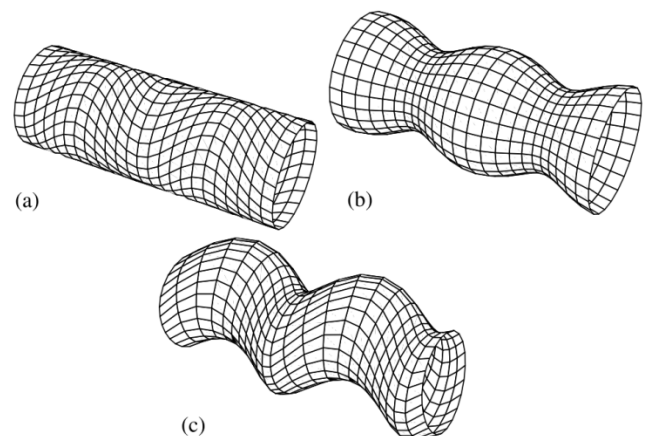
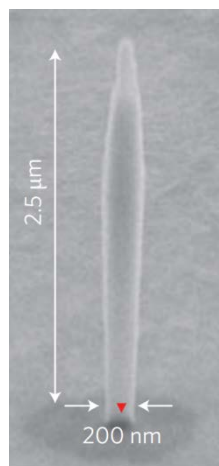


M.Sc. project

Phonon effects in a nanowire single-photon source

The aim of this theoretical project is to investigate how phonons – quantized lattice vibrations - affect the properties of photons emitted from single photon sources

Nanowires are small pillars grown in semiconductor materials (Left figure). By embedding a quantum dot (QD) inside the nanowire, single photons may be emitted from the nanowire when the QD is excited. Information may be encoded in the emitted photons, making them flying quantum bits, the quantum mechanical analogy to classical bits of “0”s and “1”s. These single-photon sources are crucial for the realization of a quantum computer, but a major requirement is that the emitted photons are *indistinguishable*, meaning that they can interfere quantum mechanically, which is at



(Left) SEM image of fabricated nanowire [1]. (Right) Sketch of the vibrational modes of an infinite nanowire [2].

the core of the quantum computer making it superior to classical computers for certain computing tasks. The indistinguishability is primarily deteriorated by coupling to the vibrational modes of the surrounding structure. A thorough understanding of this coupling is, however, not available in the existing literature.

Goals of the project (which may be modified according to the interests of the student):

- Determine the vibrational modes in a semiconductor micropillar based on [2] – either by an analytical solution and/or by using the numerical tool COMSOL.
- Understand and expand the theory of electron-phonon coupling in bulk materials to a nanowire structure, based on a model developed at DTU Fotonik [3, 4, 5].
- Propose designs for optimized functionality of the nanowire single-photon sources.

DTU Fotonik is in the front line of research within nanowire single-photon sources [1], and also has a strong collaboration with the Commissariat à l’Energie Atomique in Grenoble, France, who are fabricating and characterizing the single-photon sources with structures based on research done at DTU Fotonik.

The project consists of both theoretical and numerical work and seeks a student with a strong theoretical background with a knowledge of quantum mechanics (e.g. from 10112 Advanced Quantum Mechanics), solid state physics (e.g. from 10303 Condensed Matter Physics and Nanoscale Materials Physics), and also a basic knowledge of Matlab programming.

If you want to hear more about the project, do not hesitate to come by our offices or send us an email.

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