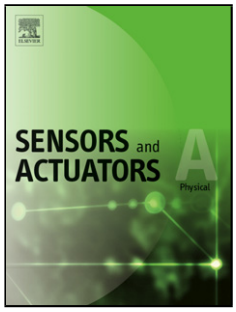


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# Optimization of Mach–Zehnder Interferometer with Cascaded Up-tapers and Application for Curvature Sensing

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1. All-fiber Mach-Zehnder interferometers (MZIs) working as curvature sensors have been attracting increasing attention. However, previously reported MZI-based curvature sensors with offset or abrupt-taper structures suffer from weak mechanical strength and low curvature sensitivity. In this letter, a robust and highly-sensitive MZI-based curvature sensor formed by cascading two up-tapers in a single mode fiber (SMF) is proposed and experimentally demonstrated.
2. By optimizing structural parameters of the MZI both in simulation and in experiment, a high quality interference spectrum with a maximum extinction ratio (ER) around 20 dB is obtained, which is crucial in curvature sensing with spectrum intensity variation and interference dip identifiability considered. Experimental results show that a high curvature sensitivity of 35.41 nm/$m^{-1}$ is obtained in the range of 0.6846 $m^{-1}$– 1.0606 $m^{-1}$, which is 2.4 times higher than that of the interferometer with single-mode-multimode-single-mode (SMS) structure.
3. The two up-tapers, featured by great mechanical strength, are fabricated by only fusion pushing together a whole SMF without cleaving procedure, contributing to excellent repeatability and consistency in the sensor fabrication process. Such an all-fiber sensor exhibit advantages of simple configuration, ease of fabrication, excellent mechanical strength, low cost, and high curvature sensitivity.

**Abstract**

All-fiber Mach-Zehnder interferometers (MZIs) working as curvature sensors have been attracting increasing attention. However, previously reported MZI-based curvature sensors with offset or abrupt-taper structures suffer from weak mechanical strength and low curvature sensitivity. In this letter, a robust and highly-sensitive MZI-based curvature sensor formed by cascading two up-tapers in a single mode fiber (SMF) is proposed and experimentally demonstrated. By optimizing structural parameters of the MZI both in simulation and in experiment, a high quality interference spectrum with a maximum extinction ratio (ER) of around 20 dB is obtained, which is crucial in curvature sensing with spectrum intensity variation and interference dip identifiability being considered. Experimental results show that a high curvature sensitivity of -35.41 nm/$m^{-1}$ is obtained in the range of 0.6846 $m^{-1}$– 1.0606 $m^{-1}$, which is 2.4 times higher than that of the interferometer with single-mode-multimode-single-mode (SMS) structure. The two up-tapers, featured by great mechanical strength, are fabricated by only fusion pushing together a whole SMF without cleaving procedure, contributing to excellent repeatability and consistency in the sensor fabrication process. Such an all-fiber sensor exhibits advantages of