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Ferroelectric two-dimensional electron gases based on SrTiO3 thin films

Two-dimensional electron gases (2DEG) at SrTiO3 (STO)-based oxide interfaces gained a wide interest not only from the fundamental aspect but for their potential usage in technological applications.1-2 A rich variety of emergent phenomena such as quantum Hall effect, Shubnikov-de Haas oscillations, Rashba effect, 2D superconductivity, inverse Edelstein effect etc. were observed at such interfaces.3-4 For future integration, it would be more interesting to create the high mobility 2DEG in STO thin films rather than using the single crystal substrates. In addition, introducing epitaxial strain in thin films could be used to manipulate the properties of STO and therefore of the 2DEG based in STO thin films. However, to date reports on interfacial 2DEGs based on STO films have shown mixed results, with mobilities only in the range of 10 cm^2/Vs at low temperature vs more than 1000 cm^2/Vs for 2DEGs based on single crystal STO.5-6

In this presentation, we will present results on STO 2DEGs based on STO films grown by oxide molecular beam epitaxy and formed by a redox process through the deposition of ultrathin Al films by sputtering. The mobility is higher than in previous reports. We can then harness epitaxial strain to introduce ferroelectricity (FE) in such films and hence, in 2DEGs created at their surfaces. We will show our data on strained STO thin films epitaxially grown on LSAT substrate in which Raman study shows the signature of FE. The transport data of 2DEG in STO thin films also shows the coupling between FE and electronic properties. The ferroelectric transition temperature in 2DEGs created in strained STO thin films is one order of magnitude higher than that of bulk doped STO single crystals.

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