Gate-tunable superconductivity in the AlOx/SrTiO3 heterostructure

Shamashis Sengupta[a*], Emilie Tisserond[b], Florence Linez[c], Miguel Monteverde[b], Tobias Rodel[a], Anil Murani[b], Philippe Lecoeur[c], Thomas Maroutian[c], Claire Marrache-Kikuchi[a], Andrés Santander-Syro[a], and Franck Fortuna[a]

a. Centre de Sciences Nucléaires et de Sciences de la Matière,
Univ. Paris-Sud, CNRS/IN2P3, Université Paris-Saclay, 91405 Orsay, France
b. Laboratoire de Physique des Solides,
Univ. Paris-Sud, CNRS, Université Paris-Saclay, 91405 Orsay, France
c. Centre de Nanosciences et de Nanotechnologies,
Univ. Paris-Sud, CNRS, Université Paris-Saclay, 91405 Orsay, France

* shamashis.sengupta@csnsm.in2p3.fr

SrTiO3-based two-dimensional electron gases (2DEGs) have led to important discoveries [1,2] about superconductivity in low dimensions, such as the observation of pairing interactions without superconductivity [3] and density-of-states features resembling the pseudogap in cuprates [4].

We have devised a method for the facile realization of a 2DEG by the creation of oxygen vacancies (Rodel et al., Advanced Materials 28,1976 (2016)). The deposition in ultra-high vacuum of a thin layer of metallic Al on SrTiO3 leads to the creation of a 2DEG due to the withdrawal of oxygen atoms from the surface by the reducing agent Al (which turns into insulating AlOx).

Transport experiments show that the 2DEG is superconducting with a critical temperature of 320 mK. The critical parameters (temperature and field) are tunable with the gate voltage, leading to a 'superconducting dome' in the phase diagram. The possibility of continuously varying the carrier density allows us to study different equilibrium and non-equilibrium features characterizing the electronic phases. Results of some recent experiments will be presented.

[1] Reyren et al., Science 317, 1196 (2007)
[2] Caviglia et al., Nature 456, 624 (2008)
[3] Cheng et al., Nature 521, 196 (2015)
[4] Richter et al., Nature 502, 528 (2013)