Supercontinuum generation using all-normal dispersion soft-glass fibres

SUPercontinuum broadband light sources covering UV to IR applications

Tanvi Karpate (ESR7)
Institute of Electronic Materials Technology, Warsaw, Poland

Objective

- To obtain fibers with enhanced nonlinearities and with ultra-flattened all-normal dispersion profile for highly coherent supercontinuum generation
- This is obtained by modelling, fabrication and characterization of soft-glass fibers

Progress towards expected results

- Hexagonal air-hole lattice with 2 air-hole diameter rings have been designed and fabricated for tellurite preform developed (milestone M1) for supercontinuum generation and single mode propagation with controlled dispersion of the fundamental mode
- Tellurite PCF for mid-IR has been fabricated and characterized for the hexagonal lattice design (milestone M4)
- Suspended core fiber has been designed for ZDW shifted to λ = 1 μm range

Results: Hexagonal Lattice PCF

- Lattice layout with different air hole diameters in subsequent rings has been used to enhance engineering flexibility in terms of dispersion control for the fundamental mode and waveguide losses for higher order modes

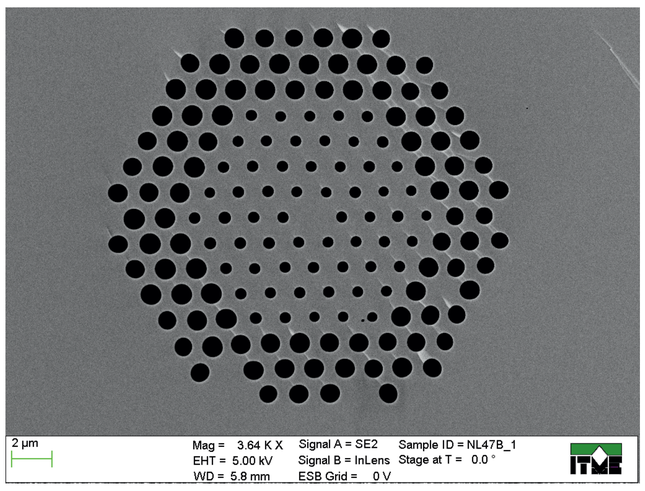

Fig.1 SEM image of typical tellurite glass photonic crystal fibers developed in scope of this work (shown here: NL47B1)

- Under the scope of the project, a comprehensive analysis has been carried out for hexagonal lattice tellurite fibers with two air hole diameter rings
- These fibers are spectrally broad across near infrared wavelengths, and experimentally verified by dispersion measurement up to 2.3 um
- Geometric parameters of the PCF structure optimized using numerical simulations is: the pitch size Λ= 1.4 μm, diameter of air-holes in inner rings d_i=0.6 μm and the diameter of air-holes in the outer rings d_o=1.0 μm

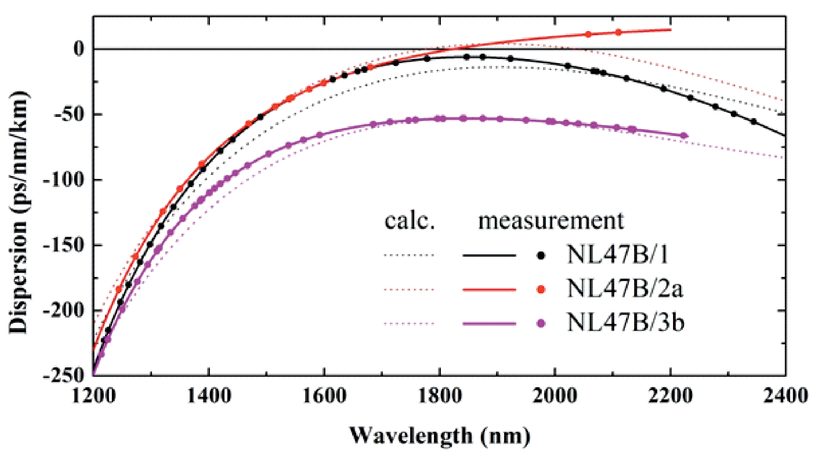

Fig. 2. Dispersion measurements to identify fibers with all-normal dispersion and comparing it with dispersion calculated from SEM images

- **Dispersion measurements** were carried out using balanced Mach-Zehnder interferometer setup with a compact supercontinuum source (Leukos) and an optical spectrum analyzer (OSA, Yokogawa, 1200-2400 nm)

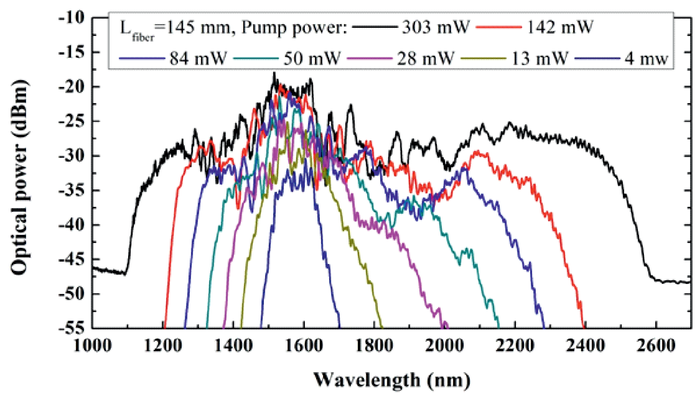

Fig. 3. Supercontinuum spectra measured at different incident average pump powers

- Flat and spectrally broadened **supercontinuum generation** was observed for each fiber using Menlo C-fiber femtosecond laser (pulse duration < 100 fs, central wavelength 1560 nm) and analyzed at different input power, which confirmed purely self-phase modulation and optical wave breaking dynamics of spectral development

Results: Suspended Core PCF

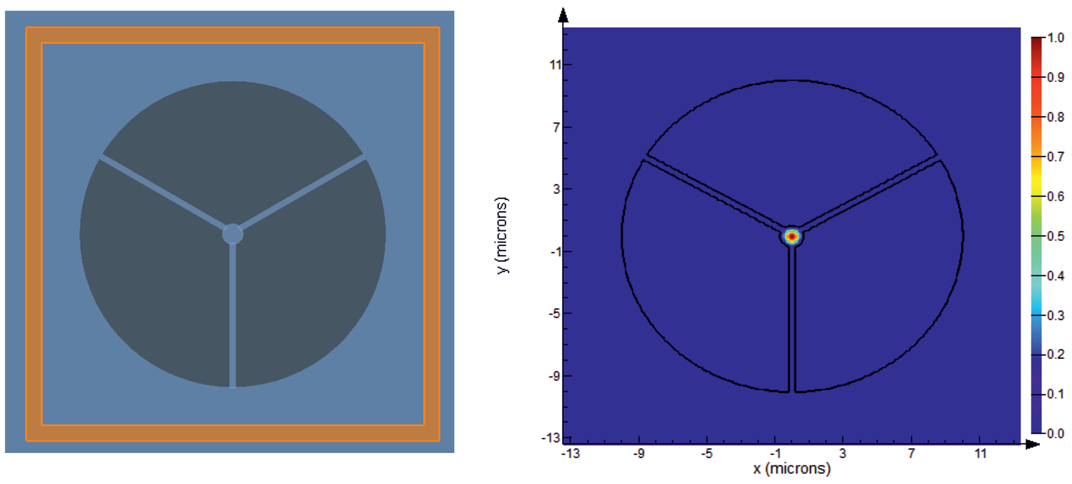

Fig. 4. Suspended core fiber structure and its mode field at λ = 900

- This fiber is designed to obtain an all-normal dispersion where the dispersion value at the pump wavelength (1μm) is about -50 to -100 ps/nm/km.

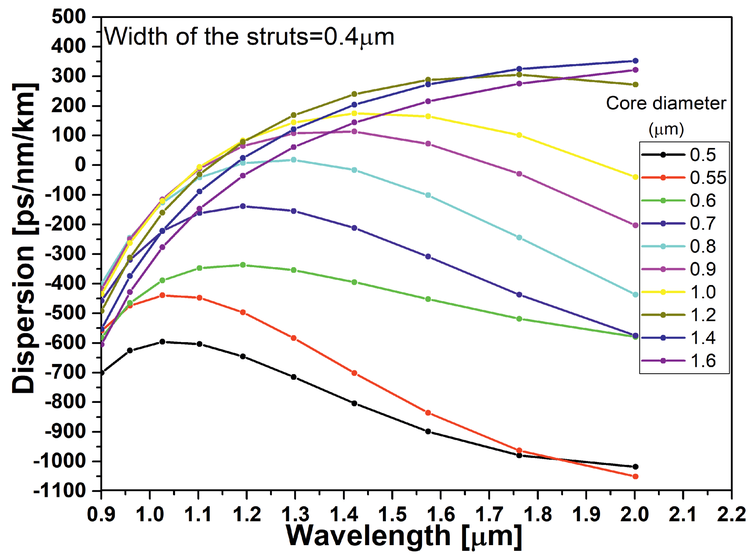

Fig. 5. Dispersion profiles for different core sizes for a suspended core

- Simulations were run for different core sizes and strut widths so as to obtain a mode plot across wavelength 0.9-2 μm for core diameter 0.5-1.6 μm.

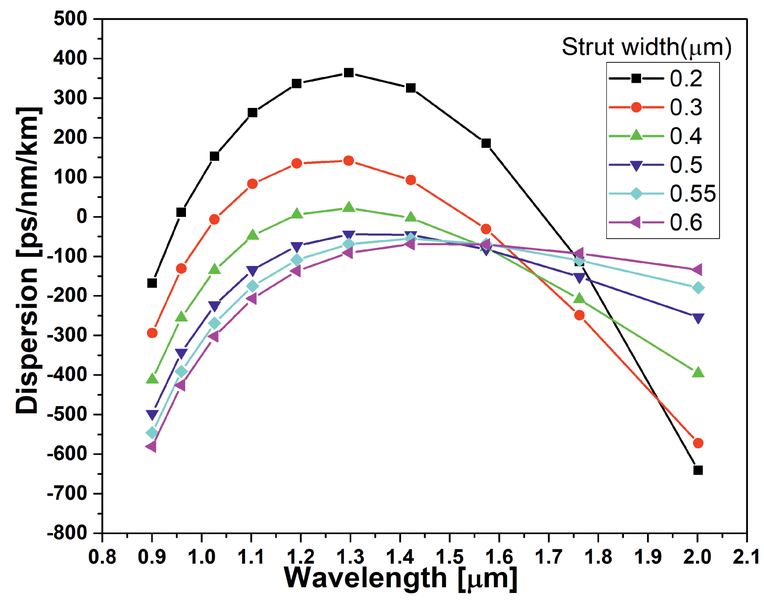

Fig. 6. Dispersion for different values of strut width for core size of 0.8 μm

Planned Secondments

- Secondment is planned at FEMTO-ST in March, 2019
- Secondment in LEUKOS- to be determined

Publications

- M. Klimczak, D. Michalik, G. Stepniewski, T. Karpate, X Foriestier, J. Cimek, R. Kasztelanic , D. Pysz, R. Stepien, R. Buczynski, “Coherent supercontinuum generation in tellurite glass regular lattice photonic crystal fibers”, submitted for reviews to J. Opt. Soc. Am. B special edition “Supercontinuum Generation”

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