**Optoelectronic Nanowire Neuron**

Thomas Kjellberg Jensen[1], Joachim Sestoft[2], David Alcer[3], Vidar Flodgren[1], Abhijit Das[1], Rasmus D. Schlosser[2], Thomas Kanne[2], Magnus Borgström[3], Jesper Nygård[2], Anders Mikkelsen[1]
[1] Division of Synchrotron Radiation Research, Department of Physics, and NanoLund, Lund University, Box 118, Lund 221 00, Sweden, [2] Center for Quantum Devices & Nano-science Center, Niels Bohr Institute, University of Copenhagen, 2100 Copenhagen, Denmark, [3] Division of Solid State Physics, Department of Physics, and NanoLund, Lund University, Box 118, Lund 221 00, Sweden

## INTRODUCTION

The swift progress of neuromorphic computing necessitates innovative hardware development for combing diverse materials, low power consumption, and significantly reducing circuit footprint. Here three different semiconductor nanowires are combined into a single optoelectronic artificial neuron.

## METHODS

InP nanowires (p-i-n doped) and InAs nanowires are grown using standard methods, individually placed using a micromanipulator on a substrate containing a field-effect gate structure, and contacted using Electron Beam Lithography. The device is characterized using Optical Beam Induced Current measurements [1], with a $\lambda_0$ = 660 nm laser diode. The assembled device is shown in A).

## RESULTS

B) Selective illumination of the two InP nanowires causes a symmetric offset of the InAs current (at $V_G$=0V), with the sign of the offset depending on which InP nanowire is illuminated. The offset remains constant at various light intensities (orange fields) and decays over time when the illumination is turned off. C) The gate response is sigmoidal as the illumination intensity is swept linearly from zero. The maximum intensity used in C) is lower than the intensities used in B).

## CONCLUSION

The optoelectronic nanowire neuron exhibits excitatory and inhibitory action, as well as a post-excitation memory effect. Together with its sigmoidal response, the device provides the basic functionalities needed for a neuromorphic computing node [2,3].

[1] J. Fast, et al. ACS Applied Energy Materials 2022 5 (6), 7728-7734.

[2] D. Winge, et al. ACS Photonics, vol. 10, pp. 2787_2798, 2020.

[3] D. Winge, et al. Neuromorph. Comput. Eng., vol. 3, no. 034011, 2023.