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Multi-Wavelength Fiber Laser Operation Based on Wavelength Conversion in a Ring Cavity

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ABSTRACT— A multi-wavelength fiber laser source is created by using a dispersion compensating fiber (DCF) of length 7.7 km in a ring cavity. Two bundles of multi-wavelength Brillouin fiber lasers (MBFLs) assisted by four-wave mixing processes are produced by employing two Brillouin pump sources (BPs) at the different wavelengths of 1529 and 1530 nm, but operated at the same BP peak power level of 16 dBm after coupling into the DCF. These two bundles of MBFLs having 12 lines are surrounded by two other 8-line bundles of multi-wavelength fiber lasers produced by degenerate four-wave mixing processes. This total of 20 lines is generated when a BP wavelength is set in the wavelength region 1526.5-1533 nm, whereas the other BP wavelength is fixed at 1530 nm. Although the line spacing in each bundle of lines is about 0.155 nm and equal to double the Brillouin shift in the DCF, the wavelength spacing between the maximum peak power lines of the two adjacent bundles of lines is equal to the difference in the BP wavelengths. When the difference between the BP wavelengths is increased from 0.5 to 7 nm, the signal-to-noise ratio of the maximum peak power lines in the FWM bundles decreases from 31 dB to 5 dB.

KEYWORDS: Fiber optics, Four-wave mixing, Multi-wavelength light source, Stimulated Brillouin scattering

I. INTRODUCTION

New multi-wavelength sources have an important role in facilitating the needs in areas such as optical communication, spectroscopy, light detection and ranging (LiDAR), imaging, optical sensing and metrology [1-14]. Among the various methods for generating these multi-wavelength sources, the method based on cascaded stimulated Brillouin scattering (SBS), a nonlinear effect, is common because of its simplicity of configuration, easy tunability without any ultra-narrow filter requirements, and accurate line spacing [15-17]. Even though nonlinearities in electromagnetism are weak effects, it is known that confining coherent light, especially for a long time in a small volume waveguide or cavity, can enhance the interaction of light with matter and increase the intensity of the light sufficiently to generate significant and useful nonlinear effects [18-20]. Hybrid Brillouin-erbium and Brillouin-Raman gains may also be used to increase the number of Brillouin Stokes lines generated in multi-wavelength Brillouin-erbium fiber lasers (MBEFLs) and multi-wavelength Brillouin-Raman fiber lasers (MBRFLs), respectively