UNIVERSITI TEKNOLOGI MARA

MODELLING THE MODE EVOLUTION AND EXCITATION IN TAPERED SINGLE MODE FIBER SENSOR

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ABSTRACT

Fiber optic sensors have gain much interest in recent years. Optical fiber sensors such as temperature, pressure, displacement, chemical concentration, vibration and other are widely used. It can be very good sensor because of the small size, stability, no electromagnetic interference and high sensitivity.

This project is to investigate the mode evolution and excitation in single mode tapered fiber using analytical and numerical technique. The objectives are to classify and identify the modes in a single mode fiber (SMF) taper using analytical solver (FIMMWAVE software) and finite element solver (COMSOL software). Second is optimising the taper dimension for a sensitive fiber optic taper sensor. Next objective is to verify the adiabatic and non-adiabatic tapered SMF criterion for sensor application. Modal expansion technique is used to calculate the power coupling between the different modes and the evolution of the modes along the taper length. In this simulation, the taper is symmetrically excited with LP_{01} (HE_{11}) mode and this will excite the higher order $LP_{0\mu}$ ($HE_{0\mu}$) modes, mainly the LP_{02} (HE_{12}) and LP_{03} (HE_{13}) modes along the tapered fiber. The interferences of these modes give rise to the constructive and destructive interference formed along the length of the taper waist. The amplitude of these interference patterns is dependent on the length of the down-taper. And the position of this interference pattern is dependent on the refractive index contrast between the tapered fiber with its surrounding, temperature, operating wavelengths, length and diameter of the taper waist.

This research is to overcome the limitation on previous optical sensor such as Fabry-Perot, Fiber Bragg Grating, Raman Scattering and cladding mode resonant sensor that has been developed but encounters difficulties and limitations such as difficult to fabricate, costly and unstable.

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