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Modeling of Multi-Wavelength Brillouin Fiber Laser Based on Analytical Solutions in a Linear Cavity

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Abstract *In this article, an accurate model of multi-wavelength Brillouin fiber laser is developed by analytically solving cascade-stimulated Brillouin scattering equations in a linear cavity. The dependence of Stokes signal power on the incident pump power and the successive reflected transmitted powers is calculated. Furthermore, an analytical approach that can be used to predict the generated Stokes signals power is derived. Finally, this derived model is checked with experimental results that show significant agreement with the analytical solution of the model.*

Keywords fiber laser, linear cavity, multi-wavelength Brillouin fiber laser, stimulated Brillouin scattering

Introduction

Stimulated Brillouin scattering (SBS) is a non-linear process that is likely to occur in optical fibers at low input power levels. It manifests through the generation of a backward-propagating Stokes wave that carries most of the input power once the Brillouin threshold is reached. For this reason, SBS severely limits the channel power in optical communication systems [1]. A theoretical analysis of the SBS phenomenon in a single-mode fiber (SMF) within a conventional technique (without feedback) in which the effects of pump depletion and attenuation are neglected has been presented in many works [2–9]. An analytical model that considers the effects of pump depletion and attenuation was considered in [10]. Further, an analytical model of the SBS threshold reduction using a recycling technique in which the residual pump power is reflected back into the Brillouin gain medium was achieved in [11]. The theoretical and experimental behavior of Brillouin ring resonator lasers (BRRLs) highlight the differences between Brillouin scattering in ring resonators and long fiber lengths. In this model, the non-linear interaction is well described by two coupled equations for the optical waves and agrees well with measured data [12].

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