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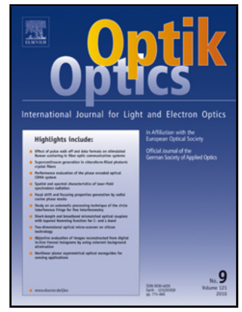

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Novel design of broadband dispersion compensating photonic crystal fiber with all solid structure and low index difference

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ABSTRACT By employing germanium up-doped and fluorine/boron down-doped cylindrical inclusions instead of air-holes in pure silica, a novel kind of broadband dual concentric core dispersion compensating photonic crystal fiber (DCC-DCPCF) with all solid structure and low index difference is proposed. By analyzing the kappa value's influences on the dispersion compensating behavior, it is found that the DCC-DCPCF whose kappa curve intersects twice with that of compensated fiber in the targeted band is most preferable for ultra-broadband dispersion compensation. The bandwidth of the DCC-DCPCF can be readily managed by tuning the position and the interval of the two kappa matched wavelength. Following the design procedure of broadband DCC-DCPCF given in this paper, an all solid DCC-DCPCF aims at compensating the accumulated dispersion of Corning SMF28 fiber in entire S+C band are designed. Negative dispersion ranging from -183 to -281 ps/(nm•km) in S+C bands is achieved with the refractive index differences between matrical material and cylindrical inclusions no more than 0.03. Numerical results show that the DCC-DCPCF can compensate 15.43 times its length of Corning SMF28 fiber with small residual dispersion in the range of ±0.15 ps/(nm•km). The calculated effective mode area is 16.01 μm^2 at 1550 nm, corresponding to a coupling loss of 1.35 dB to the Corning SMF28 fiber, the confinement loss and bending loss with 1cm bending radius less than 0.058dB/km and 0.315dB/km at 1550nm, respectively.

Keywords photonic crystal fiber; broadband dispersion compensation; all solid; low index difference

1. Introduction

Group velocity dispersion (GVD)[1] of optical fibers is one of the most important parameters for optical communication systems because of its temporal broadening effects on optical pulse[2-5]. Dual concentric core dispersion compensating photonic crystal fiber (DCC-DCPCF)[11-13] is one of the best schemes to achieve negative dispersion to compensate for the dispersion of standard single mode fiber (SMF)[14-16]. Since first proposed by Gerome in 2004[17], the reported value of GVD has reached -52100 ps/(nm•km) at 1550nm[21]. However, in a dense wavelength-division multiplexed (DWDM) system, one channel at most can be located at the zero-dispersion wavelength[7]. Broadband dispersion compensation is essential to compensate for the accumulated dispersion of all the channels after long transmission distance[8-10] and smaller residual dispersion means longer transmission length of dispersion limited transmission. One way to achieve broadband dispersion compensation is to design a DCC-DCPCF that will compensate the dispersion and dispersion slope of the SMF simultaneously at certain wavelength at the cost of compensation efficiency. In 2016, DCC-DCPCF with negative dispersion varying from -1000~-2500 ps/(nm•km) over 200 nm range is designed. Its kappa value, which is defined by dispersion divided by dispersion slope, matches well with kappa value of standard SMF at 1550