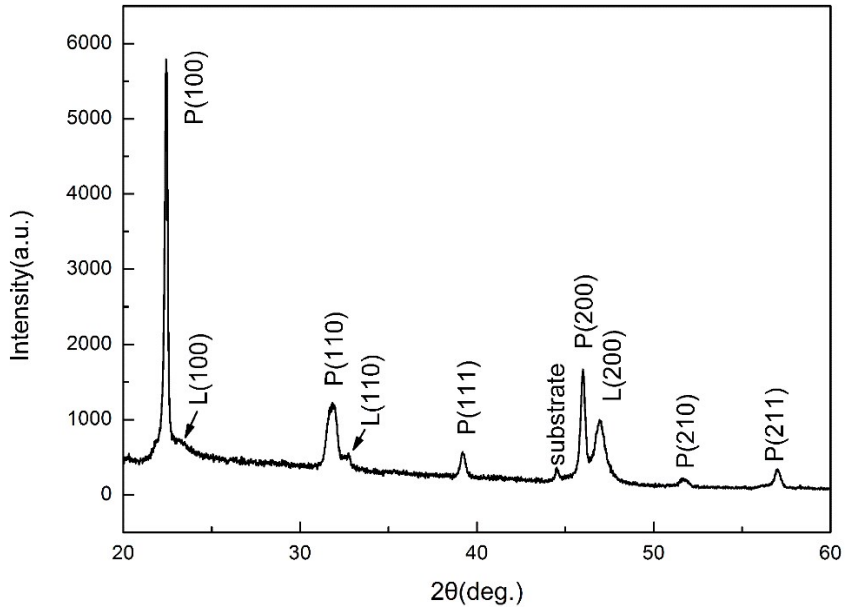

Fig.S2 XRD pattern of PTSF10 thin film on $LaNiO_3$-buffered Si substrate.