Cryo-SNOM studies of nanostructured functional oxides

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Quantum oxides exhibit a remarkable variety of ordering phenomena that can be useful for applications, such as (multi-)ferroicity, superconductivity and metal-insulator transitions. Typically, near the ordering temperature, different phases coexist at the nanoscale. Furthermore, some of the important effects appear at the nanometer-thick interfaces between the different oxide layers, exemplified by the famous LAO/STO system ([1-3]). Infrared cryo-SNOM is an ideal technique to study these materials as it combines the access to charge, spin and lattice dynamics, nanoscale resolution and broad-band performance.

In this contribution, we will present SNOM studies of LAO/STO systems and nanostructures [1,2], as a function of temperature, the laser wavelength and the gate voltage. We find that the s-SNOM signal is highly sensitive to the density and the mobility of the charge carriers in the 2DEG, which is explained by the formation of coupled plasmon-phonon polariton modes at the interface. We also demonstrate that SNOM can be used to map spatially inhomogeneous structures, such as AFM-written conducting wires, lithographically made nanostructures and domain walls in $SrTiO_3$.

References:

[1] W. Luo, M. Boselli, J.-M. Poumirol, I. Ardizzone, J. Teyssier, D. van der Marel, S. Gariglio, J.-M. Triscone and A.B. Kuzmenko, Nature Communications **10**, 2774 (2019).

[2] M. Boselli, G. Scheerer, M. Filippone, W. Luo, A. Waelchli, A. B. Kuzmenko, S. Gariglio, T. Giamarchi and J.-M. Triscone, Phys. Rev. B, in press (2021), arXiv:2009.07867.