BROADBAND SUPERCONTINUUM GENERATION IN ALL-NORMAL DISPERSION CHALCOGENIDE MICROWIRES

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***Abstract*—We report the first chalcogenide microwire that is designed with all-normal dispersion to generate supercontinuum by optical-wave-breaking, a low-noise nonlinear process. The generated supercontinuum spectrum spans over an octave from 960 nm to 2500 nm using a microwire length of only 3 mm.**

Keywords—Nonlinear Optics, fiber; Ultrafast Optics;

I. INTRODUCTION

Broadband supercontinuum (SC) sources are important for applications such as nonlinear microscopy, optical coherence tomography, frequency metrology, and ultra-short pulse compression. Tapered fibers (or microwires) receive much attention for broadband SC generation due to the ability to engineer their dispersion and nonlinear properties [1].

Chalcogenide (ChG) microwires are excellent candidate to generate broadband SC due to their high nonlinearity and their wide transparency. Such microwires are usually optimized to produce maximum spectral bandwidth such that the pump wavelength is close to the fiber's zero-dispersion wavelength and lies in the anomalous dispersion range [2]. However, the dominant spectral broadening mechanisms are then soliton fission, which is sensitive to shot to shot fluctuations, and modulation instability, which is seeded from noise. Both nonlinear processes result in phase noise and unstable amplitude across the spectrum [3]. Noise can be reduced by suppressing soliton fission by engineering the fiber group-velocity dispersion (GVD) such that it is always normal.

In this presentation, we demonstrate the first ChG microwire that is designed with all-normal dispersion to generate SC by optical-wave-breaking, a low-noise nonlinear process. The ChG microwire structure of As_2S_3-glass core with a PMMA-polymer cladding and the tapering to a diameter of 0.58 µm are essential in the achievement of GVD that is always normal. The PMMA cladding improves also the mechanical strength of the microwire [4]. To generate a SC with over an octave of bandwidth, we use an Er-doped fiber laser emitting pulses at a wavelength of 1550 nm with FWHM duration of 590 fs and energy of 150 pJ. Numerical simulations of SC generation are also performed by solving the generalized nonlinear Schrödinger equation and agree well with experimental results.

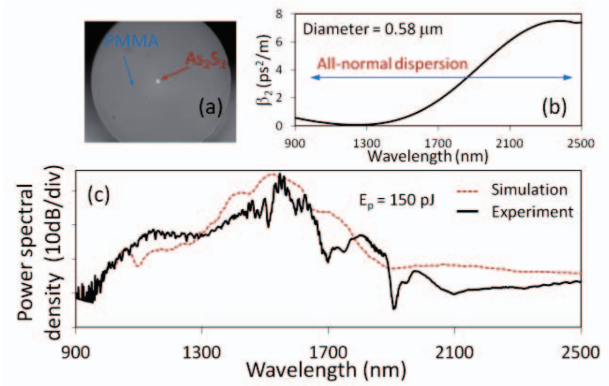

Fig. 1: (a) Input facet of the hybrid microwire. (b) GVD of ChG-PMMA microwire with 0.58 µm diameter. (c) Supercontinuum generation.

Fig. 1(a) shows the input facet of the ChG-PMMA microwire used in the experiment. Fig. 1(b) shows the calculated GVD of ChG-PMMA microwire with a diameter of 0.58 µm. The GVD is always normal from 900 nm to 2500 nm. Fig. 1(c) depicts the experimentally generated (solid-line) and numerically calculated (dashed-line) SC spectra from a microwire with 0.58 µm diameter and 3 mm long. The spectrum covers a spectral bandwidth from 960nm-(>2500nm) wavelength range at 30 dB below the peak value.

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