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Gate tunable spin-orbit coupling and superconductivity in KTaO3-based two-dimensional electron gases

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Oxide heterostructures are regarded as promising platforms for the next generation of electronic devices, displaying straightforward properties like high carrier mobility to exotic functionalities like multiferroicity. In polar heterostructures, the interfacial electric field can produce a two dimensional electron gas (2DEG). The broken inversion symmetry results in Rashba spin-orbit coupling that the source of rich physics. For example, it promotes the direct and inverse Edelstein effects that enable interconversion between spin and charge currents for spin-orbitronics. Furthermore, if the system is superconducting, a source of time-reversal symmetry breaking like a magnetic field could enable the generation of topological states.

The family of $KTaO_3$ 2DEGs are good candidates for such effects. On (111) and (110)-terminated $KTaO_3$, superconductivity is observed up to 2,2 K and 1 K respectively. The heavy Ta element confers a large Rashba coupling strength to the 2DEG, around 300 meV.A for $KTaO_3$ (001), compared to few tens of meV.A in $LaAlO_3/SrTiO_3$. However, to assess the functional perspectives of these systems, a fine control of their transport properties needs to be achieved.

Here, we present the tuning of superconductivity and spin-orbit coupling by field-effect in $KTaO_3$-based devices and relate to their band structure. The investigation of the interplay between these effects may shed light on the unconventional pairing mechanism.

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