Teemu Hakkarainen

Short bio

Teemu Hakkarainen is a Senior Research Fellow at the Institute of Advanced Study of Tampere University and the leader of the semiconductor nanostructure research at Optoelectronics Research Centre. His main expertise is in molecular beam epitaxy of III-V semiconductor nanomaterials, including nanowires, quantum wells, and quantum dots, and their applications in photonics technology. His recent research interests encompass development of 1.5µm quantum light sources based on GaSb quantum dots as well as cryogenic optoelectronic devices for interfacing superconducting quantum processors.

Recent publications related to telecom wavelength quantum dots:

- Johannes Michl, Giora Peniakov, Andreas Pfenning, Joonas Hilska, Abhiroop Chellu, Andreas Bader, Mircea Guina, Sven Höfling, Teemu Hakkarainen, Tobias Huber-Loyola, "Strain-Free GaSb Quantum Dots as Single-Photon Sources in the Telecom S-Band", Advanced Quantum Technologies 6, 2370125 (2023).
- Lucie Leguay, Abhiroop Chellu, Joonas Hilska, Esperanza Luna, Andrei Schliwa, Mircea Guina, Teemu Hakkarainen, "Electronic structure of GaSb/AlGaSb quantum dots formed by filling droplet-etched nanoholes", preprint, arXiv:2308.15418 (2023).
- Abhiroop Chellu, Joonas Hilska, Jussi-Pekka Penttinen, Teemu Hakkarainen, "Highly uniform GaSb quantum dots with indirect–direct bandgap crossover at telecom range" APL Materials 9, 2021.
- Joonas Hilska, Abhiroop Chellu, Teemu Hakkarainen, "Nanohole etching in AlGaSb with gallium droplets", Crystal Growth & Design 21, 1917-1923 (2021.

Title: Telecom wavelength non-classical light sources based on GaSb quantum dots grown by filling droplet-etched nanoholes

Abstract:

Solid-state single and entangled photon emitters linked coherently over long distances with optical fibers enable a new generation of quantum-based communications networks. Currently, epitaxial semiconductor quantum dots (QDs) pave the way as a scalable approach for fabricating deterministic non-classical light sources that can be integrated with other photonic or electronic components in miniaturized form. Here, we present a new quantum material system based on GaSb QDs formed by filling droplet-etched nanoholes [1,2], a technique which has been previously used for the state-of-the-art single- and entangled-photon sources in the GaAs-based materials emitting at wavelengths shorter than 800 nm [3-6]. We show that while the GaSb QDs exhibit high homogeneity and small fine structure splitting similarly to their GaAs counterparts, they also enable single-photon emission in the 3rd telecom window [7] with prospects for extending towards 2µm. These properties make them ideal candidates for quantum photonic applications requiring compatibility with Si-photonics and fiber-based telecom.

[1] J. Hilska et al. Cryst. Growth Des. 21 1917−1923, 2021
[2] A. Chellu et al. APL Materials 9, pp. 051116, 2021
[3] J. Liu et al. Nature Nanotechnology 14, 586 (2019).
[4] D. Huber et al. Nature Communications 8, 15506 (2017).
[5] E. Schoöll, et al. Nano Letters 19, 2404 (2019).
[6] D. Huber et al. Phys. Rev. Lett. 121, 033902 (2018).
[7] J. Michl et al, Adv Quantum Technol. 6, 2300180 (2023).