

Measurement of higher order dispersion in a photonic fiber using spectral interferometry

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The photonic bandgap (PBG) fibers have recently obtained considerable attention since their dispersion coefficients can be tailored in wide range. Because of the uncertainties of the parameters used during modeling, it is necessary to measure the dispersion of the fibers. Spectral interferometry has proved to be an effective tool for dispersion measurement. To retrieve the spectral phase of a fiber from the interferograms, generally the stationary phase point (SPP) [1], the minima-maxima [2] or cosine function fit (CFF) [3] methods are used. So far the dispersion coefficients have been determined up to third order. However, the shorter the duration of the pulse to be transmitted through the fiber, the more significant the effect of the higher order dispersion terms on the temporal profile of the pulse. Therefore it is important to measure the higher order dispersion as well. Here we report on our experimental results considering the measurement of the forth and fifth order dispersion of a PBG fiber using the SPP, the CFF and the Fourier transform [4] methods comparing their sensitivity and accuracy.

The experimental setup consisted of a combination of a Mach-Zehnder interferometer and an Ocean Optics spectrometer. The interferometer was illuminated by a Ti:sapphire oscillator (20 fs@800 nm), and a 37 cm long PBG fiber was inserted in one arm. The spectrally resolved interferograms were recorded at different delays, and were evaluated by the three methods. We found that the CFF method provided the best results because of its sensitivity to the presence of the higher order dispersion terms. The accuracy of the third, fourth and fifth order dispersion terms was 0.4%, 2% and 4 %, respectively. The sensitivity rises to view in particular at the delays where two stationary phase points appear in the interferogram because of the dominant third order dispersion of the fiber [5] (see Fig. 1). The price of the sensitivity is that the initial values of the fitting should be very close to the real values. Contrarily the Fourier transform method runs almost automatically though with a little lower accuracy. The SPP method gave the lowest accuracy because of the fewer data points and the accuracy of the determination of the SPP's position.

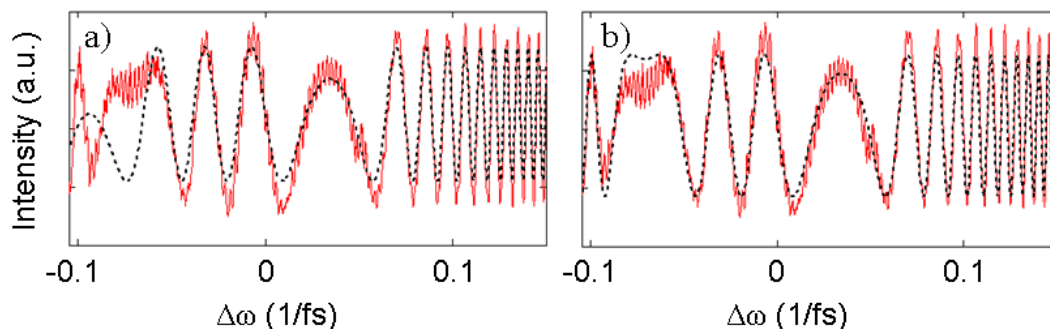


Fig. 1 A measured spectral interferogram (solid line) of a PBG fiber with (a) the fourth and (b) the fifth order polinomial fit (dashed line). $\Delta\omega = \omega - \omega_0$ meaning the relative angular frequency, where ω_0 corresponds to wavelength of 800 nm.

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