Microresonator with compact fiber coupling for wavelength sensor

Graduate

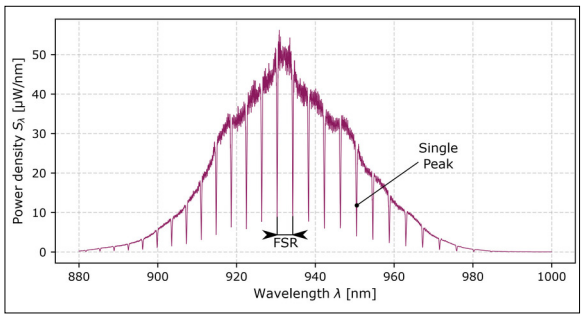
Marco Hölzle

Introduction: In this bachelor thesis, a microcavity with compact fiber coupling is developed and characterised. This is part of the EU Horizon project PionEar, which aims to develop a photonic microphone with superior sound quality. The microcavity is based on a Fabry-Pérot interferometer (FPI) with plane-parallel, dielectric mirrors and an adjustable mirror spacing in the range of a few tens of micrometres.

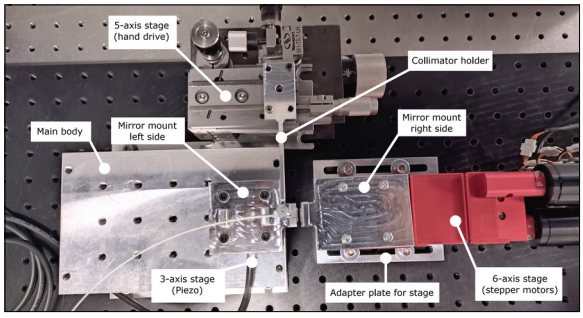
Objective: The objective of this thesis was the design, setup and validation of an optical test system that couples a broadband light source with a central wavelength of 940 nm into the resonator via a GRIN lens and records the spectral response using optical spectrum analysers. For the alignment of the microcavity, a combined adjustment technique consisting of a pilot laser and power optimization was developed. A 6-axis stage (stepper motors), a 5-axis stage (manual drive), and a piezo actuator were employed. The mirrors used were fabricated in the cleanroom of the IMP and optimized for a reflectivity of approximately 92% in the range from 880 nm to 1000 nm. Simulations in the non-sequential mode of OpticStudio provided reference data for free spectral range (FSR), spectral full width at half maximum (FWHM), peak shift, and sensitivity to mirror tilt.

Result: The measurement series confirmed the functionality of the experimental setup and showed good agreement with simulation and theory regarding the FSR, FWHM, and peak shift. At a mirror spacing of 60 µm - representing a typical application case - an FSR of 7.2 nm and an FWHM of 1.08 nm were obtained. When one of the mirrors was displaced by 100 nm, the peaks shifted by 1.42 nm. Critical parameters were also identified, such as the narrow alignment tolerance (±0.005°) and the sensitivity to vibrations. Potential improvements lie particularly in the mechanical stability and the automation of the measurements. The results achieved provide a foundation for the targeted further development of the photonic microphone system.

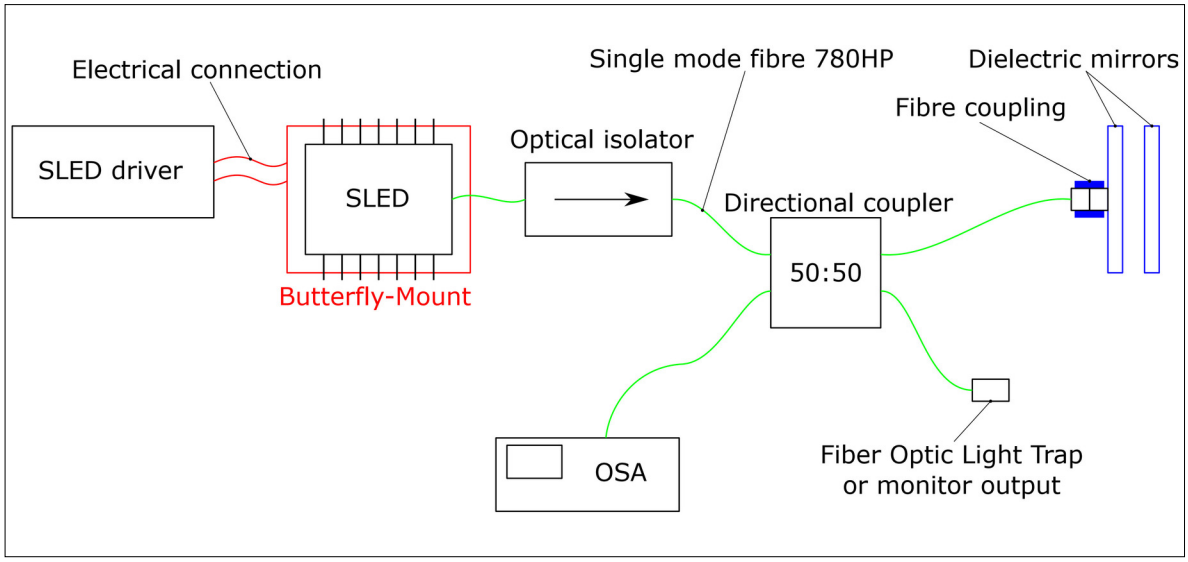
Measured reflection spectrum at 100 µm mirror distance
Own presentment



Experimental setup realised in the photonics laboratory
Own presentment



Schematic overview of the experimental setup
Own presentment



Advisor
Prof. Dr. Markus Michler

Co-Examiner
Prof. Dr. Tobias Lamprecht

Subject Area
Photonics