Poster-2-11

Geometrically, electrostatically and thermally tunable phonon polaritons in $SrTiO_3$-based interfaces

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Surface phonon-polaritons (SPhPs) - strongly coupled light-phonon modes bound to interfaces between two media, one of which is a polar material with negative permittivity - hold high promise in nano-photonics due to their capacity to squeeze the electromagnetic energy on ultra-subwavelength scales. While the SPhPs are extensively studied in conventional semiconductors (SiC, AlN) and van der Waals materials (hBN, MoS_2), little is done in the vast family of complex perovskite oxides ABO_3. Using scattering-type near-field optical microscopy (s-SNOM) we explored SPhP modes in $LaAlO_3$(LAO)/$SrTiO_3$(STO) heterostructures [1] and 100 nm-thick transferable STO membranes [2]. The presence of conducting 2D electron gas (2DEG) at the LAO/STO interfaces strongly increases the temperature dependence of the PhP frequency, due to a coupling between the SPhPs in STO and the plasmon-polaritons in the 2DEG and also allows for electrostatic tuning by applying voltage to a back gate [1]. In ultra-thin membranes, we observe an even-odd SPhP mode splitting, where the low energy mode shows a propagating behavior with a strongly confined wavelength, while the high-energy mode (Berreman mode) shows the epsilon-near-zero (ENZ) behaviour with a huge enhancement of the electric field inside the sample. Our work shows great potential of oxides for infrared nano-photonics.

[1] *Thermal and electrostatic tuning of surface phonon-polaritons in $LaAlO_3/SrTiO_3$ heterostructures*, Y. Zhou, A. Waelchli, M. Boselli, I. Crassee, A. Bercher, W. Luo, J. Duan, J.l.m. van Mechelen, D. Van Der Marel, J. Teyssier, W. Rischau, L. Alexander Korosec, S. Gariglio, J.-M. Triscone, A. B. Kuzmenko, Nature Communications **14** , 7686 (2023).

[2] *Highly confined epsilon-near-zero and surface-phonon polaritons in $SrTiO_3$ membranes*, R. Xu , I. Crassee , H. Bechtel , Y. Zhou , A. Bercher , L. Korosec , C.W. Rischau , J. Teyssier , K. Crust , Y. Lee , S. Gilbert Corder , J. Li , J. Dionne , H. Hwang , A. B. Kuzmenko, Y. Liu, arXiv:2312.14093, to appear in Nature Communications.