III-V NANOWIRE BASED NEUROMORPHIC NANOPHOTONIC DEVICES

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Introduction: On-chip optical communication between individual nanostructures have novel applications in e.g. neuromorphic computing. Exploring the potential of neuromorphic nanophotonic computing, by the creation of true nanoscale optical communications circuits is a fundamental question. However, while efficient single nanostructure light emitters and receivers have been realised, on-chip optical communication between individual nanostructures has not.

Methods: We detail how lithographically defined oxide depressions may steer nanowire deposition, allowing for efficient fabrication of many aligned multiwire devices (see Figure 1), each using a broadcasting strategy where one wire directs part of its emission to another. Nanowire performance and communication are evaluated in detail in a variety of experimental setups and supported by theoretical simulations.

Results: We demonstrate optical communication, with variable current response, between individual InP nanowires on a standard Si substrate. Free space communication between wires is clearly demonstrated through detection of light emission, from one nanowire to another along with a range of test measurements on the individual wires. The observed communication efficiency agrees well with theoretical simulations, pointing towards high energy efficiency in nanowire-to-nanowire optical communication.

Conclusions: This experimental demonstration opens up for a range of applications of on-chip nanophotonic circuitry. It lays the foundation for neuron-like nodes constructed from efficient III–V materials being used in optoelectronics-based artificial neural networks [1,2].

References

[1] www.insectneuronano.eu

[2] D.O Winge, et. al , ACS Photon. 7 (2020) 2787