On-chip RF-to-optical transducer

Simonsen, Anders; Tsaturyan, Yeghishe; Seis, Yannick; Schmid, Silvan; Schliesser, Albert; Polzik, Eugene S.

Published in:
Proceedings of SPIE, the International Society for Optical Engineering

Link to article, DOI:
10.1117/12.2229012

Publication date:
2016

Document Version
Publisher's PDF, also known as Version of record

Link back to DTU Orbit

Citation (APA):

General rights
Copyright and moral rights for the publications made accessible in the public portal are retained by the authors and/or other copyright owners and it is a condition of accessing publications that users recognise and abide by the legal requirements associated with these rights.

- Users may download and print one copy of any publication from the public portal for the purpose of private study or research.
- You may not further distribute the material or use it for any profit-making activity or commercial gain
- You may freely distribute the URL identifying the publication in the public portal

If you believe that this document breaches copyright please contact us providing details, and we will remove access to the work immediately and investigate your claim.
On-chip RF-to-optical transducer
(Conference Presentation)

Anders Simonsen, Yeghishe Tsaturyan, Yannick Seis, Univ. of Copenhagen (Denmark); Silvan Schmid, DTU Nanotech (Denmark); Albert Schliesser, Eugene S. Polzik, Univ. of Copenhagen (Denmark)

ABSTRACT

Recent advances in the fabrication of nano- and micromechanical elements enable the realization of high-quality mechanical resonators with masses so small that the forces from optical photons can have a significant impact on their motion. This facilitates a strong interaction between mechanical motion and light, or phonons and photons. This interaction is the cornerstone of the field of optomechanics and allows, for example, for ultrasensitive detection and manipulation of mechanical motion using laser light. Remarkably, today these techniques can be extended into the quantum regime, in which fundamental fluctuations of light and mechanics govern the system’s behavior. Micromechanical elements can also interact strongly with other physical systems, which is the central aspect of many micro-electro-mechanical based sensors. Micromechanical elements can therefore act as a bridge between these diverse systems, plus technologies that utilize them, and the mature toolbox of optical techniques that routinely operates at the quantum limit.

In a previous work [1], we demonstrated such a bridge by realizing simultaneous coupling between an electronic LC circuit and a quantum-noise limited optical interferometer. The coupling was mediated by a mechanical oscillator forming a mechanically compliant capacitor biased with a DC voltage. The latter enhances the electromechanical interaction all the way to the strong coupling regime. That scheme allowed optical detection of electronic signals with effective noise temperatures far below the actual temperature of the mechanical element. On-chip integration of the electrical, mechanical and optical elements is necessary for an implementation of the transduction scheme that is viable for commercial applications. Reliable assembly of a strongly coupled electromechanical device, and inclusion of an optical cavity for enhanced optical readout, are key features of the new platform. Both can be achieved with standard cleanroom fabrication techniques. We will furthermore present ongoing work to couple our transducer to an RF or microwave antenna, for low-noise detection of electromagnetic signals, including sensitive measurements of magnetic fields in an MRI detector.

Suppression of thermomechanical noise is a key feature of electro-optomechanical transducers, and, more generally, hybrid systems involving mechanical degrees of freedom. We have shown that engineering of the phononic density of states allows improved isolation of the relevant mechanical modes from their thermal bath [2], enabling coherence times sufficient to realize quantum-coherent optomechanical coupling. This proves the potential of the employed platform for complex transducers all the way into the quantum regime.

References:

View presentation recording on the SPIE Digital Library:
http://dx.doi.org/10.1117/12.229012.5042345213001