

DESIGNS FOR ZERO POLARIZATION-MODE DISPERSION AND POLARIZATION-MAINTAINING FIBERS

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(ABSTRACT)

This dissertation addresses several aspects pertaining to polarization in optical fibers and optical waveguide devices. In particular, the analysis and design of fibers that maintain polarization over long lengths, provide zero polarization-mode dispersion, and function as polarizers or mode filters are presented.

First, optimum designs for high-birefringence as well as single-polarization single-mode fibers are studied. For high-birefringence fibers, several index profiles were obtained that provided high birefringence while achieving zero or very small dispersion in 1.3 μm and 1.55 μm windows. Also, few index profiles were found that resulted in single-polarization single-mode operation with zero or very small dispersion at about 1.3 μm and 1.55 μm . A wavelength range of 100 nm to 500 nm was achieved for truly single-mode operation.

Second, a comprehensive analysis of polarization-mode dispersion in a multiple-clad fiber due to ellipticity of fiber cross-section is carried out. The analysis results are then used to design large effective area single-mode dispersion-shifted fiber that provides zero polarization-mode dispersion at the wavelength 1.55 μm . Effective area on the order of 122 μm^2 with mode-field diameter of about 10 μm have been attained for this design.

Tolerance analysis on the transmission parameters due to $\pm 1\%$ and $\pm 2\%$ variations in the radii of the fiber layers is carried out.

Finally, a wedge-shape dielectric waveguides bounded by conducting planes is introduced and analyzed. Conductor and dielectric losses for the fundamental mode in waveguides with wedge angle of π/n ; $n \geq 1$, and $2\pi/3$ as a special case with noninteger azimuthal number have been evaluated. These waveguides generally support fewer number of modes for smaller wedge angles and the modes cannot be of TM type. They find applications as mode filters and polarizers.