Laser Phys. **23** (2013) 085111 (4pp) doi:10.1088/1054-660X/23/8/085111

Influence of a bidirectional recycling residual pump on the Stokes signal characteristics of a linear cavity Brillouin fiber laser

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Received 27 November 2012
Accepted for publication 18 June 2013
Published 15 July 2013
Online at stacks.iop.org/LP/23/085111

Abstract
The effect of a bidirectional recycling residual pump on the Brillouin Stokes signal threshold, as well as on its power, is experimentally investigated. The laser cavity is formed with two optical mirrors as the resonator reflectors which allow bidirectional residual pump recycling that causes bidirectional Brillouin gains. These gains significantly reduce the threshold power and increase the Stokes signal power. For the same single mode fiber length, the Brillouin Stokes signal threshold is reduced by up to 75% and 50% in the laser structure compared to its values in conventional and recycling Brillouin threshold reduction techniques, respectively. In addition, the effect of Brillouin gains on the Stokes signal power is illustrated and exhibits no additional gain in the laser cavity as compared with the recycling technique, especially for long fibers >8 km.

(Some figures may appear in colour only in the online journal)

1. Introduction

Stimulated Brillouin scattering (SBS) is a nonlinear phenomenon in single mode fibers (SMFs) that occurs at low power levels and propagates in an opposite direction to the input optical signal. Once the input power exceeds the threshold value of a certain SMF, the SBS will be generated and this effect limits the received power in an optical communication system [1–4]. However, this side effect can also be utilized beneficially in a laser cavity in order to generate multi-wavelength fiber lasers [5–8]. For these types of lasers one of the most important performance parameters is the SBS threshold power. A reduction in SBS threshold using a bidirectional pump has been reported in [9, 10]. In order to avoid structural complexity, threshold reduction through a recycling technique was proposed by [11, 12]. The SBS threshold is reduced due to the contribution of Brillouin amplification gain that is achieved by recycling the residual pump power back into Brillouin gain media [13]. Moreover, much research has been carried out that shows a reduction in the SBS threshold in the presence of feedback and in a lasing cavity, and both exhibit low threshold values as compared with the classical lasing threshold [14–18]. In addition, an SBS threshold reduction ratio is achieved using a multipass Herriott cell through periodic refocusing of the pump laser within the Brillouin medium [19]. However, all of the cited previous studies have illustrated a low SBS threshold in the presence of feedback as compared to its value in the conventional technique. So far, to the best of our knowledge no study has been conducted to show the influence

