Abstract Submitted
for the MAR17 Meeting of
The American Physical Society

Predicting two-dimensional electron gas mediated magnetoelectric coupling at ferroelectric $PbTiO_3/SrTiO_3$ heterostructure LAN-YING WEI, CHAO LIAN, SHENG MENG, Beijing National Laboratory for Condensed Matter Physics and Institute of Physics, Chinese Academy of Sciences — We predict the emergence of interfacial ferromagnetism in the two-dimensional electron gas (2DEG) at the ferroelectric $PbTiO_3/SrTiO_3$ heterostructure from first principles calculations. Free electrons provided by naturally existing oxygen vacancies in $SrTiO_3$ are driven to the heterostructure interface under the polarizing electric field of ferroelectric $PbTiO_3$. These spin-polarized electrons are captured by interfacial Ti atoms, forming a 2DEG, which surprisingly exhibits ferromagnetism even at room temperature, once the density of 2DEG reaches a relatively small critical value of $\sim$60 $\mu C/cm^2$. This critical value can be easily achieved in practice. The ferroelectricity-controlled ferromagnetism mediated by 2DEG via interface shows exceptional magnetoelectric coupling strength several times larger than that of other systems, which enables us to control the magnetism by electric field conveniently. Besides, the $PbTiO_3/SrTiO_3$ heterostructure is cheap, easy-growing and controllable, facilitating great promising applications in low cost spintronics and information storage at room temperature.

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Date submitted: 03 Nov 2016 Electronic form version 1.4