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Study of wavelength switching time in tunable semiconductor micro-ring lasers: experiment and travelling wave description

MULHAM KHODER,[1,*] MINDAUGAS RADZIUNAS,[2,3] VASILE TRONCIU,[4] AND GUY VERSCHAFFELT[5]

[1]*Brussels Photonics (B-PHOT), Department of Applied Physics and Photonics, Vrije Universiteit Brussel, Pleinlaan 2, B-1050 Brussels, Belgium*
[2]*Weierstrass Institute for Applied Analysis and Stochastics Leibniz Institute in Forschungsverbund Berlin e.V., Mohrenstrasse 39, 10117 Berlin, Germany*
[3]*MQ Photonics Research Centre and Department of Physics and Astronomy, Macquarie University, Sydney, NSW 2109, Australia*
[4]*Department of Physics, Technical University of Moldova, bd. Stefan cel Mare 168, Chisinau MD-2005, Moldova*
[5]*Applied Physics Research Group (APHY), Department of Applied Physics and Photonics, Vrije Universiteit Brussel, Pleinlaan 2, B-1050 Brussels, Belgium*
[*]*mulham.khoder@vub.be*

Abstract: We report in this paper the wavelength switching features of semiconductor ring lasers that are wavelength tunable based on filtered optical feedback. The filtered feedback provides a wavelength dependent loss mechanism in these devices with which a particular longitudinal mode, and thus a particular wavelength, can be selected by changing the filter characteristics of the feedback channel. We investigate how the wavelength switching speed depends on the amplitude of the modulation of the switching driving signal and on the different phase factors within the filtering branches of the SRL. We compare qualitatively the experimental results with numerical simulations based on a travelling wave model. We also investigate the dynamical behavior of the lasing and nonlasing longitudinal modes in the two channels of the clockwise and the counter-clockwise directions. We show the crucial importance of various phase relation factors on the wavelength switching behavior. Finally, we discuss what limits the switching speed and how we can accelerate it.

1. Introduction

Wavelength tunable lasers [1] are being used in several applications, such as optical sensing [2] and wavelength division multiplexing [3]. Therefore, during last years there is a large interest in the further development and optimization of such tunable lasers. There exist many different approaches in order to make a tunable laser, each approach having its particular advantages and disadvantages. These approaches typically rely on changing the laser's effective cavity length [4], by varying the physical length of the cavity or its refractive index, or by introducing a wavelength dependence in the cavity such as in the arrayed waveguide grating lasers [5].

Filtered optical feedback (FOF) is one way of achieving a laser with controllable wavelength. In this approach, part of the light emitted by the laser is reinjected in the cavity after passing through a wavelength dependent optical filter. If the reinjected light has the same phase as the originally emitted field and if the delay is short (compared to the relaxation oscillations time scale), the filtered feedback will select those laser mode(s) whose wavelength is closest to the transmission maximum of the filter in the feedback section [6]. The wavelength selective elements in such tunable lasers are thus placed outside of the laser cavity, which can have a positive effect on the stability of the selected wavelength [7] and can result in a simpler control system

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