Measurement of the Polarization Mode Dispersion in a HC-800 Photonic Crystal Fiber

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Photonic crystal fibers (PCFs) [1] have come into prominence since their properties, such as dispersion, nonlinearity, confinement loss, birefringence or single-modal guidance can be almost arbitrarily designed by introducing different microstructures in their cross-sections. Due to these confinement characteristics, which cannot be realized with conventional optical fibers, PCFs find their application in fiber-optic communication, fiber laser and sensing technology, and even in medical areas. Since there could be deviations between the simulated and the manufactured fiber properties, conducting confirming measurements would be beneficial. As birefringence and chromatic dispersion are of high interest in most applications it would be of great advantage to find an accurate measurement method which is sensitive even to higher-order dispersion, characteristics of tailored PCFs with reduced second-order dispersion.

Spectral interferometry is a commonly used technique for dispersion measurement. To retrieve the spectral phase of the fibers from the spectral interferograms numerous evaluation techniques can be applied. In this work we have used the Fourier-transform (FT) method [2], the applicability and accuracy of which has been already demonstrated in higher-order dispersion measurement performed on a Bragg-type photonic bandgap fiber [3]. The fiber under study was a commercially available 100 cm long HC-800 (NKT Photonics) photonic crystal fiber which was in the first measurement straight, in the second dangled and in the third coiled, in order to simulate the conditions the fiber is exposed to during its use. First of all, we demonstrated that both of the two fundamental modes of orthogonal polarization states could be efficiently excited despite the fact that the fiber had a hollow-core and symmetrical geometry. We found that the different placements did not affect significantly the dispersion behavior of the fiber; however, when it was dangled a considerable amount of light was coupled into both of the orthogonal polarization modes. It was shown that the sign of the second-order dispersion of the HC-800 fiber was negative in contrast to a commercial silica fiber. The relatively large dispersion of the 1 m long fiber resulted in very dense interference fringes with low visibility. In order to increase the precision of the FT method by rarefying the fringes and also to check whether the dispersion is additive in the case of the tested fiber, we cut the fiber in half, and performed the same measurement again on the 50 cm sample. As an example, the retrieved dispersion curves in the case of the straightly placed 100 and 50 cm fibers along both polarization directions are shown in Fig. 1a. It can be concluded that the dispersion was indeed additive which is an important result, because, for one, a short length sample is enough to test the dispersion and then the values can be extrapolated for arbitrary lengths, and two, the method with the highest accuracy, i.e. the FT method can be applied well to retrieve higher-order dominant dispersion.

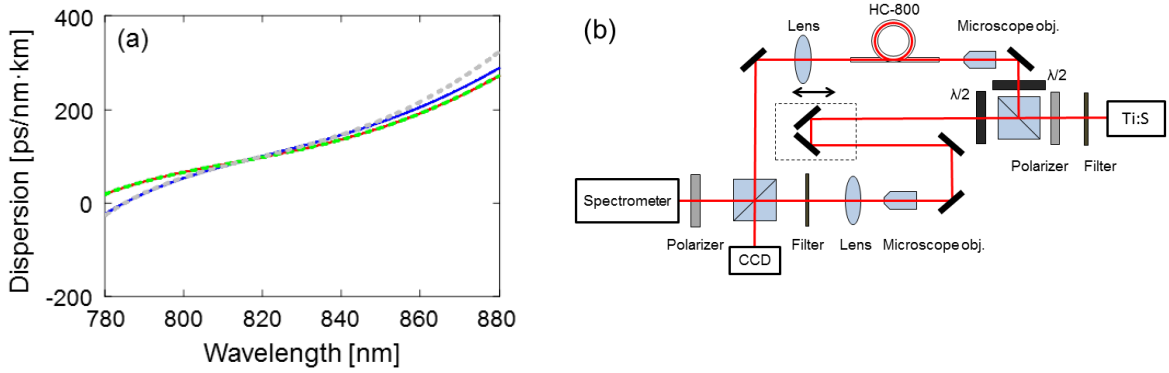

Fig. 1 Chromatic dispersion curves along the two polarization directions of a 100 (x: red, y: blue) and of a 50 cm long fiber (x: dashed green, y: dashed gray) (a). Experimental setup (b).

References

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