ID: MSCA-2020-KPanajotov01

Title: Mode Locking and Dissipative Solitons in Vertical External-Cavity Surface-Emitting Lasers for generation of Optical Frequency Combs

Optical frequency combs (OFCs) have spectra consisting of equidistant lines, which provides a link to the radiofrequency spectrum and thus, are revolutionizing a number of applications, such as precision laser spectroscopy and frequency metrology, distant measurements, optical waveform and microwave synthesis. Recent breakthroughs include OFC generation based on microresonators, Vertical External-Cavity Surface-Emitting Lasers or VECSELs and novel fiber resonator concepts. The goal of this project is to design, fabricate and experimentally and theoretically investigate VECSELs for mode-locking and dissipative soliton OFC generation, relying on improved understanding of the physics underlying comb generation.
A VECSEL consists of a gain chip, a saturable absorber chip, an output coupler, polarization controllers and a pump laser. The gain chip is composed of monolithic Distributed Bragg Mirror (DBR) with alternating GaAs/ AlGaAs layers, cavity containing the multiple active layers of quantum wells and antireflection layers. The saturable absorber mirror (SAM) is composed of quantum well or 2D material sandwiched between two asymmetric DBRs. The output coupler can be designed so that to introduce certain amount of dispersion in order to achieve dissipative soliton regime. VECSEL setups for mode-locking and dissipative soliton generation is available at VUB. The setups will be extended by implementing 2D material SAM and birefringent material for dual comb generation with tunable comb-line frequency difference that is important for spectroscopy applications. Experimental realization of dissipative solitons will allow for multi-frequency comb generation on the same device. This is a research field largely unexplored with a multitude of open issues as spatiotemporal soliton domains of stability, dynamics, interaction, etc. Furthermore, detailed theoretical studies of the mode-locking and soliton regimes in VECSELs is already undertaken by developing mean-field partial delay-differential equation models that account for the finite bandwidths of the gain and saturable absorber cavities, phase modulation caused by the phase-amplitude coupling, polarization effects, nonlinearity, light diffraction and dispersion and carrier diffusion.

Supervisor: Krassimir Panajotov: kpanajot@b-phot.org
Research Group: https://www.b-phot.org/
To apply: https://www.vub.ac.be/en/european-liaison-office#apply-msca-if

Available time frame for supervision: June 1 - July 31, 2022.