Radio frequency to optical transducer based on a soft-clamped membrane

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The transduction of quantum signals at different energy scales plays a crucial role in Quantum Technologies [1]. Since optical spectrum is well-suited for long-distance communication, while lower frequencies of the electromagnetic field prove advantageous for precise local quantum operations, achieving coherent conversion between optical and microwave/radio frequency (mw/rf) photons is one of the primary tasks of a transducer. In this talk we present a complete characterization of a nanomechanical oscillator, which might be used for the realization of a novel electro-optomechanical device that can be implemented for the sympathetic cooling of the LC circuit [2], and as building block of an rf/mw-optical transducer [3]. The key element of the device is a mechanical resonator based on a TiN-coated circular Si_3N_4 membrane, optically coupled via radiation pressure and capacitively coupled to an electrical circuit through two electrodes. Since a primary thermodynamical cooling of the device is employed for achieving a quantum regime, the quality factor of the mechanical oscillator has been characterized at room and cryogenic temperatures by means of homodyne detection and ring-down technique. For mechanical frequencies in the MHz range, a quality factor of 10^6 and over 6x10^7 at room temperature and below 100 mK, respectively, is measured by means of stroboscopic technique [4]. Moreover, the shift of the fundamental mode of the oscillator and the electromechanical induced transparency as a function of the potential difference between the device electrodes are reported as evidence of the presence of the electro-mechanical coupling.

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