Development of Fiber-Optic Pressure Sensors for the Usage in Unsteady Multi-Hole Probes

Abstract:
When measuring unsteady flow phenomena with multi-hole pressure probes, the sensors are integrated inside the probe near the probe tip. Arbitrary outer shapes of the probes can be realized with the additive manufacturing process selective laser melting (SLM). In order to realize multi-hole probes with higher temporal resolution, which can be operated in harsh environments, a fiber-optic sensor is developed. The sensor is built out of two micromachined fused silica (SiO2) wafers, which are bonded together. The sensor is operated differentially with a pressure capillary by either pressurizing the sensor or using the surrounding static pressure as the reference pressure. The measurement principle of the fiber-optic sensor is based on the Fabry-Pérot interferometer effect. The cylindrical sensor's diameter and depth is 2 mm, respectively. For the quantification of the sensor measurement capabilities, various validation tests have been performed: Besides a static and dynamic calibration, comparisons with a state-of-the-art piezo-resistive pressure sensor have been performed. The focus lies on the reproducibility of both frequency response and amplitude. The linear pressure range, the sensor resolution and the
cross-sensitivities are determined. The signal-to-noise ratio of the whole measurement chain is compared to a state-of-the-art piezo-resistive sensor measurement chain. Furthermore, the acoustic transfer function of a silicone tube is analyzed experimentally in a frequency test-rig and is compared to an analytical solution.

Stichworte: Mehrlochsonden, faser-optische Sensoren, instationäre Druckmessung, Fabry-Pérotmulti-hole probe, fiber-optic sensor, unsteady pressure measurement, Fabry-Pérot

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