Gain Spectrum of Fibre Brillouin Amplifiers

Introduction

Stimulated Brillouin scattering occurs as a result of interaction of light with the moving density fluctuations (acoustic phonons) in the medium. Due to Doppler Effect, the scattered field experiences a frequency shift determined by the acoustic wave velocity. The propagation of the acoustic waves is influenced by environmental variables such as temperature or mechanical strain and as such opens the possibility for the sensing of temperature and strain. Analysis of the acoustic phonon distribution (Brillouin gain spectrum) is important as it gives all the information required like gain coefficient, frequency shift and the line width for most of the applications using SBS.

Experimental Setup

In the Brillouin amplifier configuration shown in Fig. 1, both pump and probe waves are derived from a common narrow-linewidth tunable laser (Vortex, 1550nm).Probe radiation around the Brillouin frequency is generated by amplitude modulation using electro-optic modulator (Photline) driven by a RF frequency generator (Hittite) in the carrier suppressed mode. Probe frequency coinciding with the Brillouin gain spectrum gets amplified along the length of the fiber. Gain of the counter-propagating probe is a measure of the Brillouin gain Spectrum (BGS) of the fiber.

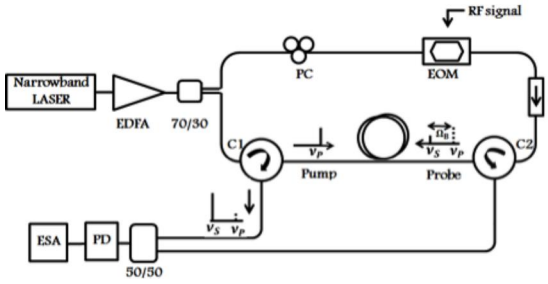

Figure 1. Experimental setup.

Results

In the experiments, the pump wave is launched into the fiber with a power above the threshold level. The self-stimulated gain spectrum is observed at a frequency shift of 10.882 GHz. When the probe frequency counter-propagating in the fiber tuned across the line width of this natural gain spectrum, it is found to amplify at the expense of gain in the self-stimulated process, shown in Fig. 2.

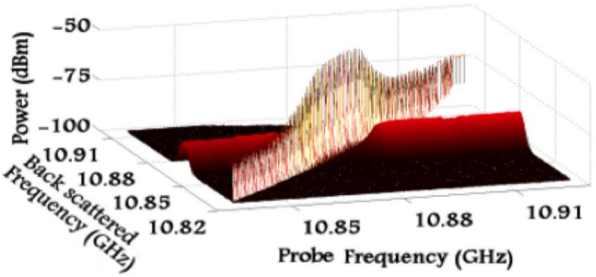

Figure 2. Depletion of gain as the probe is tuned across the Brillouin gain spectrum.

Fig. 3 shows the bandwidth of the stimulated BGS (17 MHz) with a probe signal. This is broader than the 6 MHz bandwidth of the natural (self-stimulated) gain spectrum.

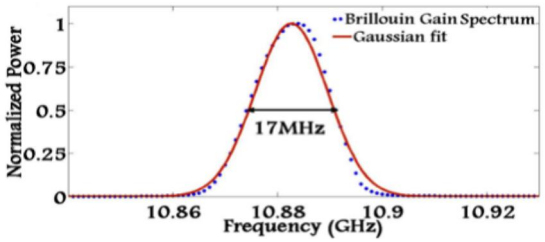

Figure 3. Linewidth of gain spectrum.

Summary

We have studied the depletion characteristics of the Brillouin gain spectrum by tuning the probe frequency across the Brillouin gain frequency band. The self-stimulated gain spectrum observed when the probe is detuned from the peak Brillouin frequency shift, is found to get suppressed when the probe is tuned to the Brillouin gain spectrum. The gain-bandwidth of the self-stimulated gain spectrum is found to be smaller than the gain bandwidth experienced by an external probe.

Publication

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