Ferroelectric and multiferroic two-dimensional electron gases for oxide spin-orbitronics

Manuel Bibes[1]

[1] *Unité Mixte de Physique CNRS/Thales, Université Paris-Saclay, 91767 Palaiseau, France*

Just as the apparent incompatibility between ferroelectricity and magnetism prompted the renaissance of multiferroics[1], the research on «ferroelectric» metals – conjectured in the 1960s by Anderson and Blount[2] – was recently revitalized. Yet, their experimental demonstration remains very challenging due to the contra-indication between the presence of free charge carriers and switchable electric dipoles. In this talk we will report on two-dimensional electron gases (2DEGs) formed on Ca-substituted $SrTiO_3$ (STO). Signatures of the ferroelectric phase transition near 30 K are visible in the temperature dependence of the sheet resistance R_S and in a strong, reproducible hysteresis of R_S with gate voltage[3]. In addition, spectroscopic explorations of the 2DEG region indicate the presence of switchable ionic displacements. Beyond their fundamental interest in materials physics, ferroelectric 2DEGs offer opportunities in spin-orbitronics: we will show how their spin-charge conversion properties, caused by the inverse Rashba-Edelstein effect, can be electrically tuned in amplitude and sign in a non-volatile way[4]. These results open the way to a whole new class of ultralow-power spin-orbitronic devices operating without the need for magnetization switching. Finally, we will describe how one can introduce magnetism into such systems to achieve multiferroic 2DEGs displaying magnetoelectric coupling[5].

References:

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