Photonic Forces group (AMOLF)

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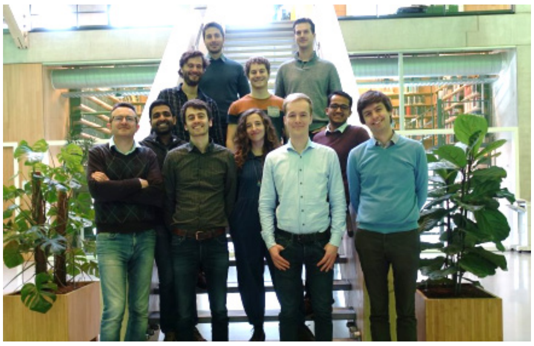
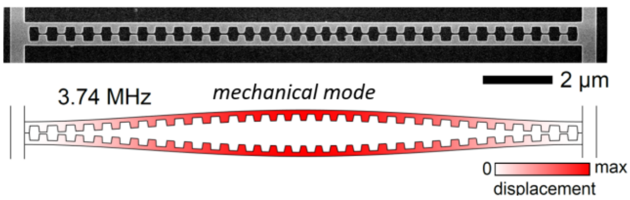
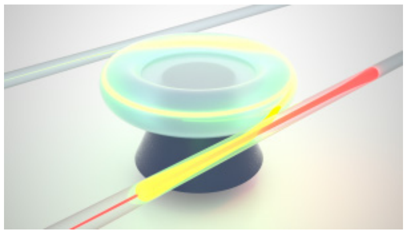


Research theme The *Photonic Forces* group studies light-matter interactions at the nanoscale, and in particular the coupling between light and mechanical vibrations, as it can occur through radiation pressure. We use these nano-optomechanical systems to develop new ways to control light and sound on a chip, and study the behavior of nanomechanical resonators down to the quantum regime.
All projects below will be supervised by Ewold Verhagen, together with a PhD student or postdoc.

Project 1. Controlling the quantum state of an ultracoherent nanostring with light
Even macroscopic objects can exhibit the strange behavior associated with the laws of quantum mechanics. In this project, you will cool a nanostring vibrating at MHz frequencies close to its quantum ground state of motion, using the forces exerted by laser light combined with very sensitive measurement. To do so, you will develop new on-chip nanomechanical resonators made from silicon nitride, in which mechanical decoherence can be extremely small. In a cryogenic setup, we will then seek to test a new theoretical prediction that a short, intense laser pulse could induce a special 'squeezed' quantum state in the mechanical string.



Project 2. One-way light propagation on a photonic chip
Light can normally propagate in two directions through a waveguide, or any optical system, equally well: the principle known as reciprocity. Non-reciprocal functions like isolation or circulation are extremely useful, as they allow protecting against the detrimental effects of backscattering and efficient routing of optical signals. However, this requires magneto-optic materials that cannot be integrated on a photonic chip. In this project, you will use sound waves to break the symmetry of light propagation and create non-reciprocity. We will investigate new materials for efficient generation of sound and interaction with light. You will fabricate the devices in the AMOLF cleanroom and test the envisioned effects in optical experiments.



Project 3. Optomechanical control of photon polarization
Recently, a new and powerful optomechanical system was discovered. It is relatively simple: consisting of a piece of crystal between two mirrors. Ultrahigh-frequency sound waves in the crystal then couple strongly to the photons in the cavity. We have predicted that an intriguing effect could happen in these cavities: A photon passing through the cavity can change its polarization under the influence of a second laser beam, through a nonlinear interaction mediated by acoustic phonons in the crystal. This is thus analogous to the Faraday effect in magneto-optic materials - but without any magnetic field. You will build a new setup and seek to observe this effect for the first time.