

Supporting Information

Tuning Ferroelectricity and Ferromagnetism in BiFeO₃/BiMnO₃ Superlattices

Cai Jin,^{a,b} Wanrong Geng,^c Linjing Wang,^b Wenqiao Han,^b Dongfeng Zheng,^d Songbai Hu,^b Mao Ye,^b Zedong Xu,^b Yanjiang Ji,^b Jiali Zhao,^e Zuhuang Chen,^f Gan Wang,^b Yunlong Tang,^c Yinlian Zhu,^c Xiuliang Ma^c and Lang Chen^{*,b}

^aSchool of Physics, Harbin Institute of Technology, Harbin 150081, China.

^bDepartment of Physics, Southern University of Science and Technology, Shenzhen 518055, China.

^cShenyang National Laboratory for Materials Science, Institute of Metal Research, Chinese Academy of Sciences, Wenhua Road 72, 110016 Shenyang, China.

^dGuangdong Provincial Key Laboratory of Quantum Engineering and Quantum Materials and Institute for Advanced Materials, South China Academy of Advanced Optoelectronics, South China Normal University, Guangzhou 510006, China.

^eLaboratory of Synchrotron Radiation, Institute of High Energy Physics, Chinese Academy of Sciences, Beijing 100039, China

^fSchool of Materials Science and Engineering, Harbin Institute of Technology, Shenzhen 518055, China.

* E-mail: chenlang@sustech.edu.cn

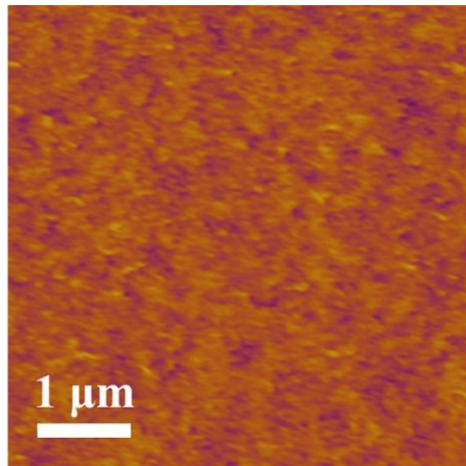


Figure S1. AFM scans of the $\text{BFO}_1/\text{BMO}_1$ superlattices grown on STO substrates, $R_{\text{rms}} \approx 200$ pm.

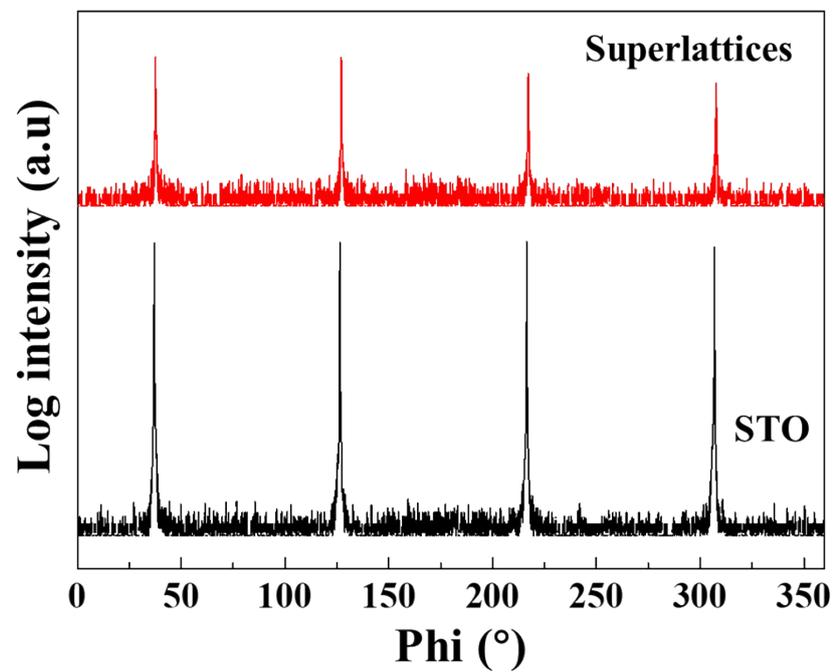


Figure S2. The φ scans of the BFO/BMO superlattices (202) and STO (202) planes.

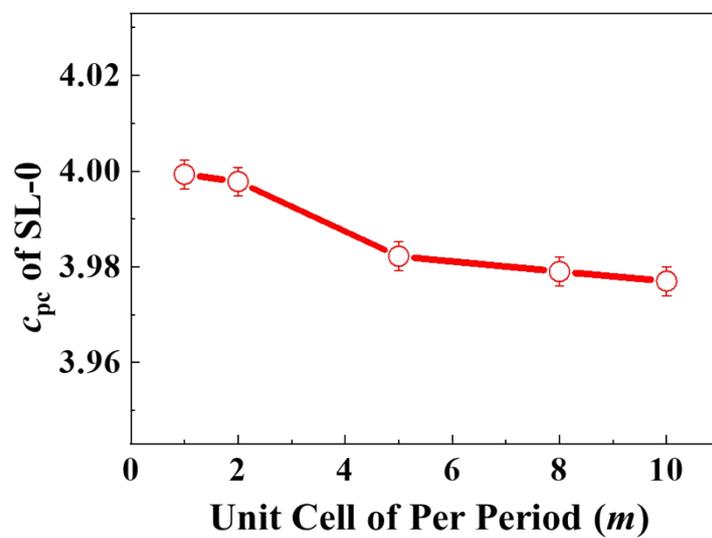


Figure S3. Out-of-plane lattice constant c_{pc} of SL-0 as a function of unit cell per period (m).

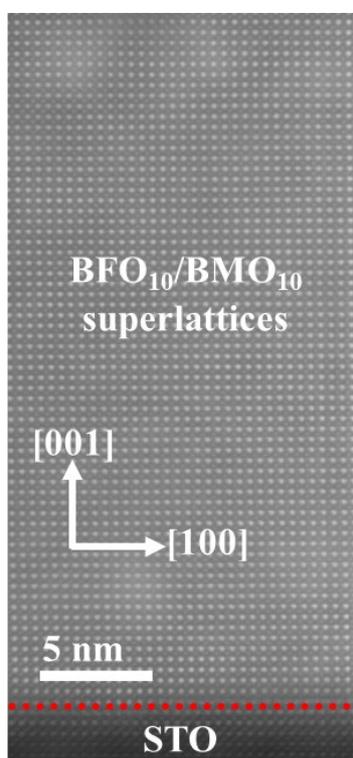


Figure S4. Atomic resolution STEM image in HAADF mode. The uniform contrast

indicates a homogeneous film composition.

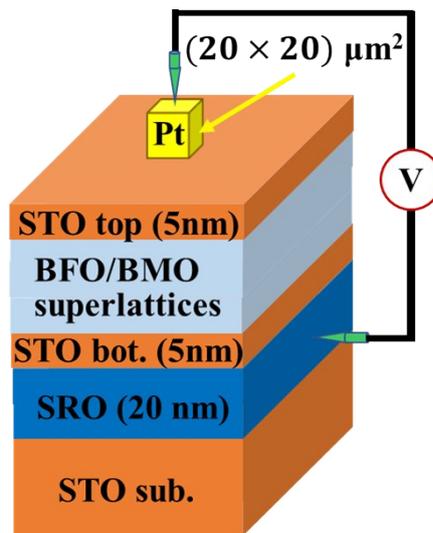


Figure S5. Schematic diagram of samples used to measure P - E loops. Metallic SRO approximately 20 nm thick serves as the bottom electrode and insulating STO about 5 nm thick deposited on the top and bottom of the superlattices forms a sandwich structure. The Pt top electrodes with the size of $20 \times 20 \mu\text{m}^2$ were fabricated on the surface of the superlattices by photolithography and magnetron sputtering.

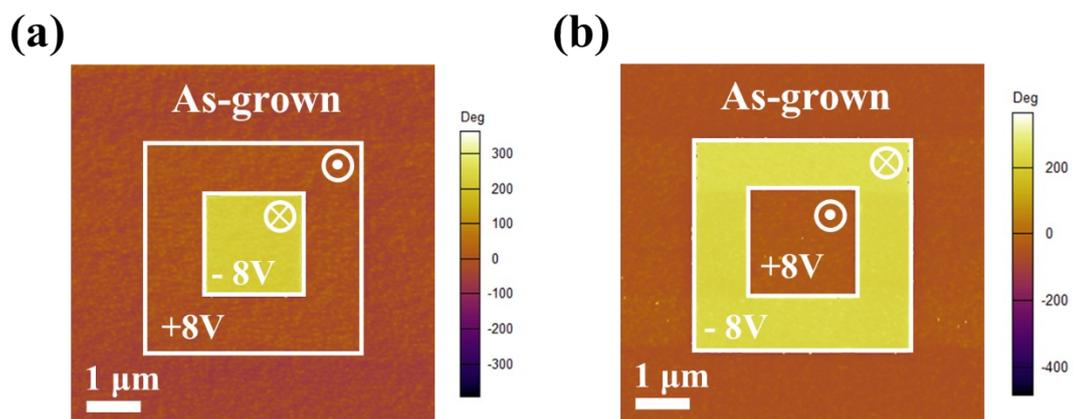


Figure S6. Phase of PFM poling map of BFO₁₀/BMO₁₀ superlattices at RT. (a) PFM poling map written at ± 8 V. (b) PFM poling map written at ∓ 8 V.

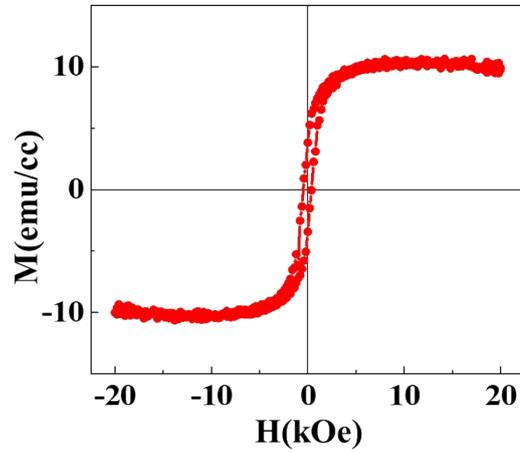


Figure S7. In-plane field dependent magnetization M - H hysteresis loops at 10 K for single-layer BFO thin films on (001) STO substrates.

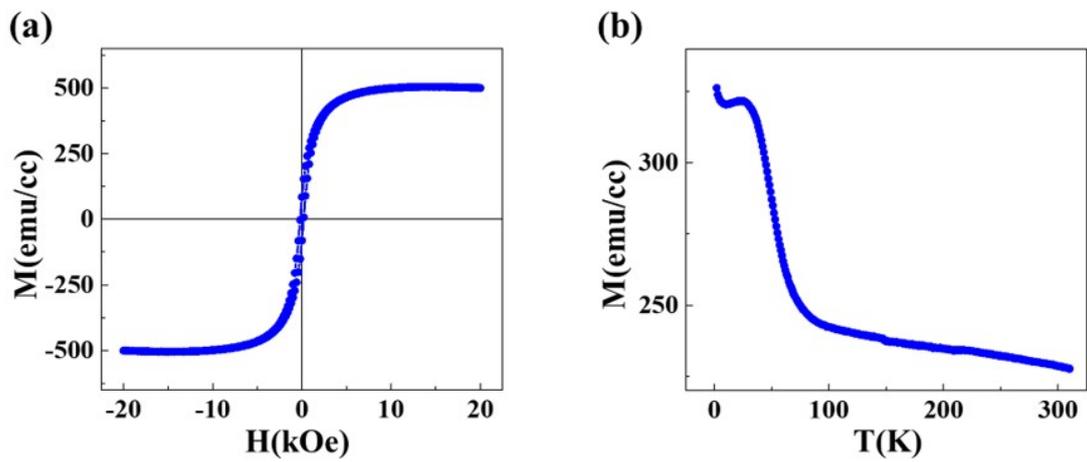


Figure S8. Magnetic properties of single-layer BMO thin films on (001) STO substrates. (a) In-plane field dependent magnetization M - H hysteresis loops at 10 K. (b) In-plane temperature dependent magnetization M - T curves at 1000 Oe.

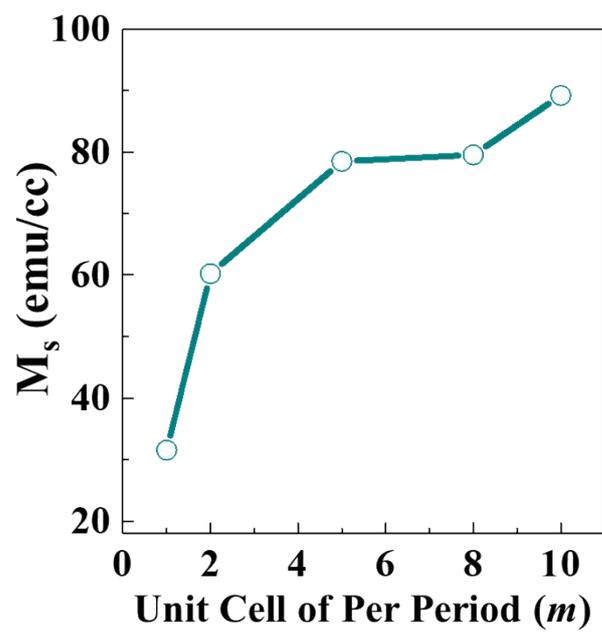


Figure S9. Magnetization M_s as a function of unit cell per period (m).