Enhanced Brillouin Fiber Laser

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Abstract

This dissertation studies the Brillouin fiber laser (BFL) performance in the both linear and ring cavities. As a high coherent light source with ultranarrow linewidth, Brillouin fiber lasers have been used in many applications especially in microwave generation, gyroscopes, and multiwavelength Brillouin fiber lasers.

High power lasers always have been a topic of research in laser physics. Thus, in this work, after some review in stimulated brillouin scattering, Brillouin fiber lasers will be generated in all the cavities. Then, the proposed ring and linear cavities will be presented to get high power BFLs and the results will be compared with the previous works in this field. By using the proposed ring cavity with the same components used in the conventional ring cavities, a new Brillouin fiber ring laser (BFRL) with higher output power has been generated. In the proposed linear cavity, BFL configuration has been demonstrated by incorporating a 3-dB coupler, a 95/5 coupler, two optical circulators, and a 25 km SMF that allows very high conversation efficiency compared with the last work. Stable BFL operation was obtained at an up-shifted wavelength of 0.086 nm from the pump wavelength with the BFL peak power at -1 dBm, which is 12.3 dB higher than the conventional BFL with the same BP power 13 dBm, due to the reduced cavity loss in the proposed configuration.

On the other hand, BFL linewidth measurement has also been a challenging research due to the ultranarrow BFL linewidth. The BFL linewidth has been measured 8 Hz and 24 Hz by using Brillouin laser pump linewidth 15 MHz and 124 MHz, respectively. This measurement has been done by the heterodyne method between two independent BFLS. The measured BFL linewidth values are in the range a few hertz which have been reported from most of the previous researches.

Abstrak

Disertasi ini menkaji kecekapan laser gentian Brillouin (Brillouin Fiber Laser) BFL, dalam kedua-dua rongga linear dan rongga gelang. Sebagai sumber cahaya koheren yang tinggi dengan glebar garis yang sangat sempit, gentian laser Brillouin telah digunakan dalam pelbagai aplikasi terutama dalam penjanaan gelombang makro, giroskop dan laser gentian Brillouin dengan pelbagai panjang gelombang.

Laser berkuasa tinggi sering menjadi bahan penyelidikan di dalam bidang fizik laser. Oleh itu, hasil kerja kali ini , selepas mengulas mengenai penyerakan dirangsang Brillouin (stimulated brillouin scattering), laser gentian Brillouin akan dijana dalam kesemua rongga tersebut. Kemudian rongga linear dan gelang yang dicadangkan akan ditunjukkan untuk mendapatkan kuasa BFL yang tinggi dan keputusan akan dibandingkan dengan hasil kerja dalam bidang yang sama sebelum ini. Dengan menggunakan rongga gelang yang dicadangkan yang mempunyai komponen yang sama dengan rongga gelang konvensional, satu laser gentian cincin Brillouin dengan kuasa hasilan yang lebih tinggi telah dihasilkan.

Dalam rongga linear yag dicadangkan,tatarajah BFL telah ditunjukkan dengan menggunakan 3dB coupler, 95/5 coupler, dua circulator optikal,dan 25 km SMF yang memberikan kadar kecekapan yang lebih tinggi, berbanding dengan kerja sebelumnya. Operasi BFL yang stabil didapati pada anjakan ke atas pada panjang gelombang 0.086nm daripada panjang gelombang pam, dengan puncak kuasa pada-1dBm, yang mana 12.3dB lebih tinggi daripada BFL konvensiona l yang mempunyai kuasa BP 13dBm, kerana berkurangnya lesapan rongga di dalam tatarajah yang dicadangkan.

Pengiraan lebar garis BFL juga menjadi bahan penyelidikan yang agak mencabar kerana penyempitan ultra bagi lebar garis BFL. Lebar garis BFL yang telah diukur ialah

8Hz dan 24Hz dengan menggunakan pam laser Brillouin dengan lebar garis 15MHz dan 124MHz, masing-masing.Pengiraan ini telah dibuat dengan menggunakan Teknik Heterodin, antara dua BFL yang tidak bersandar. Pengiraan nilai lebar garis BFL ialah di dalam julat beberapa Hertz seperti mana yang dilaporkan daripada kebanyakan penyelidikan sebelum ini.

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