LAB-ON-FIBER ACCELEROMETERS BASED ON FIBER TIP OPTO-MECHANICAL CAVITIES

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We developed "Lab on fiber" accelerometers based on micro-opto-mechanical cavities on the optical fiber tip. Cantilever and membrane based accelerometers were designed to operate in different frequency ranges. The performances of the fabricated probes have been characterized and the results are here discussed.

Keywords:Lab-On-Fiber accelerometers, optical fiber sensors, micromechanics

1. Introduction

Recently the judicious connection of Lab on fiber (LOF) technology and opto-mechanics have been successfully demonstrated for the realization of several physical and biomedical devices [1-4]. We also developed seismic accelerometers involving the integration of optomechanical micro-structures on the fiber tip and demonstrated the applicability of such technological approach in seismic surveillance applications [5]. In this framework, we investigated the realization of LOF accelerometers with differ spectral features by still exploiting micro-mechanical structures suspended in close proximity to the end facet of a single-mode fibre [6].We pursued two alternative approaches: in the former one, as shown in fig. 1a, the opto-mechanical cavity is composed of a simple cantilever suspended on the optical fiber end facet whilein the fig. 2a, the opto-mechanical structure consists of a membrane sustained by four cantilevers.The air gap between the terminal end of the optical fiber and the simple cantilever or the membrane sustained by four cantilevers behaves as a Fabry-Perot interferometer. Therefore, provided a suitable fringes visibility of the interferometer, a vertical acceleration (along the fiber axis) leads to a displacement of the proof mass, which can be remotely detected as a phase shift of the interferometer. The mechanical response of the sensors have been predicted by numerical simulations based on the finite element method. Cantilever based accelerometers were realized by using a ferrule top approach, whilst membrane based accelerometers were realized through a photolithographic process followed by a transfer step. Different cantilever-based accelerometers have been fabricated with different geometrical features by outlining the tradeoff existing between sensitivity and bandwidth. The performances of the fabricated probes have been characterized by using a shaking table. Either cantilever and membrane based LOF accelerometers, when designed to have the same mechanical resonance at 15 KHz exhibited a sensitivity of about 3mV/(m/s^2) on a 3dB-bandwidth of at least 5 kHz with a resolution of 100μg/(Hz)$^{1/2}$.The resulting performance comparison highlights the potentiality and the versatility of this emerging technology to create a novel class of labs on fiber based on the integration of micro-opto-mechanical structures with the optical fibers.

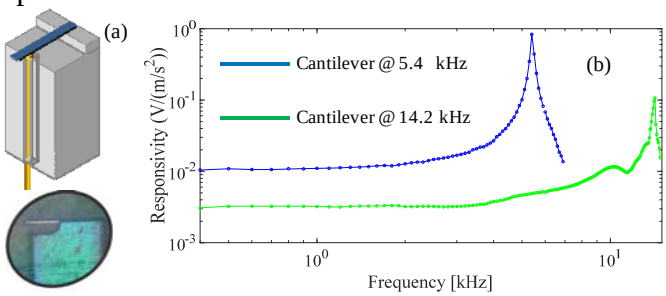

Fig. 1 (a) Schematic representation and microscopic picture (lateral view) of one cantilever based sensor. (b) Experimental responsivity of two cantilever based accelerometers

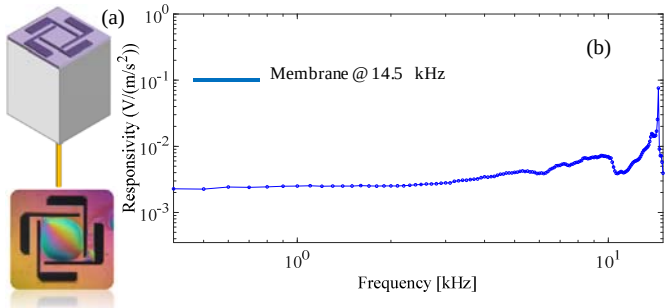

Fig. 2(a) Schematic representation and microscopic picture (top view) of one membrane based sensor. (b) Experimental responsivity of the membrane based sensor

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