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Oxide spintronics for beyond-CMOS technologies

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For the last 50 years, the semiconductor industry has relied on Gordon Moore's prediction that the number of components per integrated circuit doubles every two years. The trend was mainly possible due to the steady reduction in transistor size and cost (largely as a result of breakthroughs in materials and lithography processes), as well as increasing complexity of computer architectures. Yet, with CMOS technology reaching characteristic sizes of 7 nm, electron tunneling effects start to interfere with the regular functionality of transistors. On top of that, the last 15 years saw a deviation from Dennard's scaling, which states that as transistors get smaller, the power density stays roughly the same. In the near future, new technologies beyond-CMOS are required to sustain the increasingly higher demands imposed by the consumer electronics industry.

Among the wide range of proposed options, spintronics is considered a leading candidate, backed by recent proposals from Intel for spin- and polarization-based computation [1]. The proposed device consists of two main components: a multiferroic junction, that electrically controls the magnetization of a ferromagnet (write), and a high spin-orbit coupled interface that efficiently converts spin current in charge currents (read). Although this type of device may allow the creation of ultra-fast and low power logic gates, research efforts are still required to perfect both parts.

In this presentation, we focus on the conversion of spin currents in charge currents, using the 2D electron gas that forms at the surface of complex oxides, such as $SrTiO_3$. Using a combination of pulsed laser deposition and sputtering, we carefully engineer $LaAlO_3/SrTiO_3$ heterostructures [2] and find extremely large values for the spin-to-charge current conversion efficiency [3], making this system highly desirable for future spin-based electronic devices [4].

[1] S. Manipatruni et al., Nature 565, 35–42 (2019)
[2] D. C. Vaz et al. Advanced Materials 29, 1700486 (2017)
[3] E. Lesne, D. C. Vaz et al., Nature Materials 15, 1261–1266 (2016).
[4] D. C. Vaz et al., Japanese Journal of Applied Physics 57, 0902A4 (2018)

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