

Broadband large channel count comb filter based on small-core photonic crystal fiber

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We experimentally demonstrated a comb filter by splicing a piece small core photonic crystal fiber with a single-mode fiber and exposing it under UV light. The demonstrated comb filter with narrow comb spacing is flat over 80 nm.

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1. Introduction

Multi-wavelength light sources and multi-channel isolation filters are essential in dense wavelength-division-multiplexed networks. Among them, optical comb filters have been previously realized with Mach-Zehnder interferometers [1], Sagnac birefringence filter [2] and long-period gratings [3]. Photonic crystal fiber (PCF) catches people's eyes in recent years because of its many potential applications [4-5]. In the writing grating process in the small core Ge-doped (PCF), we found a broadband comb filter with large channel count formed. In this letter, we present our experimental results.

2. Experiment and results

The cross-section of the Ge-doped PCF adopted in the experiments is shown as Fig. 1, whose mode area diameter at 1550 nm is 2.8 μm . We firstly spliced a piece of 4.5 cm long PCF with a standard single mode fiber. Then the PCF without hydrogen-loading is placed under the phase mask. The expanded UV beam from KrF excimer laser whose energy per pulse and repetition rate are 120 mJ and 10 Hz respectively is directed by a mirror and focused with a cylinder lens into the PCF. The beam dimensions at the fiber are about 32 mm $\times$ 2.5 mm. The dimensions of the phase mask used in the experiment are 20 mm $\times$ 5 mm and it has a period of 1072 nm. The reflection spectrum evolution is monitored in real time during inscription process by launching broadband light into a circulator and an optical spectrum analyzer.

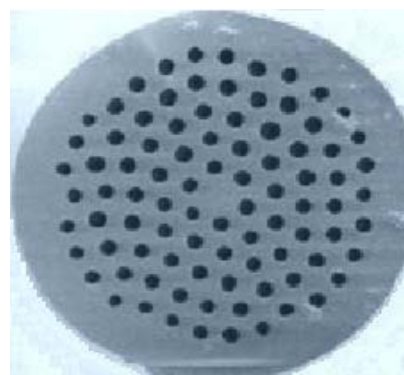


Fig. 1. Cross section of the PCF.

When the PCF was exposed to 20,000 pulses, a reflection peak appeared and reached its maximum amplitude of 2.4 dB at 55,000 pulses. With exposure pulse number increasing, the amplitude of reflection peak decreased gradually and disappeared at 110,000 pulses. With further exposure, no typical type IIA grating appeared, which is different from Bragg gratings fabricated in the normal optical fibers [6-7]. Amazingly, we found out that there were many peaks in the reflection spectrum. The reflection spectrum with 10 nm span at 170,000 pulses is shown in Fig. 2 (a). The measured results with 2 nm span and 80 nm span are given in Fig. 2 (b) and (c). We can see that it is a typical comb filter with comb spacing of 0.5 nm and extinction ration of 10.2 dB. The amplitude is quite flat over 80 nm. We repeated this experiment several times and got the similar results.

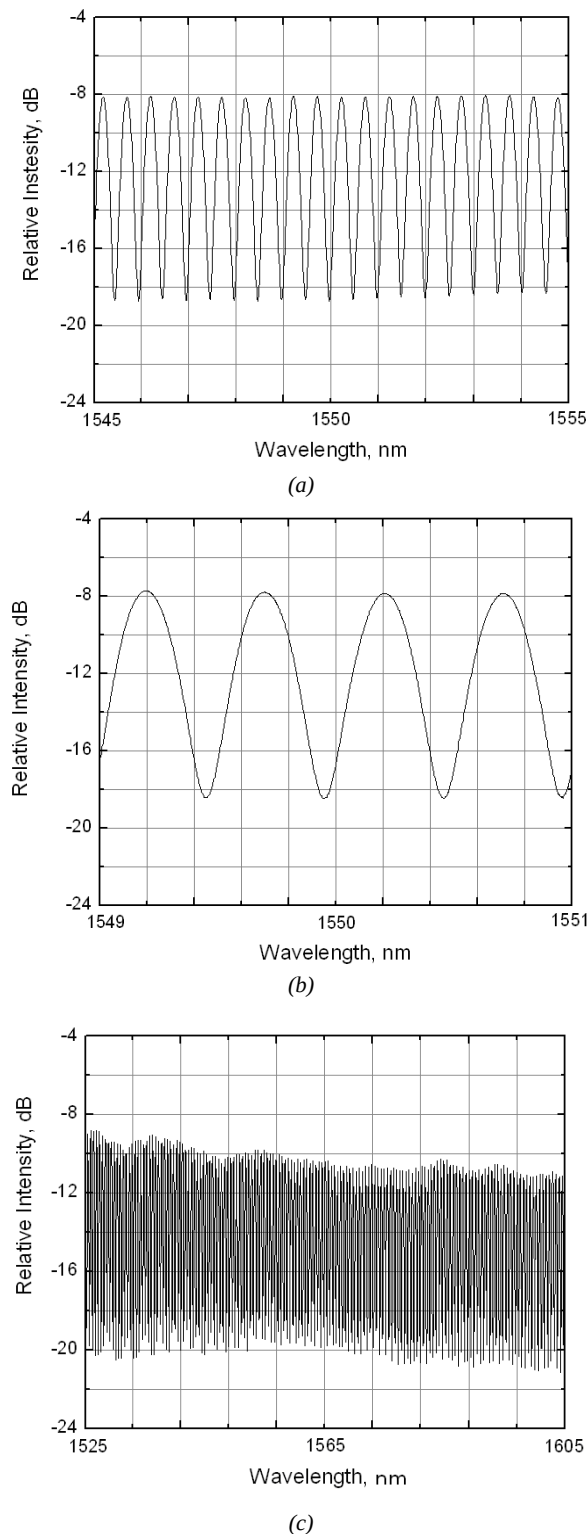


Fig. 2. Spectra of the comb filter with different span: (a) 10 nm, (b) 2 nm and (c) 80 nm.

This is a new phenomenon to our best knowledge. We think this comb filter operates like an interferometer. The modal mismatch between PCF and single-mode fiber caused different mode coupling. In exposing process, the refractive index change of PCF results in meeting interference conditions. Comb spacing can be controlled by changing PCF structure and length. We will study it in detail and will publish our theoretical analysis results in the future paper.

3. Conclusions

In summary, we experimentally demonstrated a compact all-fiber comb filter with narrow comb spacing over 80 nm. This comb filter is expected to find its applications in DWDM networks.

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