ABSTRACT

This thesis, devoted to fibre optics, is primarily concerned with the utilization of fibre Bragg gratings and optical couplers to realize optical add-drop multiplexers (OADMs). A comparative study regarding various OADM configurations is undertaken on the basis of manufacturing and the performance in terms of insertion loss, channel isolation, tuning ranges, stability and cost.

The heart of most of the OADMs is fibre Bragg gratings. The Runge-Kutta numerical integration method is used to solve the coupled-mode equations in order to simulate the spectral dependence of Bragg gratings numerically. Properties such as the grating strength, the grating length and the grating index profile governing the spectral dependence of Bragg gratings are investigated. In recent years, there has been an increasing interest in the dispersive properties of Bragg gratings. We investigate methods to limit the amount of dispersion induced by fibre Bragg gratings. The tuning of Bragg gratings for dynamic OADMs is also reviewed.

High channel isolation Bragg gratings are theoretically and experimentally investigated. DC-*apodized* gratings were designed and manufactured by using the phase mask method through the use of a preconditioning technique. Bragg gratings with channel isolations of up to $24.61\ dB$ have been realized by using this technique. The spectral dependence of DC-*apodized* gratings on the amount of preconditioning and the smoothness of the index envelope is simulated and in agreement with the experimental results. An athermal Bragg grating was designed and manufactured, exhibiting an average wavelength-temperature sensitivity of 2.76 $pm/^{o}C$. An OADM comprising a DC-*apodized* Kaiser grating and an optical circulator was realized. The device showed an insertion loss of $1.84\ dB$ and a channel isolation of $22.84\ dB$.

The coupling mechanisms for different types of optical couplers are investigated. The distribution of power was established to be either by evanescent field coupling

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(etched, polished and weakly fused couplers) or due to the beating phenomenon (strongly fused couplers).

The beating phenomenon of the HE_{11} and HE_{12} modes in the waist of the tapered-fused coupler is modelled and used to simulate different characteristics, such as wavelength, polarization and external refractive index dependence of tapered-fused couplers, in order to realize OADMs.