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Temperature Sensor BasedonFiber Bragg Grating (FBG), Implementation, Evaluation and Spectral Characterization Study

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ABSTRACT: Optical fiber plays significant roles in optical communications, optoelectronics, and sensors. The FBG sensors exceed other conventional electric sensors in many aspects, for instance, immunity to electromagnetic interference, light weight, compact size, stability, flexibility, high temperature tolerance, and resistant to harsh environment. This paper provides the operating principle, implementation of a "strain-free" FBG temperature sensors head and spectral characterization study. High-resolution detection of the wavelength-shifts induced by temperature changes are achieved using optical spectrum analyzer. Both uniform Fiber Bragg Grating (FBG) temperature and Mach-Zehnder Interferometric (MZI) temperature sensors based on single mode fibers were implemented and investigated due to measurement of the Bragg wavelength shift. It has been shown from the results that the FBG is very sensitive to variations in temperature degrees over a temperature range of (5–70) oC and the sensitivity was (1-6 pm/0.1°C), also observed from the results, the relation between the shifted Bragg wavelength and temperature degrees was linear.

KEYWORDS: fiber-optic sensors, Mach-Zehnder Interferometer,Fiber BraggGrating.

I. INTRODUCTION

In recent years, the fiber optics sensing of different based such as temperature, strain, vibration, acoustics, linear and angular position ,pressure, humidity, viscosity, acceleration, electric field measurement, magnetic field measurement, chemical measurement and others, won the special attraction because of its feature like lightweight, small size, cylindrical geometry, robust to environment, size compacted, high in sensitivity, possibility of remote sensing, immune to electromagnetic interference and interface with radio frequency [1]. Several types of fiber optic sensors were reported, among them are fiber Bragg grating sensors, fiber optic interferometer sensors like Michelson, Fabry-Perot, Sagnac, and Mach-Zehnder, and others. Fundamentally, a fiber-optic sensor works by modulating one or more properties of a propagating light wave, including intensity, phase, polarization, and frequency, in response to the environmental parameter being measured. Extrinsic (hybrid) optical sensors use the fiber only as a mechanism to transmit light to and from a sensing element, while intrinsic optical sensors use the optical fiber itself as the sensing element. In this paper, FBG will be implemented as a temperature sensor and its spectral characteristics such as sensitivity and resolution will studied and compare with another type which is a single mode Mach-Zehnderinterferometer sensors based temperature. Fiber Bragg Grating (FBG) was discovered by Ken Hill and co-workers in Canada, nearly twenty years ago. FBG is a periodic or an aperiodic perturbation of the effective absorption coefficient and/or the effective refractive index of an optical waveguide. They typically reflect light over a narrow wavelength range,which satisfies the Braggcondition and transmit all other wavelengths, but they also can be designed to have more complex spectral responses [2].

II. FIBER BRAGG GRATING (FBG) SENSOR

One of the most commonly used and broadly deployed optical sensors is the fiber Bragg grating (FBG), which reflects a wavelength of light that shifts in response to variations in temperature and/or strain. FBGs are constructed by using holographic interference or a phase mask to expose a short length of photosensitive fiber to a periodic distribution of