Otpo-mechanically controlled high-Q micro-cavities
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The possibility to manipulate the light at the micro- or nanoscale offers a large variety of applications ranging from integrated optical chips for telecommunication, to quantum optics, to (bio-)sensing, etc. A characteristic example are whispering-gallery-mode (WGM) micro-resonators in the form of glass spheres, glass toroids or polymeric goblets which exhibit very high quality factors Q (i.e., light resides for very long time in the cavity) in combination with small modal volumes, and thus can be employed for strong light-matter interaction applications or to create new types of photon states by coupling various cavities in chains or arrays.

The major challenge for such advanced applications of WGM micro-resonators is to control at will the spectral position of the resonances of a single cavity. In spite of the extremely advanced fabrication skills that have been developed in the last ten years, the possibility to fabricate two identical high-Q microcavities in which the fundamental modes spectrally overlap does not seem to be feasible, let alone a chain of several cavities coupled together. For this and other type of applications, the development of optical techniques able to tune *a posteriori* microresonators is considered valid alternative strategy that can open new research opportunities. Such a tunability has been shown to be possible in different types of cavities with a variety of approaches (electrical injection, temperature control, all-optical switching) which always induce a minute variation of the refractive index accompanied by a spectral shift of the resonance.

An alternative (unexplored) strategy can be based on opto-mechanics. In this respect photoactive elastomeric materials significantly modify their shape upon electromagnetic irradiation. Recently, the group of D. Wiersma (LENS, Florence, IT), which has been awarded with an ERC Advanced Grant on optically-driven micro-robotics, has developed a fabrication technique able create films of photoactive liquid-crystal elastomers (LCE) of few tens of microns. These films can be chemically and mechanically engineered in order to have different types of deformation (expansion, contraption, rotation, etc). Such a polymer could be use to deform WGM microcavities, which in turn changes the spectral position of their fundamental modes. Recently the groups of H.Kalt (Institute of Applied Physics at KIT) and T.Mappes (Institute of Microstructure Technology at KIT) have introduced a novel type of WGM resonator based on polymers. Such a material is softer than glass (the most common material employed to fabricate micro resonators), and thus more apt to modify their shape under an applied force.

Currently, the two Institutes are collaborating, within the Erasmus Mundus project, running the first feasibility tests on the opto-mechanical tunability based on LCE with extremely promising results.

The task of a PhD candidate will be to further extend the research from mere testing to the actual implementation of a WGM microcavity tunable with light. Further development of the research will aim to achieve tunable (strong) coupling between two (or more) microcavities. The candidate will also explore the possibility to employ these tunable cavities for (bio-)sensing applications

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