ETH zürich

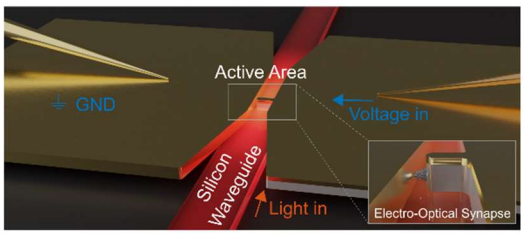
Master / Semester Thesis

Integration and Up-Scaling of Nanoscale Electro-Optical Synapses for Neural Network Applications

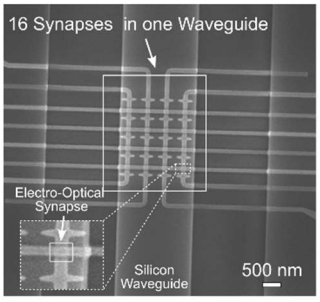
Short Description
The electro-optical (EO) synapse is able to emulate the behavior and functionality of a biological synapse. In order to effictively mimic the computation in the brain, a lot of electro-optical devices need to work in parallel at the same time. In this work, the goal is to integrate several devices onto a single waveguide and characterize their switching properties. More specifically, you will understand electro-optical synapses and their application in hardware suited for deep and spiking neural networks.

The Big Picture
Why can our brain work in such an energy-efficient way? The reason is that the storage, which takes place in the synapses, and the processing, which is done in the neurons, is happening at the same place so that information transfer can be minimized. In modern computers, the exact opposite is the case: the processing unit (CPU) and the memory units are physically separated. As a consequence, deep learning and other machine learning algorithms consume a lot of energy when being executed directly on hardware. The aim is thus to build hardware that is similar to the structure of the human brain, which uses electro-optical synapses as the central storage units.

Current stage: One *planar* single device



Goal: Several ***vertical*** devices integrated onto one single waveguide



Type of Work
We are flexible and the thesis can be tailored to your interests and skills:

- Design optimization and simulation of up-scaled structures using COMSOL
- Testing (Electrical+Optical) of fabricated devices and optimizing/extending the existing measurement routines/protocols using Matlab
- Fabrication and testing of device stacks in the clean room at the BRNC Center of IBM Rüschlikon (*only master thesis students*)

Prerequisites
We are looking for a candidate with a general interest in optics and nano-devices. Basic programming skills and knowledge in Matlab/Python and/or COMSOL are beneficial.

Status: Available
Looking for 1 Master/semester student
Interested candidates please contact: Kevin Portner → kportner@iis.ee.ethz.ch
ETH Supervisor: Dr. Alexandros Emboras → aemboras@ethz.ch

References
1. Portner, K. *et al.* Analog Nanoscale Electro-Optical Synapses for Neuromorphic Computing Applications. *ACS nano, 15(9)*, 14776–14785 (2021).