Observation and Comparison of Multiwavelength Generation Erbium Doped Fibre Ring Laser Utilising Photonic Crystal Fibre With Zero Dispersion at 1040nm and 1550 nm

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Abstract: We conducted an experiment to demonstrate the generation of multi wavelength by incorporating fibre Bragg gratings (FBGs) and photonic crystal fibre (PCF) which has zero dispersion of 1040 nm and 1550 nm in erbium doped fibre ring laser (EDFRL). The multiwavelength was generated at gain bandwidth EDFRL setup. The results showed a good agreement of less than 0.03 % of peaks wavelength generation based on both experimental set-up. The set-up also shares good repeatability of peaks wavelength generation of 0.01 nm and power deviation of 0.15 dBm. Nevertheless, experimental set-up with PCF of ZDW at 1550 has generated multi wavelength phenomenon by 30% effectively compared to PCF with ZDW at 1040 nm by 30% effectively. The results produced an impactful finding whereby the multiwavelength was clearly observed.

Results & Discussions: As result shown in figure 1(a), it exhibits the multi wavelength spectrum generated through this arrangements at which has peak wavelengths positioned at ω1 (1530.480 nm, -37.19 dBm), λ1 (1531.450 nm, -30.81 dBm), λ2 (1531.800 nm, -30.48 dBm), λ3 (1532.300 nm, -26.13 dBm), ω2 (1532.835 nm, -21.15 dBm), λ4 (1533.245 nm, -33.02 dBm), λ5 (1533.715 nm, -39.08 dBm) and ω3 (1535.025 nm, -39.44 dBm). Coincides with the spectrum gain, sufficient power stimulates the multi wavelength phenomenon within the range. Multi wavelength lasing was generated in this oscillation with a constant spacing of FBGs and assisted by FWM process which exterminate photons from the lasing to create new photons at different wavelengths. This continuous effect does stimulate EDFRL and amplified the process. Subsequently, the lasing wavelengths represent the effects of each FBGs and the nonlinear effect of assisted by FWM.

In this situation, sufficient power gain of EDFRL which oscillates in the cavity as required for FWM process to generate additional lasing. The phenomenon easily generated at power output at 80 mW. Meanwhile, through the same experimental set-up but with application of PCF ZDW at 1040 nm, the spectrum output as shown in figure 1(b). The peak wavelengths positioned at ω1 (1530.425 nm, -37.93 dBm), λ1 (1531.635 nm, -32.79 dBm), λ2 (1532.000 nm, -31.538 dBm), λ3 (1532.660 nm, -32.02 dBm), ω2 (1532.840 nm, -36.03 dBm), λ4 (1533.110 nm, -32.94 dBm), λ5 (1533.545 nm, -31.12 dBm) and ω3 (1535.020 nm, -39.17 dBm).

In order to stimulate multi wavelength phenomenon through the set-up, 115mW was pumped into the configuration. More power is required to pump into the configuration in order to excite multi wavelength generation. This is due to the mismatch of PCF ZDW at 1040 nm applied into 1550 nm of the transmission wavelength of the configuration. As a result, an increment 30% of power is required to match PCF ZDW 1550 nm set-up and to encourage new signals occurrence of signals pump diffraction through aperture of PCF ZDW at 1040 nm. Conversely, the power of FBG1 signal declined nearly 6 % in turn to generate five new signals with multiple power output displayed at average at -34 dBm. It and also decrease the power of FBG2 and FBG3 signals to 41% and 0.7 % respectively.

We also extend our experiments by monitoring peaks wavelength and the stability output on both experimental set-up at period of 160 minutes at temperature of 22ºC±3°C and relative humidity of 60%±10%. Through the findings, the agreement of peaks wavelength generated on both set-up is less than 0.03% as shown in Table 1. Based on figure 2, the repeatibility of the wavelength was excellent with an average deviation of 0.02 nm and power deviation of 0.13 dBm.

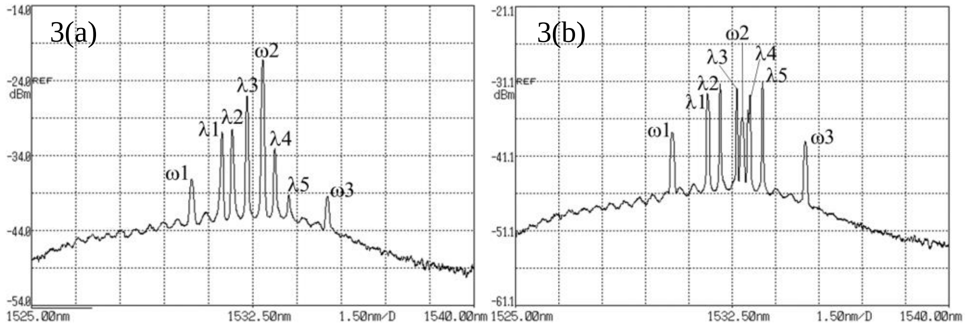

Fig. 1. EDFRL generated spectrum which produced multi wavelength through the experimental setup with PCF ZDW at (a) 1550 nm and (b) 1040 nm

PCF ZDW 1550 nm	PCF ZDW 1040 nm	Ratio
1530.430	1530.425	1.000003
1531.450	1531.635	1.000121
1531.800	1532.000	1.000131
1532.300	1532.660	1.000235
1532.835	1532.840	1.000003
1533.245	1533.110	1.000088
1533.715	1533.545	1.000111
1535.025	1535.020	1.000003

Table 1. EDFRL generated peaks wavelength through the experimental setup with PCF ZDW at 1550 and 1040 nm

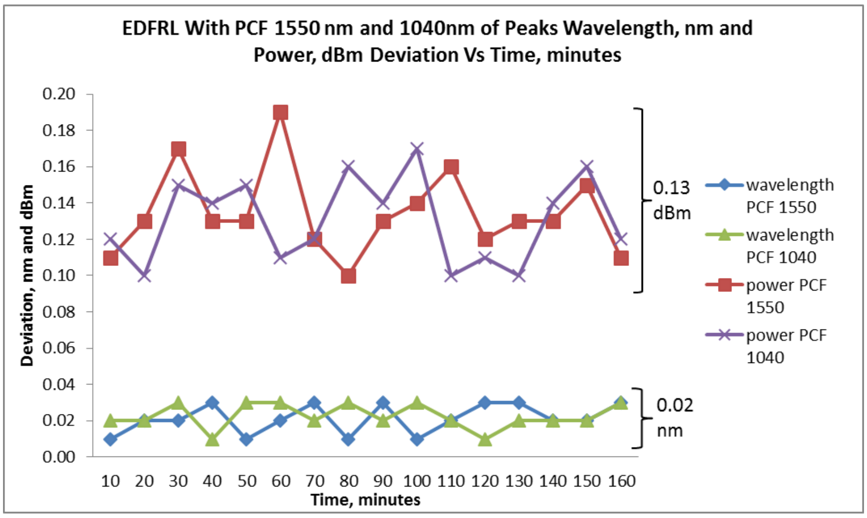

Fig. 2. Peaks wavelength and power deviation output based on 160 minutes duration

Conclusions: Through this comparative study, we concluded that the agreement of peaks wavelength generated through application of EDFRL via PCF ZDW at 1550 nm and 1040 nm is 0.03 %. The repeatibility which potrayed the stability performance on both experiments of peaks wavelength with an average deviation of 0.02 nm and power deviation of 0.13 dBm. More power at 30% incremental is needed to stimulate multi wavelength phenomenon at EDFRL using PCF ZDW at 1040 compared to PCF ZDW at 1550 nm. This setup has achieved remarkable results by producing multi wavelength signals using FBGs and PCF with zero dispersion mismatch from transmission window based on EDFRL.

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