Highlights

RESEARCH AREA 2 - Functional and Complex Materials for Innovative Electronics and Sensing - 2024

Integration of High-Tc Superconductors with High-Q-Factor Oxide Mechanical Resonators

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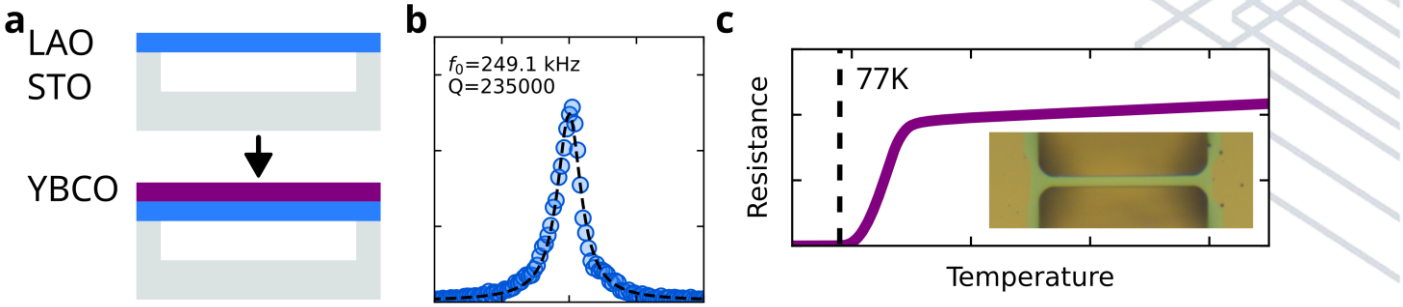
Micro-mechanical resonators are building blocks of a variety of applications in basic science and consumer electronics. This device technology is mainly based on well-established and reproducible silicon-based fabrication processes with outstanding performances in term of mechanical Q-factor and sensitivity to external perturbations. Broadening the functionalities of micro-electro-mechanical systems (MEMS) by the integration of functional materials is a key step for both applied and fundamental science. However, combining functional materials with silicon-based devices is challenging. An alternative approach is directly fabricating MEMS based on compounds inherently showing non-trivial functional properties, such as transition metal oxides. Here, a full-oxide approach is reported, where a high-Tc superconductor YBa2Cu3O7 (YBCO) is integrated with high Q-factor micro-bridge resonators made of single-crystal LaAlO3 (LAO) thin films. LAO resonators are tensile strained, with a stress of about 350 MPa, show a Q-factor above 200k, and have low roughness. YBCO overlayers are grown ex situ by pulsed laser deposition and YBCO/LAO bridges show zero resistance below 78 K and mechanical properties similar to those of bare LAO resonators. These results open new possibilities toward the development of advanced transducers, such as bolometers or magnetic field detectors, as well as experiments in solid state physics, material science, and quantum opto-mechanics.



(a) Scheme of the fabrication process of YBCO/LAO mechanical resonators, where YBCO is grown ex-situ on top of a template made of suspended LAO microbridges fabricated by optical lithography and wet chemical etching. (b) Mechanical spectrum of the first flexural mode of a 500 µm-long LAO microbridge at room temperature. The mechanical quality factor is above 200k. (c) Superconducting transition of a suspended YBCO/LAO bridge showing zero-resistance state at liquid nitrogen.