CHAPTER 5:

Conclusion and Future Works

This chapter summarizes and concludes all of the research done in this thesis and gives suggestions for further research in this field in the future.

5.1 Conclusion

A new work is presented to improve Brillouin fiber laser (BFL) efficiency and to measure the BFL linewidth. The research includes the experimental work in the BFL generation in both ring and linear cavities. A detailed review on the stimulated Brillouin scattering (SBS) phenomena has been done in the chapter 2 to identify the dynamics of BFLs. This reader is then led to the three-wave modeling and the Brillouin fiber laser generation in the ring cavities.

In chapter 3, the initial experimental research managed to determine the SBS effects in a single-mode fiber. The effective length L_{eff} and the effective area A_{eff} are reviewed in this work according to our available optical fibers. In addition to this, the effect of the Brillouin laser pump linewidth on the SBS performance has been shown. Then, after reviewing the past research done on Brillouin fiber ring lasers (BRFLs), a new ring cavity is proposed to acquire higher power BFRLs and to increase BFRLs efficiency. The generated BFRL has a peak power which is 5.7 dB higher than that one produced in the conventional ring cavity with the same components. BFL generation in linear cavities are also mentioned by using fiber

Bragg gratings (FBGs) or optical circulators where ports 3 and 1 are connected to each other, see Fig. 3.14 (a) for example. Although some research have been focused on producing high power BFLs, the generated Brillouin peak power is normally lower than the transmitted BP peak power as reported in many literatures. In this work, after reviewing the conventional BFL linear cavities, we focus to solve the problem. Even though the second Brillouin Stokes has been generated in our proposed linear cavity, the generated BFL peak power is higher than the Brillouin laser pump peak power. The BFL peak power generated in the proposed linear cavity is 12.3 dB higher than the BFL peak power in the conventional one when the Brillouin laser pump have the same peak power 14.4 dBm. Since BFLs are very coherent light sources with ultra-narrow linewidths, BFLs have been used in various applications such as microwave generation and gyroscopes.

In chapter 4, the BFL linewidth is been measured using the heterodyne method. BFL linewidth measurements have been a challenge due to the ultra-narrow BFL linewidth. In this work, the linewidth measurement is done using a Brillouin fiber ring laser (BFRL) in the heterodyne configuration. The BFRL is generated in a conventional ring cavity by using a tunable laser source (TLS) in the narrow linewidth setting. In the heterodyne configuration, the BFRL is emitted as the local oscillator or the continuous wave to measure the linewidths of an independent TLS in the narrow and wide linewidth settings. It is revealed that the TLS has the linewidth values of 15 MHz and 124 MHz in the narrow and wide linewidth settings, respectively. In the same configuration, the BFRL linewidths are determined to be 8 Hz and 24 Hz by using two uncorrelated BFRLs generated by a BP linewidth of 15 MHz and 124 MHz, respectively. The measured BFL linewidths are in the range of a few hertz as reported by past research.

5.2 Suggestions for works in the future

This thesis is primarily based on enhancing the Brillouin fiber laser (BFL) peak power in addition to measuring the BFL linewidth using the heterodyne method. In the future, theoretical works on BFL high efficiency should be directed towards further improvement of the proposed linear cavity BFL. This understanding should also focus particularly on the four-wave mixing and the initial noise on the BFL which seems to be important factors in fluctuations in the BFL generation. It seems that further theoretical work is also necessary to be done on the BFL linewidth. In the BFL generation, other phenomena such as mutiwavelength Brillouin fiber lasers and SBS threshold power reduction under Raman amplification are also investigated which are beyond this thesis. Therefore, SBS and BFL have much potential as far as further research is concerned.

Journals

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Conferences

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