Index No: 132/16/Phys/25

## Abstract

### Propagation Parameters of First Higher Mode in Graded Index Fiber and Coupling Optics Involving Cylindrical Microlens on the Tip of Graded Index Fiber: Estimation by Simple and Accurate Method"


Communication through optical fiber has emerged as the potential area in present technology. This is because the doped silica made optical fiber has low attenuation loss (0.2 dB/km) and it has sufficient bandwidth (~1000 GHz) so as to meet the challenges of the huge growth of information traffic. Attenuation loss becomes minimum for the operating wavelength 1.55 μm whereas for the operating window 1.3 μm, zero material dispersion is obtained.
Broadening of a particular mode transmitted through a fiber happens due to dispersion. Total dispersion is the sum of waveguide dispersion, material dispersion and composite profile dispersion. Waveguide dispersion occurs due to the dependence of the propagation constant on the wavelength. Material dispersion is caused due to the propagation of different optical wavelengths with different velocities. Composite profile dispersion depends on the derivative with respect to wavelength of the relative core – cladding refractive index difference. It is less than 0.5ps/ (km nm) and hence practically negligible. During optical propagation, the refractive index profile and the radius of the core of the fiber are monitored in such a fashion that at the wavelength 1.55 μm, the waveguide dispersion neutralizes the oppositely directed material dispersion. Hence the two main disturbing factors of optical communication such as dispersion and attenuation loss simultaneously are reduced to minimum at the wavelength of 1.55 μm. Thus very long repeater less communication as well as very high bandwidth propagation can be possible within a fiber. The optical fiber having these properties is known as dispersion shifted fiber. Another kind of optical fiber, which practically possesses almost zero dispersion over a large range of wavelengths, is called dispersion flattened fiber. By using the later kind of fibers, the information carrying capacity can be enhanced by wavelength division multiplexing. Thus different kinds of novel modelling have been explored to study the propagation parameters of dispersion managed as well as other kind of optical fibers.

Recently, in optical communication system, the effect of nonlinearity in the doped material used in the optical fiber has emerged as the subject of interest in optical communication system. Different mathematical methods are available for the study of the effect of non-linearity. The non-linearity has huge impact on the data transferring capability and channel capacity of optical communication system. But the methods available in the literature for study of these nonlinear effects are very lengthy and complicated. So to predict different performance parameters of nonlinear optical fiber, there is a huge scope to find out a simple but accurate method. In addition, investigations relating to first higher mode in nonlinear optical fiber is also important in view of the performance of dual mode optical fiber.

Again, in order to optimize the optical beam launch involving the coupling of incident laser beam with the optical fiber, different types of micro lenses are designed. These lenses are fabricated at the tips of different kinds of fibers to get maximum efficiency. Hence, the design of different kinds of such coupling efficient couplers along with development of simple and accurate model for their study is of tremendous importance in present communication system. The structure of the thesis has been presented below in a nutshell.

Chapter 1 comprises introduction to basics of optical waveguides, electromagnetic theory associated with it and optical communication system. This chapter also describes the objective of the present research work together with its importance to contemporary interest and future researches as well. The relevant citations have also been made here.

Chapter 2 consists of the literature survey, highlighting its relevant research gaps and the needful address to the gaps thereof.

Chapter 3 involves study of some useful propagation parameters of graded index optical fibers for first higher order mode both in presence and absence of Kerr type nonlinearities. This chapter also contains prescription of a simple but accurate method based on Chabyshev technique for estimation of the concerned propagation parameters.

Chapter 4 presents the study of coupling optics relating to an optical coupler consisting of laser diode, graded index fiber and cylindrical microlens fabricated on the tip of the fiber. Here, ABCD formalism appropriate for the system has been developed to predict the coupling optics in a simple but accurate fashion.

Chapter 5 describes the conclusion arrived at on the basis of the research work described in the thesis. The conclusion basically aims at presenting the novelty of the present work and the enrichment of the literature in terms of its potential in present as well as future research.

Chapter 5 precedes the reference section which is followed by my publications and the reprints.


**Index Number: 132/16/Phys/25**

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