Ferroelectric control of Rashba states: towards non-volatile spintronics driven by ferroelectricity

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After 50 years of exponential increase in computing efficiency, the technology of today's electronics is approaching its physical limits, with feature sizes of just a few nm. New schemes must be devised to contain the ever-increasing power consumption of information and communication systems, which requires the introduction of non-traditional materials and new state variables. As recently highlighted, the remanence associated with collective switching in ferroic systems is appealing to reduce power consumption[1]. A particularly promising approach is spintronics, which relies on ferromagnets to provide non-volatility and to generate and detect spin currents. However, magnetization reversal by spin transfer torques is a power consuming process. This is driving research on multiferroics to achieve a low-power electric-field control of magnetization, but practical materials are scarce and magnetoelectric switching remains difficult to control. In this talk, we will propose an alternative strategy to achieve low-power spin detection and generation, in non-magnetic systems combining ferroelectricity and Rashba spin-orbit coupling[2]. We will focus first on oxide-based 2-dimensional electron gases (2DEGs) based on ferroelectric $SrTiO_3$ and show how both spin-charge and charge-spin conversion can be controlled by ferroelectricity[3]. While these results were obtained at low temperature, we will describe our current efforts to realize ferroelectric 2DEGs with high Curie temperature, and present room-temperature operation with the ferroelectric Rashba semiconductor GeTe[4]. These observations open the way to the electric-field control of spin currents and to ultralow-power spintronics, in which non-volatility would be provided by ferroelectricity rather than by ferromagnetism.

References

1. Manipatruni, S. *et al.* Nature Phys 14, 338 (2018).
2. Varignon, J. *et al.* Nature Phys 14, 322 (2018).
3. Noël, P. *et al.* Nature 580, 483 (2020).
4. Varotto, S. *et al.* Nat Electron 4, 740 (2021).

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