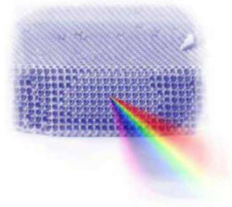


University of Belgrade
Institute of Physics Belgrade
Kopaonik, March 16-20, 2025



Book of Abstracts
18th Photonics Workshop
-International Conference-



18th Photonics Workshop 2025

Book of abstracts

Kopaonik, Serbia, March 16-20, 2025

Publisher, 2025:

Institute of Physics Belgrade

Pregrevica 118

11080 Belgrade, Serbia

Editors:

Marina Lekić, Zoran Grujić, Aleksandra Kocić

ISBN 978-86-82441-71-7

Printed by:

NEW IMAGE d.o.o.

Tošin Bunar 185, Belgrade

Number of copies: 60

CIP - Каталогизација у публикацији
Народна библиотека Србије, Београд

535(048)
681.7(048)
66.017/.018(048)

PHOTONICS Workshop (18; 2025 ; Kopaonik)

Book of Abstracts / 18th Photonics Workshop, (International Conference), Kopaonik, March 16-20, 2025 ; [organized by Institute of Physics Belgrade, Photonics center [and] Optical Society of Serbia] ; [editors Marina Lekić, Zoran Grujić, Aleksandra Kocić]. - Belgrade: Institute of Physics, 2025 (Belgrade: New image). - 60 str.: ilustr. ; 25 cm

Tiraž 60. - Registar.

ISBN 978-86-82441-71-7

а) Оптика -- Апстракти б) Оптиелектроника -- Апстракти в) Технички материјали -- Апстракти

COBISS.SR-ID 164647945

Modelling of THz quantum cascade laser dynamics

Nikola Vuković^{1,2}, Milan Ignjatović¹, Novak Stanojević^{1,3}, Aleksandar Demić⁴, Aleksandar Atić^{1,2,5}, Aleksandar Milićević⁵, Nikola Basta¹, Filip Perišić¹, Mihailo Stojković¹, Dragan Indjin⁴, Jelena Radovanović^{1,2}

(1) *University of Belgrade, School of Electrical Engineering, Bulevar kralja Aleksandra 73, 11120 Belgrade, Serbia*

(2) *Centre for Light-Based Research and Technologies COHERENCE, Mike Petrovića Alasa 12-14, 11001 Belgrade, Serbia*

(3) *Vlatacom Institute of High Technologies, Bulevar Milutina Milankovica 5, 11070 Belgrade, Serbia*

(4) *University of Leeds, School of Electronic and Electrical Engineering, Woodhouse Lane LS2 9JT, Leeds, United Kingdom*

(5) *University of Belgrade, Vinča Institute of Nuclear Sciences, Mike Petrovića Alasa 12-14, 11001 Belgrade, Serbia*

Contact: N. Vuković (nvukovic@etf.bg.ac.rs)

Abstract. We report on our recent progress in modelling THz frequency quantum cascade laser [1] (QCL) dynamics, where we have considered regimes of passive mode locking using distributed saturable absorber [2] and configuration for laser feedback interferometry [3]. Carrier transport simulations are used for the extraction of parameters for the dynamical simulations. Localized wavefunctions are calculated by solving the Schrödinger-Poisson equation system using the first neighbour and tight binding approximations, together with the infinite period QCL consideration. The transport of electrons through the quantum well heterostructure is modelled by a density matrix approach [4] where all the relevant scattering mechanisms are described as perturbations with the Fermi-golden rule, using the wavefunctions and material parameters as inputs. In order to model passive mode locking we then solve Maxwell-Bloch equations using two approaches: (i) a full wave model and (ii) a model which has reduced numerical complexity by employing rotating wave approximation (RWA) and slowly varying envelope approximation (SVEA). Graphene saturable absorber interacts with the optical field via an intensity-dependent loss. For modelling laser dynamics under optical feedback we use effective semiconductor Maxwell-Bloch equations.

REFERENCES

- [10] J. Faist et al., *Science* **264** (1994), 553–556.
- [11] E. Riccardi, et al., *Nat. Photon.* **17** (2023), 607–614.
- [12] A. Rakić, et al., *Appl. Phys. Rev.* **6** (2019), 021320.
- [13] A. Demić et al., *IEEE Transactions on Terahertz Sci. Technol.* **7** (2017), 368–377.

Acknowledgements

This work was financially supported by the Science Fund of the Republic of Serbia, Grant 10504, "Ultra-short pulsations from TERAHERTZ quantum cascade laser using passive mode-LOCKing with graphene saturable absorber" - TERALOCK, Ministry of Science, Technological Development and Innovation of the Republic of Serbia under contract number: 451-03-65/2024-03/20010, COST Action CA21159 PhoBioS, and Vlatacom Institute of High Technologies under project 178.

ORCID: 0000-0002-4941-2546, 0000-0001-6066-8764, 0009-0007-5122-2219, 0000-0001-6066-8764, 0000-0001-8436-436X, 0000-0001-8436-436X, 0000-0001-6141-7414, /, /, 0000-0002-9121-9846, 0000-0003-3031-7802