타원 코어를 갖는 불규칙적 미세구조 광섬유의 편광 의존 초연속 스펙트럼 생성

Polarization dependent supercontinuum generation in irregularly microstructured elliptic core fibers

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Pure silica fibers having periodic arrays of microscopic air holes in cladding, photonic crystal fibers, are of significant research interest(1). It has been demonstrated that the high nonlinearity induced by the strong light confinement and the controllable dispersion properties can give rise to ultra-wide supercontinuum (SC) spectra that are useful in Raman spectroscopy, optical coherence tomography, and the frequency metrology.

In this work, we investigate the SC spectra generated in an irregular microstructured fiber having an elliptic core by varying the polarization direction of linearly-polarized input pulse. The dependence of SC spectra on the angle between the polarization direction of input pulse and the long axis of the elliptic core shows that the long wavelength part of SC spectrum can be tuned by the polarization direction of input pulse.

Figure 1 shows the simulated two fundamental guiding mode profiles of irregular microstructured elliptic core fiber that we used. One is a long axis mode whose polarization is parallel to the long axis of elliptic core (a) and the other is a short axis mode whose polarization is parallel to the short axis of elliptic core (b). We can see that their spatial distributions have the elliptic shape.

For experimental study of the SC spectra, 10-fs width 300-mW power Ti:sapphire laser pulse was employed. The central wavelength of the pulse is 800 nm. The irregular fiber of 12 cm is used and the spectra of output pulses are measured by an optical spectrum analyzer. The polarization of the linearly polarized input pulse is controlled by the half wave plate.

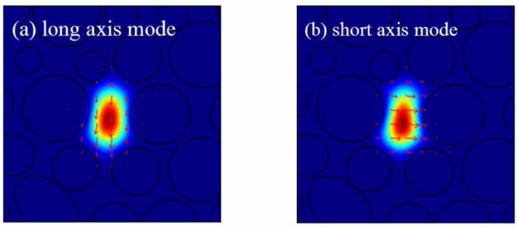

Fig. 1. Simulated two fundamental guiding mode profiles of irregularly microstructured elliptic core fiber. (a) long axis mode. (b) short axis mode. The red arrows indicate the electric field directions.

We investigated the SC spectra by varying the angle between the polarization of input pulses and the long axis of the elliptic core, θ The red lines in Fig. 2 show the SC spectra for θ = 0, 15, 30, 45, 60, 75, and 90.

As expected, the SC spectra, especially, the spectral components in the range of wavelength longer than

1000 nm, are mainly affected by the change of θ

To confirm the origin of generation of the new spectral components and its dependence on input pulse polarization, we studied numerically the SC by using the nonlinear schrödinger equation and the split step fourier method. We assumed that the input pulse is split into the long and the short axis modes because the two modes are independent. Thus the input powers of the principal axes were calculated from the power of input pulse P_0 and the angle θ The simulated output spectrum are shown in Fig. 2. It is well known that the new spectral components in the short wavelength region around 450 nm are originated from the dispersive wave and ones in the long wavelength region below 1000 nm come from the soliton.

The sum of the spectra of long and short axis modes seems to be in good agreement with the experimental results, excepting the input pulse range around 800 nm. The comparison of the experimental and simulated results shows that the angle dependent input power through the two principal axes plays a role in the polarization dependent SC generation.

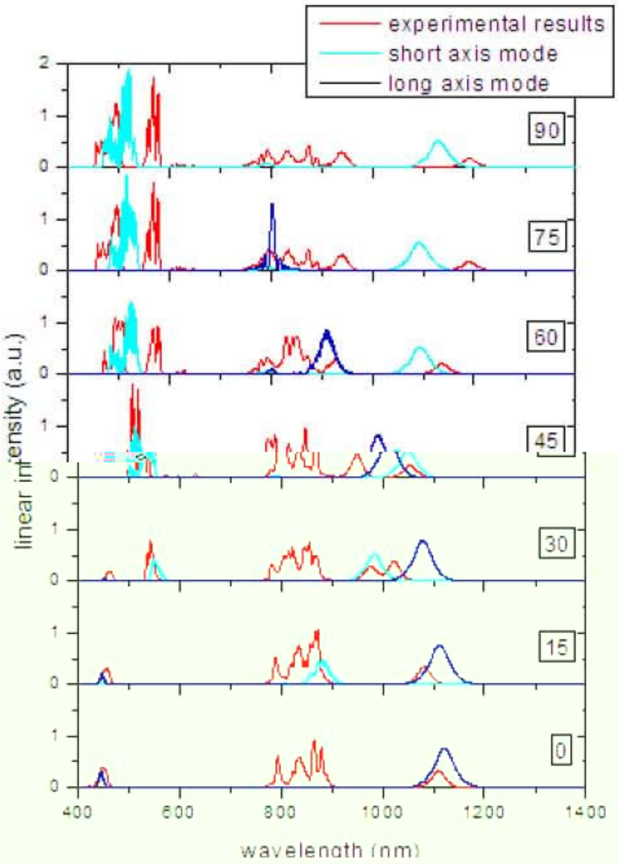

Fig. 2. Dependence of SC spectra on θ the angle between the polarization of input pulses and the long axis of the elliptic core, when θ = 0, 15, 30, 45, 60, 75, and 90°

In conclusions, we investigated experimentally and numerically the SC spectra generated through the fiber having elliptic cores surrounded by irregularly arranged air holes. The polarization direction of input ultrashort pulse affects the SC spectra. The polarization dependent SC spectra give possibility to make controllable SC sources.

Reference

1. Jinendra K. Ranka, Robert S. Windeler, Andrew J. Stentz, "Visible continuum generation in air-silica microstructure optical fibers with anomalous dispersion at 800nm." Opt. Lett. 25, 25-27 (2000).