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ORIGINAL PAPER

Dependence of thermal sensitivity of LPFG on waveguide and material parameters

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Abstract This article demonstrates the effect of waveguide and material parameters on thermal sensitivity trends adopted by different cladding modes based on long-period fiber grating. Three-layer fiber geometry-based mathematical model has been implemented to estimate cladding modes. It is observed that for a cladding mode, the sign and magnitude of thermal sensitivity slope depend upon the designed grating period closer to period at dispersion turn around point. The LP_{10} and LP_{11} cladding modes have shown blueshift and maximum thermal sensitivity above all other modes at designed grating periods of 225 and 195 μm, respectively. The material parameter of fiber (thermo-optic coefficient) has also resulted in increment in sensitivity with the increase in difference amid its values for core and cladding region.

Keywords Long-period fiber grating (LPFG) · Temperature sensor · Thermal sensitivity

1 Introduction

The optical fiber gratings have shown their presence in the field of communication and sensing devices tremendously till now [1–3]. The fiber gratings have been categorized on the basis of their periodic perturbation magnitude, like gratings with period less than a micrometer (fiber Bragg gratings) and hundreds of micrometers (LPFG) [4,5]. The wavelength selectivity of LPFG has explored its applications in fiber sensors and fiber communication systems. LPFG has the ability to couple HE_{11} core mode power with several cladding modes propagating in same direction at different coupling (resonant) wavelengths. The coupling results attenuation band related to each coupled cladding mode at specific coupling wavelength in spectral profile [5]. Any variation in surrounding physical or chemical environment affects strength of core–cladding mode coupling, which in turn modifies the position and depth of attenuation band [2–6]. The shift in the position of spectrum has explored LPFG as a sensor. Also, the grating sensors are the best choice having less propagation loss and electromagnetic interference as compared to their rival counterparts.

MacDougall et al. [7] have reported that the sensitivity characteristics of LPFG are dependent on waveguide dispersion factor (γ). The dispersion factor is one of the factors that outlines the structure of fiber, coupling wavelength and cladding mode order [7–10]. Some researchers have studied experimentally temperature sensitivity of LPFG in consideration to dispersion factor [8–10]. Authors of Ref. [8] have reported appearance of dual peaks of resonance in the spectral profile of a LPFG designed for a grating period at the dispersion turn around point of a cladding mode. They have also claimed that shift in wavelength toward shorter or longer wavelengths with temperature relies on the sign and magnitude of dispersion factor. On the other hand, we have modeled thermal response of LPFG designed at a period which exists in the proximity of period at dispersion turn around point of a cladding mode. The designed LPFG period has registered control over the redshift or blueshift in resonant wavelength with temperature and sensitivity magnitude. In addition to this, increment in temperature also affects material proper-

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