UNIVERSITI TEKNOLOGI MARA

MODELING THE EVANESCENT WAVE AND MODE INTERACTIONS OF DIFFERENT FIBER TAPER PROFILE IN MICROSTRUCTURED OPTICAL FIBER

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MSc

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AUTHOR'S DECLARATION

I declare that the work in this thesis was carried out in accordance with the regulations of Universiti Teknologi MARA. It is original and is the results of my own work, unless otherwise indicated or acknowledged as referenced work. This thesis has not been submitted to any other academic institution or non-academic institution for any degree or qualification.

I, hereby, acknowledge that I have been supplied with the Academic Rules and Regulations for Post Graduate, Universiti Teknologi MARA, regulating the conduct of my study and research.

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ABSTRACT

Single mode fiber (SMF) is one of the most broadly used groups of optical fiber in fiber sensing applications. In optical fiber, single mode fiber (SMF), multimode fiber (MMF) are contained within a pure silica or glass. Photonic crystal fiber (PCFs) is a microstructure optical fibers or holey fibers and it is also widely used in optical sensing. PCFs descent into two basic categories, an index-guiding PCF, and guiding based on a photonic bandgap (PBG). This dissertation focusses on the simulation of lightwave propagation in planar photonic waveguides, which include investigation on single mode tapered fiber (SMTF) refractive index sensor versus taper waist length at fixed taper angle, investigation on SMTF refractive index sensor versus taper angle at constant waist length, investigation on single mode-multimode-single mode (SMS) refractive index sensor and investigation on transverse scattering refractive index sensor. In the design and simulations of tapered fiber structure, 3-D scalar and 2-D radial symmetry beam propagation method (BeamProp-RSOFT) were used. It is because cylindrical coordinate modelling allows an accurate representation of the fiber structure and accurate solution may be obtained. In the transverse scattering problem, the PCF structure was modeled and simulated using finite difference time domain method for refractive index sensor. The result for investigation of tapered single mode fiber refractive index sensor sensitivity vs taper waist length at waist length, L=20000μm and investigation of tapered single mode refractive index sensor sensitivity vs taper angle at taper angle, α=1.05° is 273.32 and 277.92 nmRIU^{-1} respectively. For both results, the technique used was PCA technique. The SMS structure design give the sensitivity of 78.2 nm/RIU. For the transverse scattering analysisit was concluded that, untapered produce the highest sensitivity at 7.45 a.u/RIU. In summary, for tapered single mode fiber interferometric protein sensor, the analysis was computed between wavelengths 1.49 – 1.65 μm. The tapered single mode fiber works well with changes of refractive index. Hence, the PCA analysis give the maximum sensitivity compare with transmission spectrum wavelength shift. As for the analysis of the transverse scattering transmission spectrum, the PCF works equally well in tapered and untapered conditions for the correlation of the transverse scattering against the RI change in crystal holes. Hence, there is a relationship between the transmission spectra and the RI in the liquid filled PCF for the taper ratio of analysis over the wavelength range of 0.6 μm to 1.7 μm. Hence, this technique can be used as a RI sensor. We have shown that the sensitivity of the RI sensor base of transverse transmission spectrum is the most sensitive in the untapered PCF.

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