Enhancing Information Transmission Methods Using Femtosecond Radiation

Oleksandr Hnatenko[1], **Vladyslav Chaplyhin[1]**, Olha Kravchuk[1]

[1]Kharkiv National University of Radioelectronics, Nauky ave. 14, Kharkiv, Ukraine

In telecommunications, there is increasing interest in developing stable sources for the third fiber optic transmission window, particularly ring fiber lasers with passive mode-locking. Erbium-doped optical fibers, operating at a wavelength of 1550 nm, play a key role in this field. It is expected that these lasers will eventually replace many semiconductor data transmission lasers used in Dense Wavelength Division Multiplexing (DWDM) systems according to the ITU frequency grid. Recent years have seen significant progress in ring fiber laser technology, but the field still needs reliable, compact, and cost-effective solutions to compete with the variety of laser diodes available. While existing ring fiber lasers offer advantages, they also face challenges such as complex designs, expensive semiconductor saturable absorbers, and pulse durations of about 200 femtoseconds (fs). Some ring fiber lasers using non-linear polarization rotation (NPR) for mode-locking are more affordable and achieve shorter pulse durations of around 30 fs. However, these lasers still struggle with issues related to stability and mode-locking consistency. To address these issues, our goal is to develop a ring fiber laser circuit and explore mode-locking

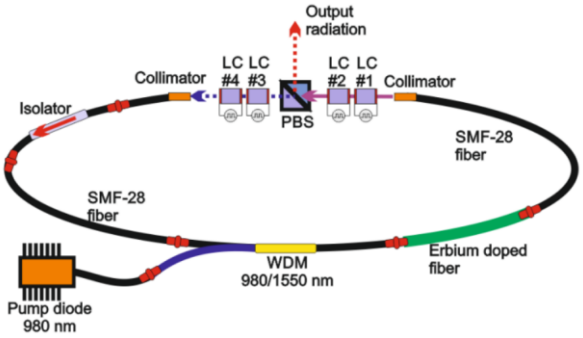

Fig. 1

techniques using liquid-crystal (LC) polarizers. NPR involves the interaction

between the polarization of electromagnetic waves and the strength of radiation, where a polarizing beam splitter (PBS) acts as a saturable absorber to stimulate laser pulse generation. Effective mode-locking requires controlling polarization in a non-linear medium. This can be achieved using polarizers or wave plates, which rotate to maintain the necessary polarization state. Precise motorized polarization rotators have been proposed, while mechanical methods such as fiber bending and piezoelectric actuators offer alternative solutions. However, these methods often require prolonged tuning and can result in performance drift. We propose using LC polarizers for electronic control of the NPR mode (Fig.1). LC polarizers offer low-voltage control signals, fast response times, and long-term stability, potentially improving the performance and reliability of ring fiber lasers [1-2].

References

[1] S.Gnatenko, Yu. P. Machekhin, Yu. S. Kurskoy, V. P. Obozna Providing mode locking in fiber ring lasers . J. Nano- Electron. Phys. 10 No 2, 02033 (2018). DOI: 10.21272/jnep.10(2).02033.

[2] A.S. Gnatenko, Yu.P. Machekhin, Yu.S. Kurskoy, V.P. Obozna, A.V. Vasianovych. Ring fiber lasers for telecommunication systems. Telecommunications and Radio Engineering. - Vol.77, No6. - P. 541-548. DOI: 10.1615/TelecomRadEng.v77.i6.60