Multi-wavelength oscillation of an uncoated SOA-based fiber ring laser

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Summary

We present a multiwavelength ring laser source using an uncoated semiconductor optical amplifier (SOA) for providing both gain as well as the comb-like filtering function in the cavity. A SOA-based ring laser source oscillates over a wide bandwidth range due to heterogeneous spectral broadening and the broad gain spectrum of the SOA. Multi-wavelength operation can be obtained by inserting comb-like filters inside the cavity. Fig. 1 (a) shows the relative simple experimental setup used. Gain was provided by a bulk, 500μm long, InGaAsP/InP ridge waveguide SOA (OptoSpeed, S.A.) with facets tilted at $10^{o}$and without AR-coatings. The reflectance of the uncoated facets was calculated to be about 0.3. A polarization controller was incorporated to adjust polarization state and an isolator to ensure unidirectional oscillation in the ring cavity. Output was obtained via a 50:50 fused fiber coupler. The total length of the cavity was 11,45m corresponding to a fundamental ring frequency of 16.9MHz. The oscillating spectrum was defined by the Fabry-Perot modes of the uncoated SOA whose free spectral range was 65GHz. At the output of the ring laser a 1.5mm SOA was used for amplification and a fiber Fabry-Perot for individual channel isolation and detection in an optical or electrical spectrum analyzer.

Multi-wavelength operation is possible even by using the reflection coated SOA alone considered as a linear, 500 um long, cavity, providing lasing lines determined by the Fabry-Perot modes that experience the highest gain. However, due to gain compression caused by the extreme low cavity losses, its performance as a multi-wavelength source is rather poor. Fig. 1(b) depicts the oscillating spectrum of this configuration that consists of only 4 lasing lines within a 3 dB power variation when the SOA is driven at 250 mA dc current. On the contrary, multi-wavelength operation in a ring laser configuration is significantly improved due to strong optical feedback that forces carriers to deplete the heavily saturated energy levels and occupy the less saturated, shifting the oscillating spectrum to longer wavelengths. Further bandwidth broadening is obtained by coupling the lasing signal in both polarization axes of the semiconductor. Fig. 1(c) illustrates the obtained oscillating spectrum using the ring laser configuration with the SOA driven again at 250 mA. The lasing window is broadened by a factor of 7 consisting of 29 oscillating lines within a 2 dB power variation. The intracavity uncoated-SOA is heavily saturated as the recirculating optical power in the cavity (as well as total output power) is close to 2mW. In order to improve on the accuracy on determining the linewidth and the extinction ratio of the lines, each line was isolated with an external fiber Fabry-Perot (FFP) filter (5.2 GHz bandwidth) and was detected by a photodiode. The FWHM of each oscillating wavelength was measured in an electrical spectrum analyzer from the resulting beat spectrum of the cavity modes. With this technique and assuming a Lorentzian lineshape, the oscillating width of each wavelength line was found to be less than 160 MHz. Using the external fiber Fabry-Perot filter we have also measured the power level of each wavelength line and the noise background level in order to calculate the extinction ratio between the lines. The extinction was found to be 29 dB, but it is expected to be significantly better because the measurements were made after signal amplification in a bulk, 1500 μm long SOA.

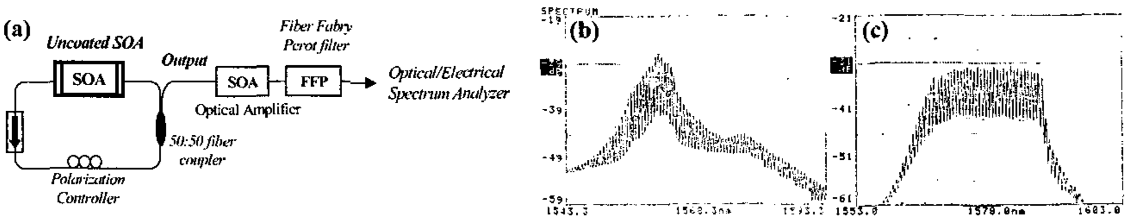

Figure 1: (a) Experimental setup and oscillating optical spectrum (b) at the output of the uncoated-SOA and (c) at the output of the ring laser. SOA current is set to 250 mA.

References

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