Mykhailo Vorobiov

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Education

- **Virginia Commonwealth University** — **Richmond, VA, USA**
  PhD candidate in Nanoscience and Nanotechnology — *August 2018 – May 2024 (expected)*
- **Virginia Commonwealth University** — **Richmond, VA, USA**
  M.S. in Physics and Applied Physics — *January 2017 – May 2018*
- **Kharkiv National University of Radio Electronics** — **Kharkiv, Ukraine**
  M.S. in Electrical and Electronic Engineering — *September 2012 – June 2013*
- **Kharkiv National University of Radio Electronics** — **Kharkiv, Ukraine**
  B.S. in Electrical and Electronic Engineering — *September 2008 – June 2012*
- Additional training
  - Cavity Quantum Optomechanics (EPFL, Certificate Link)
  - Quantum Optics 1: Single Photons (École Politechnique, Certificate Link)
  - Quantum Optics 2: Two photons and more (École Politechnique, Certificate Link)
  - Nonlinear Optics (École Politechnique, Certificate Link)
  - Advanced Statistical Physics (EPFL, Certificate Link)
  - Becoming an Antiracist Educator (VCU)

Working Experience

- **Graduate Teaching/Research Assistant** — **Richmond, VA, USA**
  Virginia Commonwealth University, Department of Physics — *January 2017–Present*
  - Currently serving as a Graduate Research Assistant in Professor Reshchikov's Lab, utilizing photoluminescence spectroscopy to investigate point defects in Gallium Nitride thin films. Building equipment and software for experiment control.
  - Instructing the laboratory component of calculus-based Introductory Physics I and II, as well as Modern Physics classes, specifically designed for engineering and science students. Conducting recitation classes, providing guidance in both group settings and personalized one-on-one sessions for effective problem-solving.

- **Machine Learning Engineer** — **Kharkiv, Ukraine**
  IT-Jim, LLC — *December 2015–December 2016*
  - Devised a novel feature extraction technique for texture classification, leveraging Krawtchouk and Chebyshev polynomials, along with cumulant expansion methods.
  - Constructed a fusion algorithm system for texture classification by integrating Convolutional Neural Networks and Support Vector Machine frameworks with the aforementioned feature extraction method.
  - Designed a client-server interface for a commercial augmented reality system focused on optical character recognition for Tamil, Malay, and Chinese languages.

- **Research Assistant** — **Kharkiv, Ukraine**
  Insititute of Radio Astronomy of the NAS, Microwave Engineering Department — *October 2014–December 2015*

- Developed a matched filtering algorithm for adaptive accelerated targets detection for commercial pulse-Doppler radar systems.
- Developed a software-based pulse-Doppler radar simulator as part of the algorithm testing phase.

Engineer **Kharkiv, Ukraine**

○ *Institute of Radio Astronomy of the NAS,*
Microwave Engineering Department *December 2013–October 2014*

- Modified a signal processing architecture for the UTR-2 radiotelescope's spectroscopy software, a key analysis tool for the institute's astronomical departments. Achieved 30% speed increase with the implementation.
- Developed and refined multiple target detection algorithms for commercial radar hardware, encompassing a spectrum from thresholding to adaptations of CFAR.

Research Assistant **Kharkiv, Ukraine**

○ *Institute of Radiophysics and Electronics of the NAS,*
Department of Radiospectroscopy *September 2012–May 2013*

- Conducted experimental investigations on Anderson localization in one-dimensional microwave photonic crystals.
- Explored the formation of defect modes in photonic crystals by inducing local deviations from periodicity, both through experimental observation and computational analysis.

Teaching Experience

Teaching Assistant (Lab Instructor)

○ University Physics II: Electricity and Magnetism (PHYS 208)
Virginia Commonwealth University *Fall 2020 – Spring 2023, Spring 2024*

- Conducted weekly laboratory sessions featuring hands-on demonstrations and theoretical insights.
- Guided discussions in recitation classes, offering students strategies for effective problem-solving.
- Edited laboratory manual for the course, ensuring comprehensive support for students' practical learning.

Lecturer/Lab Instructor

○ Experimental Skills for Physicists (PHYS 491)
Virginia Commonwealth University *Fall 2023*

- **Independently developed** and delivered lectures, laboratory sessions, assignments, and provided thorough feedback to students. Topics covered: linear and nonlinear electronic circuits, Fourier analysis, modulation and demodulation, filtering, and fundamentals of scientific programming.

Laboratory Assistant

○ Experimental Skills for Physics (PHYS 491)
Virginia Commonwealth University *Summer 2023*

- **Created a series of teaching laboratories** specifically tailored for upper-level undergraduate students. Topics covered: linear and nonlinear electronic circuits, filters, AM modulation, feedback and OpAmp circuits.

Teaching Assistant

○ Modern Physics (PHYS 320)
Virginia Commonwealth University *Spring 2019 – Spring 2023*

- Offered guidance and feedback to students regarding their weekly laboratory assignments, aiding their progress and understanding.
- Compiled a comprehensive solution manual for the course.

Substituting Lecturer

○ Semiconductor Nanostructures (**Graduate Course**, PHYS 560)
Virginia Commonwealth University *Fall 2022*

- Conducted lectures on optical properties of semiconductor nanostructures.

Teaching Assistant (Lab Instructor)

- University Physics I: Mechanics (PHYS 207)
  Virginia Commonwealth University *Spring 2017 – Spring 2019*
  - Conducted weekly laboratory classes, delivering physical demonstrations and theoretical overviews to engineering and science students.
  - Engaged in individualized problem-solving discussions, addressing physics challenges in one-to-one sessions.
  - Guided discussions in recitation classes and provided instruction on effective problem-solving strategies to students.

Conferences and Talks

- M. Vorobiov "Spectroscopy of beryllium-related defects in gallium nitride", invited talk at the National Institute of Standards and Technology (**NIST**), Gaithersburg MD, USA (April 2024)
- M. Vorobiov, O. Andrieiev, D. O. Demchenko, and M. A. Reshchikov "Nitrogen vacancy - acceptor complexes in GaN" presented at the *31st International Conference on Defects in Semiconductors* (online)(July 2021)
- M. Vorobiov "Making physics classes inclusive" presented at *Modernzation of Education in the Context of Multiculturalism and Inclusivity Conference* (online)(April 2021)
- M. Vorobiov and O. Andrieiev "Shallow state of beryllium acceptor in GaN" presented at the *International Symposium on Clusters and Nanomaterials, Richmond VA, USA (November 2019)*
- M. Vorobiov "Quantum Mechanics: Mathematical Structure and Applications", talk at the *Department of Mathematics and Applied Mathematics, VCU, Richmond VA, USA (March 2019)*

Publications

[1] D. O. Demchenko, M. **Vorobiov**, O. Andrieiev, B. McEwen, and M. A. Reshchikov, "Physics of acceptors in GaN: Koopmans' tuned HSE hybrid functional and experiment," **Submitted** (March, 2024), 10.48550/arXiv.2404.06603.

[2] M. A. Reshchikov, O. Andrieiev, M. **Vorobiov**, D. O. Demchenko, B. McEwen, and F. Shahedipour-Sandvik, "Photoluminescence from Cd_{Ga} and Hg_{Ga} acceptors in GaN," **Accepted to the J. Appl. Phys.** (March, 2024).

[3] M. **Vorobiov**, O. Andrieiev, D. O. Demchenko, and M. A. Reshchikov, "Nitrogen vacancy–acceptor complexes in gallium nitride," J. Appl. Phys. **135**, 155701 (2024).

[4] M. A. Reshchikov, M. **Vorobiov**, O. Andrieiev, D. O. Demchenko, B. McEwen, and F. Shahedipour-Sandvik, "Dual nature of the Be_{Ga} acceptor in GaN: Evidence from photoluminescence," Phys. Rev. B **108**, 075202 (2023).

[5] M. A. Reshchikov, O. Andrieiev, M. **Vorobiov**, D. O. Demchenko, B. McEwen, and F. Shahedipour-Sandvik, "Photoluminescence from GaN implanted with Be and F," Phys. Stat. Sol. (b) (2023).

[6] M. A. Reshchikov, M. **Vorobiov**, O. Andrieiev, B. McEwen, E. Rocco, V. Meyers, D. O. Demchenko, and F. Shahedipour-Sandvik, "Photoluminescence from Be-doped GaN grown by metal-organic chemical vapor deposition," Phys. Stat. Sol. (2022).

[7] M. A. Reshchikov, D. O. Demchenko, M. **Vorobiov**, O. Andrieiev, B. McEwen, F. Shahedipour-Sandvik, K. Sierakowski, P. Jaroszynski, and M. Bockowski, "Photoluminescence related to Ca in GaN," Phys. Rev. B **106**, 035206 (2022).

[8] M. A. Reshchikov, O. Andrieiev, M. **Vorobiov**, D. Ye, D. O. Demchenko, K. Sierakowski, M. Bockowski, B. McEwen, V. Meyers, and F. Shahedipour-Sandvik, "Thermal annealing of GaN implanted with Be," J. Appl. Phys. **131**, 125704 (2022).

[9] B. McEwen, M. Reshchikov, E. Rocco, V. Meyers, K. Hogan, O. Andrieiev, M. **Vorobiov**, D. D., and F. Shahedipour-Sandvik, "Toward highly efficient p-doping in iii-nitride optoelectronics: MOCVD growth of Be-doped GaN," in *Gallium Nitride Materials and Devices XVII* (SPIE, 2022) p. PC120010B.

[10] M. A. Reshchikov, D. O. Demchenko, D. Ye, O. Andrieiev, M. **Vorobiov**, K. Grabianska, M. Zajac, P. Nita, M. Iwinska, M. Bockowski, *et al.*, "The effect of annealing on photoluminescence from defects in ammonothermal GaN," J. Appl. Phys. **131**, 035704 (2022).

[11] M. **Vorobiov**, O. Andrieiev, D. O. Demchenko, and M. A. Reshchikov, "Point defects in beryllium-doped GaN," Phys Rev. B **104**, 245203 (2021).

[12] M. A. Reshchikov, O. Andrieiev, M. **Vorobiov**, B. McEwen, F. Shahedipour-Sandvik, D. Ye, and D. O. Demchenko, "Stability of the C_NH_i complex and the blue luminescence band in GaN," Phys. Stat. Sol. (b) **258**, 2100392 (2021).

[13] M. A. Reshchikov, M. **Vorobiov**, K. Grabianska, M. Zajac, M. Iwinska, and M. Bockowski, "Defect-related photoluminescence from ammono GaN," J. Appl. Phys. **129**, 095703 (2021).

[14] D. O. Demchenko, M. **Vorobiov**, O. Andrieiev, T. H. Myers, and M. A. Reshchikov, "Shallow and deep states of beryllium acceptor in GaN: Why photoluminescence experiments do not reveal small polarons for defects in semiconductors," Phys. Rev. Lett. **126**, 027401 (2021).

[15] M. A. Reshchikov, M. **Vorobiov**, O. Andrieiev, K. Ding, N. Izyumskaya, V. Avrutin, A. Usikov, H. Helava, and Y. Makarov, "Determination of the concentration of impurities in GaN from photoluminescence and secondary-ion mass spectrometry," Nat. Sci. Rep. **10**, 1–7 (2020).

[16] M. A. Reshchikov, M. **Vorobiov**, D. O. Demchenko, Ü. Özgür, H. Morkoç, A. Lesnik, M. P. Hoffmann, F. Hörich, A. Dadgar, and A. Strittmatter, "Two charge states of the C_N acceptor in GaN: Evidence from photoluminescence," Phys. Rev. B **98**, 125207 (2018).

Society Memberships and Service

- American Physical Society
- Optical Society of America
- IEEE
- Journal of Applied Physics (Ad-hoc reviewer)
- Journal of Materilas Chemistry C (Ad-hoc reviewer)

Awards

- Cam Satterthwaite Award for excellence in research (VCU, 2024)
- Physics Graduate Academic Award (VCU, 2024)
- VCU Service Award (VCU, 2023)
- Graduate Academic Excellence Award (VCU, 2018)

Notable Projects

- **Cathodoluminescence Setup for Spectroscopy of Wide-Bandgap Materials (Dec. 2023):**
  Built a cathodoluminescence spectroscopy setup for wide-bandgap materials. Designed and implemented a system featuring a cryostat operating at a temperature of 10 K, equipped with an RHEED electron source, and incorporating pumps to achieve an ultra-high vacuum of 1.2×10^{-9} Torr.
- **Photoluminescence Experiment Setup: major update (2022):**

Revamped control software (in Python) for the updated lock-in amplifier, executed recalibration procedures and successfully installed a new cryostat.

- **Research Software Development (2020):**
  Developed a software program (in Python) to manage data acquisition and facilitate semi-automatic processing of time-resolved photoluminescence spectra.
- **Masters Thesis (2018):** *'Photoluminescence from GaN Co-doped with C and Si'*
  Advisor: Michael A. Reshchikov
  For my master's thesis conducted as part of the NSF-funded project (Grant No. DMR-1410125), I played a key role in identifying and characterizing a novel defect-related luminescence band in GaN, referred to as BL_C. This work included determining electron and hole-capture coefficients. It was observed that BL_C exclusively appears in samples with relatively high concentrations of carbon impurity, leading to the dominance of the yellow luminescence band in the spectrum.
  Moreover, through a combination of numerical calculations utilizing a phenomenological rate-equations model and first-principles calculations, strong evidence emerged supporting the hypothesis that the presence of carbon substituting for nitrogen defect, with -/0 and 0/+ transition levels, gives rise to both the yellow and BL_C bands.
- **Photoluminescence Experiment Setup (2017):**
  Built and configured a setup for photoluminescence spectroscopy experiments, incorporating **customized software** (in Python) to enable comprehensive control of the monochromator and lock-in amplification system.
- **Technical Project (2016):** *'Feature extraction method for machine learning applications'*
  Created a distinctive feature extraction method utilizing Krawtchouk moments, followed by dimensionality reduction through cumulant expansion. This method was successfully integrated into image texture recognition software, demonstrating a remarkable 99% recognition capability.
- **Technical Project (2015):** *'Spectroscopy software improvement for UTR-2 radio-telescope'*
  Modified a signal processing architecture for the UTR-2 radio-telescope's (Kharkiv region, Ukraine) spectroscopy software, a key analysis tool for the institute's astronomical departments. Achieved 30% speed increase with the implementation.

Practical Skills

- **Programming languages:** Python, C/C++, LabView, Verilog (basic).
- **Mathematical software:** MatLab, Mathematica
- **Electromagnetics Simulation:** CST Microwave Studio, MEEP (FDTD code).
- **Statistics:** Frequentist and Bayesian with Python, Stochastic Processes.
- **Electronics:** Laboratory Equipment Control, Digital Signal Processing, PCB design (KiCAD), Soldering.
- **Mictrocontrollers and FPGA:** STM32, ATMega; Xilinx Artix7, Spartan 6.
- **Electronic equipment:** Photomultipliers, Avalanche and p-i-n Photodiodes, Lock-in Amplifier, Oscilloscope, Vector Network Analyzer.
- **Optical equipment:** Laboratory Optics, Grating Monochromator (Newport, Horiba), Optical Fibers, Lasers (He-Cd, Nitrogen, Diode).
- **Cryogenic equipment:** Dry Cryocoolers (Sumitomo, 10 K), Vacuum Pumps (Pfeiffer: turbo, fore-vacuum)
- **Materials characterization equipment:** RHEED Electron Source (Staib RH-15), Scanning Electron Microscope, Transmission Electron Microscope, X-ray Diffraction.
- **First-Principles Electronic Structure Codes:** GPAW, VASP.
- **Extra:** CAD (Fusion 360, FreeCAD), 3D Printing (SLA, PLA).

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