Highly Nonlinear Multi-Material Chalcogenide Spiral Photonic Crystal Fiber for Supercontinuum Generation

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In this paper, we have investigated a highly nonlinear multi-material chalcogenide photonic crystal fiber. The photonic crystal fiber is designed with borosilicate and As_2S_3 glass, where borosilicate is doped in a spiral shape in the cladding. The designed fiber was investigated carefully for effective refractive index, effective mode area, and dispersion and nonlinearity coefficients. The estimated parameters are satisfactory and suitable. This motivates the idea to further investigate the design for broadband supercontinuum generation.

Photonic crystal fibers have attracted attention of researchers since their inception due to the higher design flexibility and their enormous applications in field of communication, sensing and biomedical science. Photonic crystal fibers commonly also known as microstructured optical fibers and holey fibers are special class of photonic crystals with core surrounded by a micro-structure of air-hole arrangement in a lattice forming the cladding.The geometry of the photonic crystal fibers offers greater degree of freedom to tailor its optical properties. The advancement in fabrication technology it is now possible to fabricate the photonic crystal fibers with different materials other than only silica.

Supercontinuumcan be simply defined as a pulse broadening. It can be well explained as nonlinear phenomena where an intense ultra-short (narrow) laser pulse undergoes a spectral broadening during its propagation in nonlinear medium results in a super-wide continuous optical spectrum. The parameters which greatly affect the generation of supercontinuum include chromatic dispersion, peak power of the pulse, pump wavelength, pulse duration and length of the of nonlinear fiber.

In the paper presented here a multi-material photonic crystal fiber with hexagonal lattice arrangement of air-hole is investigated for its characteristics like effective refractive index, effective area, dispersion and nonlinear coefficients. The range for flat dispersion of the proposed photonic crystal fiber design is from 1.8 µm to 8 µm. The nonlinear coefficient (γ), effective area (A_{eff}) and dispersion at the wavelength (λ) 2.8 µm are 1052 W^{-1} km^{-1}, 8.53242 μm^2 and 4.903392 ps/km/nm, respectively for the design of the fiber. The results of the investigation are satisfactory and it can be further investigated for broadband supercontinuum generation.