C2N General Seminar

Friday July 5th 2019 - 10h 00

Amphitheater of C2N

Strongly non-linear superconducting silicon resonators

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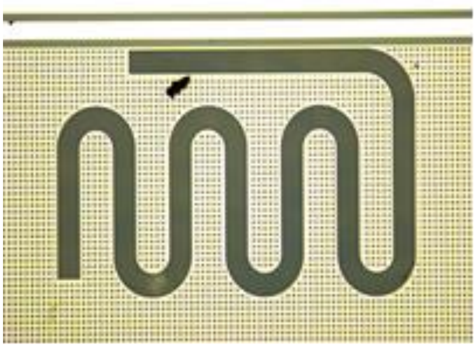
Silicon is one of the most well-known materials, and the main actor in today electronics. Despite this, silicon superconductivity was only discovered in 2006 in laser doped Si:B samples. Laser annealing is instrumental to cross the superconductivity threshold, as the required doping is above the solubility limit, and cannot be reached using conventional micro-electronic techniques. Laser doping allows the realization of epitaxial, homogeneous, thin silicon layers (5-300 nm) with extreme active doping as high as 11 at. %, and without the formation of B aggregates.

Silicon is a disordered superconductor, with a lower carrier density (10^{20} – 10^{21} cm^{-3}) than metallic superconductors, a critical temperature modulable with doping from 0 to 0.7 K, and a relatively high resistivity that allows to easily match the devices to the void impedance.

After demonstrating all-silicon SQUIDs and Josephson junctions, we have realized microwave silicon resonators, working in the 1-10 GHz range and with quality factors about 4000. We have shown a strong non-linear response with power, observing a Kerr coefficient of the order of 300 Hz/photon where less than 1 Hz/photon was expected. This suggests that, once the losses sources identified and reduced, silicon resonators may be promising candidates for Kinetic Inductance Detectors.



Superconducting Silicon resonator coupled to an Al transmission line and surrounded by an Al ground plane

To better understand the losses and recombination mechanisms, we have measured the relaxation dynamics of the resonators following a light or a microwave pulse.

Francesca CHIODI is Maître de Conférences at Université Paris Sud. She joined the 'Laser epitaxy' group in 2011, to work on laser ultra-doping of Si and Ge, and to develop and investigate the first superconducting Si devices. She graduated from ENS, Paris, obtained a PhD at LPS, on the dynamics of long SNS Josephson junctions, and joined as a Post-Doc at Material Sciences Dept., Cambridge, UK, on triplet superconductivity in inhomogeneous SFS Josephson junctions.

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