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A Study on Pressure Sensor Based On Photonic Crystal

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Abstract **Photonic crystal technology is used in many areas of detection and measurement of parametrs like pressure, temperature, displacement etc.MOEMS based micro-sized pressure sensor can be developed to detect even sub-micron range dimension change using the photonic crystal. The applied pressure on the object will change the dimension of the waveguide carved in the photonic crystal. As a result, this change in spacing can alter the propagation feature of electromagnetic waves that pass through them that is changing the transmission spectrum. So, this change can directly be mapped to pressure on the observed object. In this paper, the pressure sensor using photonic crystal has been modeled and analyzed.**

Index Terms— photonic crystal, pressure sensor, optical ring resonator, PhCs

I. INTRODUCTION

"Micromachined Fabry-Perot cavity pressure sensor" presented that surface Micromachined Fabry- Perot cavity used as a pressure sensor has been fabricated using standard IC technology. Dielectric film stacks consisting of layers of silicon dioxide and silicon nitride were used as mirrors. Polysilicon was used as a sacrificial layer that was then removed to from an air gap cavity. The Fabry-Perot sensor was optically interrogated using a multimode optical fiber. The measured response of the sensor agrees well with theoretical simulation, which takes into account the averaging effect caused by the shape of the deflected mirror in the cavity. [1]

"Integrated optical ring resonator with Micromechanical diaphragms for pressure sensing", an optical pressure sensor has been fabricated which uses an integrated- optical ring resonator to measure the strain induced in a Micro machined silicon diaphragm. A silicon substrate is etched from the side opposite the silicon oxy nitride optical waveguides to produce a rectangular diaphragm whose long edge lies underneath a straight section in the ring. Pressure-induced changes in the resonant frequency of the ring are measured using a frequency swept laser diode. A linear response to pressure is observed for the TM mode with a sensitivity of 0.0094 rad/kPa. This pressure sensor is rugged, is amenable to batch fabrication, and it provides a link-insensitive readout. [2]

"Integrated optical microcavities for enhancedevanescent wave spectroscopy", demonstrated the use of integrated optical microcavities (MCs) for enhanced optical spectroscopy and sensing is investigated. The MC sustains high-Q whispering-gallery modes, in which the energy of the optical field can be efficiently stored. The resulting enhanced field can be used to probe fluorescent molecules in the cladding of the MC. Enhanced fluorescence excitation with an integrated optical MC is demonstrated experimentally for what is believed to be the first time. A comparison between a MC and a straight waveguide shows that the MC may give an increase of 40 times in fluorescence excitation. Because of the ultra small size of the MC (15micrometer in radius), the fluorescence signal may be observed from only 20 molecules in the cladding. [3]

"Micro displacement sensor based on line-defect resonant cavity in photonic crystal" is based on the micro displacement sensor and its sensing technique based on line-defect resonant cavity in photonic crystals (PhCs) are presented. The line-defect resonant cavity is formed by a fixed and a mobile PhC segments. With a proper operating frequency, a quasi-linear measurement of micro-displacement is achieved with sensitivity of 1.15 a(-1) (a is the lattice constant) and Q factor of 40. The sensitivity can be adjusted easily by varying either Q factor of operating frequency of the sensing system. In addition, the sensing range can be broadened to -0.55a ~0.60a by using multiple operating frequencies. The properties of the micro displacement sensor are analyzed theoretically and simulated using finite-difference-time-domain (FDTD) method. [4]

The "High sensitivity photonic crystal pressure sensor", has a two-dimensional photonic crystal micro cavity coupled to a photonic crystal waveguide to realize a high sensitive pressure sensor, designed on a GaAs membrane. In this paper a theoretical model is developed to evaluate the change of the refractive index induced by the application of a force onto a sensing surface. A linear calibration curve is obtained relating the resonant drop position to the applied pressure. The sensor is realized in a two-dimensional photonic crystal GaAs membrane, having a 600nm thick GaAs layer. The photonic crystal is composed by a triangular lattice of air holes, characterized by a lattice constant equal to 360nm, an air-hole radius equal to 0.35a, whereas the hole-depth is equal to 600nm. A line defect is introduced by removing a row of air holes in the GK direction (W1), allowing guided modes to propagate within the photonic band gap. The W1 is coupled to a resonant cavity: the transmission spectrum experiences the presence of a frequency drop caused by the presence of the cavity, which is able to trap the light at a specific frequency. [5]

"Photonic crystals modeling the flow of light" includes the types of the Photonic crystals as they are consistent varieties of materials with distinctive refractive indices furthermore order of photonic crystals. Photonic crystals are arranged principally into three classifications, that is, one-dimensional (1D), two dimensional (2D) crystals as indicated by the dimensionality of the stack. [6]

"Photonic crystal based all-optical pressure sensor", is the first ever vertical silicon nanowire array based all-optical pressure sensor. Vertical silicon nanowire arrays with photonic crystal structure can selectively trap or diffract light, depending on the optical wavelength, nanowire diameter, and nanowire pitch spacing. In this paper the realization of all-optical pressure sensor by fabricating controllable vertical silicon nanowire arrays on a Si/SiO2 membrane can be seen. Applying hydrostatic pressure bends the membrane, leading to membrane color change due to the modulation of the nanowire pitch and deflection angle. By acquiring the membrane image with a camera, the color image can be cross-correlated with a calibration data set to calculate pressure. [7]

In "High pressure sensor based on photonic crystal fiber for downhole application" authors have demonstrated a polarization-maintaining (PM) photonic crystal fiber (PCF) based Sagnac interferometer for downhole high pressure sensing application. The PM PCF serves as a direct pressure sensing probe. The sensor is transducer free and thus fundamentally enhances its long-term sensing stability. The PM PCF can be coiled into a small diameter to fulfill the compact size requirement of downhole application. A theoretical study of its loss and birefringence changes with different coiling diameters has been carried out in this paper. This bend-insensitive property of the fiber provides ease for sensor design and benefits practical application. The proposed pressure sensor has exhibited low temperature cross sensitivity and high temperature sustainability. [8]

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