# 측면연마 광섬유 빗살필터를 이용한 다중파장 EDF 링 레이저

# Multi-wavelength EDF Ring Laser Using a Side-polished Fiber Optic Comb Filter

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Wavelength division multiplexing (WDM) has been introduced to meet the growing data traffic of optical fiber communication systems since it is economical and efficiency way to send many independent channels on a single-mode fiber. There are various approaches to generate multiple lasing simultaneously [1-4]. The comb filters using an in-line fiber interferometer have been employed to the erbium-doped fiber (EDF) ring laser. Generally, the doped-fiber should be cooled in liquid nitrogen at 77K to reduce the homogeneous broadening [1, 2]. For multiple lasing at room temperature, many researchers have reported the new technologies including a fiber bragg grating, a spatial mode beating filter [3] and a frequency shifter [4]. We propose here the novel EDF ring laser based on a side-polished fiber comb filter [5] and a long period fiber deformer (LPFD) filter [6] in order to achieve simultaneous multiple wavelength operation in room temperature.

The architecture of a proposed multi-wavelength EDF (MWEDF) ring laser is shown in Fig. 1. The 17m-EDF is optically pumped at 980nm laser diode through a WDM coupler. The side-polished fiber optic comb filter is used as a frequency selective element to promote multi-wavelength lasing. The comb filter is composed of a single-mode optical fiber and a multimode overlay waveguide (MMOW) as shown in Fig. 2. The fiber is fixed into the convex V-groove block for supporting the macro-band shape and cemented by an optical adhesive. To get access to the evanescent field of the guide mode in the fiber, the quartz block is carefully polished up to a distance 1.5$\mu m$ to the fiber core. After that, a polished $LiNbO_3$ with 200$\mu m$ thickness is glued on the polished fiber block. The optical spectra shows the periodic filtering characteristics with free spectral range of 4nm in the range of 1200nm-1600nm.

While the ring cavity contains only 17meters of EDF without the comb filter, the gain is clamped at 1565nm and a single inhomogenously broadened output spectrum is appeared in our experimental setup at the 980nm by 50mW pump power. To promote the multiple wavelengths lasing, the fabricated side-polished fiber comb filter with 4nm FSR is used in the doped fiber cavity. The output of the laser incorporating the side-polished fiber comb filter is shown in Fig. 3. Due to the gain cross-saturation between the adjacent wavelengths at room temperature, only two modes among the multi-channels separated by the comb filter are lasing as can be seen Fig. 3 (a). To extend the lasing bandwidth, the band suppression filter in the range of 1560nm -1570nm, which is formed by the LPFD, is introduced in the ring cavity. The LPFD consisted of the graphite rode takes role of the band suppression filter to reduce the homogeneous broadening of the doped fiber. This structure has the advantages of the very simple architecture, low cost, and easy tuning of the filtering profile. The diameter of graphite rods is 700$\mu m$ and the number of the rods is 60. The mechanical grating, which is induced by the pressure loaded with weight on the superstrate, forms the macro band shapes of the single-mode fiber placed between two deformers. The wanted notch wavelength can be adjusted by changing the angle between the fiber and the deformers. Herein, the angle is adjusted about 30° so that the peak wavelength is 1565nm. When the suppression depth is about 1dB, four laser lines centered at 1551.40nm, 1559.44nm, 1559.52nm, and 1562.88nm and an extinction of 30dB are observed as shown in Fig 3(b). When the pressure is increased, the suppression depth is deeper and the multiple lasing lines are disappeared due to the round-trip cavity loss. The required filtering profile is dependent on the doped fiber, input saturation signal power, and pump power. Therefore, the multiple wavelength operation of the laser can be obtained with the specially designed band suppression filters.

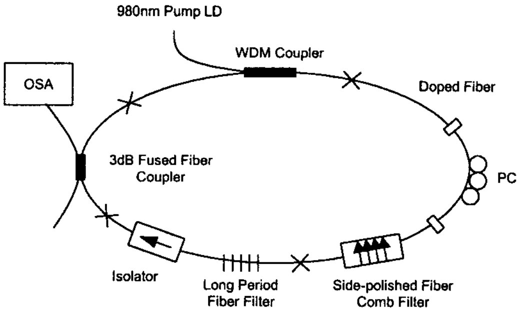


Fig. 1 Configuration of the proposed ring laser

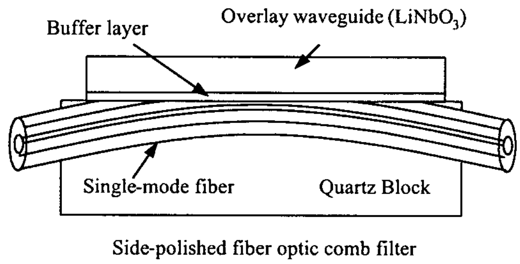


Fig. 2. Schematic of the proposed comb filter

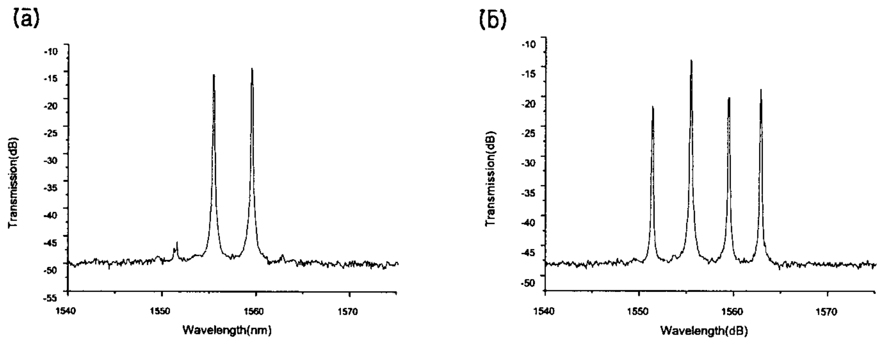


Fig. 3. Measured output spectrum of the proposed MWEDF ring laser.
(a) Without LPFD filter, (b) With LPFD filter

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