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Dispersion Engineering towards Ultra Broadband Supercontinuum generation in Soft glass based High-Index-Core Bragg Fiber

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1. Introduction

Soft glasses exhibiting high non-linearity (γ), high refractive index and extended transmission window are of keen interest for effective Supercontinuum generation in conventional step-index fibers and microstructured photonic crystal fibers (PCF) [1]. For step-index fiber, though the design investigation of broadband generation is accurate because of analytically tractable exact solution, the exercise is limited by the lack of design flexibility of simple core-cladding fiber. On the other hand, PCFs are superb in view of their huge flexibility of microstructure design, even though the design is governed by the effectiveness of numerical tool used. Bragg fibers with high-index core, known as High Index Core (HIC) Bragg fiber [2], are of tremendous potential in this field owing to have many unusual and unique transmission characteristics In our research, we focused at this fiber and worked out for the first time the analytical formulation (both scalar and vector modes) towards supercontinuum generation. The structure was then optimized to map the flat- and preferred zero dispersion to achieve selectively ultra-broadband generation in mid IR region for dedicated application. This may not be possible through conventional optical fibers and is well consistent with the Supercontinuum generation achieved with PCFs [3]. To the best of our knowledge, the phenomenon of Supercontinuum generation in such a structure is not yet explored. Additionally, the model presented is precise because of our analytical mode evaluation used in dispersion engineering of the fiber. The reported results are unique and not touched upon in the contemporary literature.

2. High index core Bragg fiber: Dispersion Engineering

The modal (both scalar and vector) characteristics of HIC Bragg fiber is investigated by using the appropriate and physically permissible Bessel function in various distinct region of the Bragg fiber (see Fig.1). The efficacy of

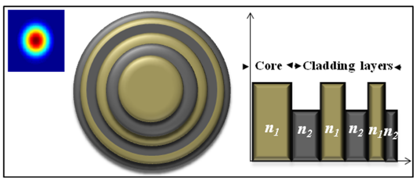

Fig. 1: Schematic of the HIC Bragg structure

our analytical technique is verified by reproducing the already published results in the contemporary literature. The structure is subsequently optimized by changing the width of the low- (LLF1 glass) and high index (SF6 glass) region of individual layer to attain preferred zero-dispersion wavelength (ZDW), steeper slope in normal group velocity dispersion (GVD) region, flat dispersion in anomalous

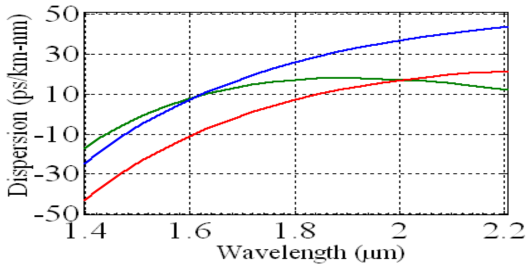

Fig. 2: Dispersion characteristics of HIC Bragg fiber

GVD regime and large mode effective area (A_{eff}) for yielding the effective Supercontinuum generation. Figure 2 is a typical plot depicting the flexibility of dispersion engineering in HIC Bragg fibers.

3. Supercontinuum generation

The data values (A_{eff}, γ, GVD) procured from the aforementioned mode analysis scheme is used as input to the envelope based nonlinear Schrödinger equation (NLSE) taking into account the contributions from the nonlinear effects, namely, *self-phase modulation*, *Raman scattering*, *four-wave mixing* [4]. In our analysis, we considered the propagation of high power (1kW) secant hyperbolic pulse [$A(0,T) = \sqrt{P_0}\,\mathrm{sech}(T/T_0)$] and neglected the loss-term. The input pump wavelength is set close to ZDW (1.55 μm), based on the commercial availability, to achieve solitonic fission and get rid of amplification of higher order dispersive waves. The Supercontinuum band (1300 nm - 2100 nm) generation presented in figure 3 is obtained from HIC Bragg fiber structure corresponding to the parameter of dispersion curve in green (see Fig. 2), when seeded with 200 femtosecond pulse. The complete analysis tool and other related crucial findings of this research would be presented in detail in the conference.

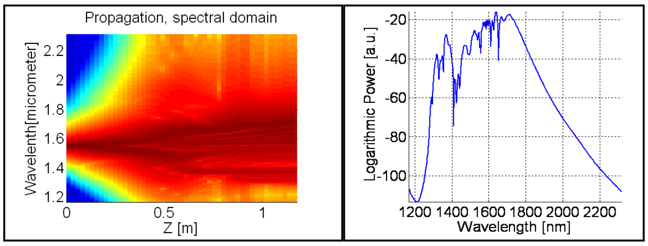

Fig. 3: Propagation of pulse in spectral domain & its output spectrum

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