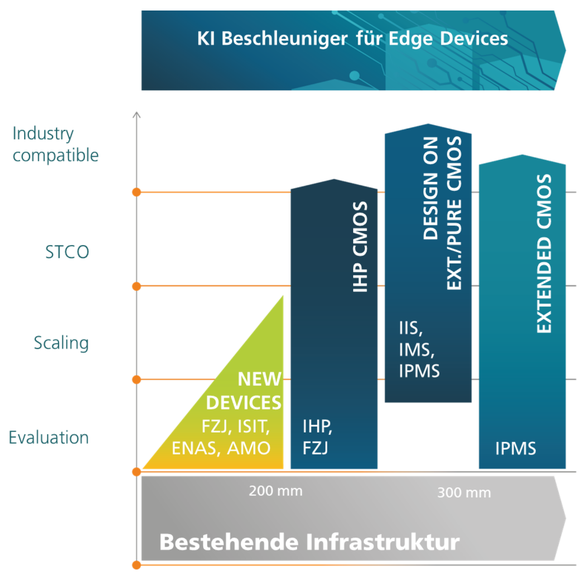
Neuromorphic pilot lines and new material systems for storage technologies

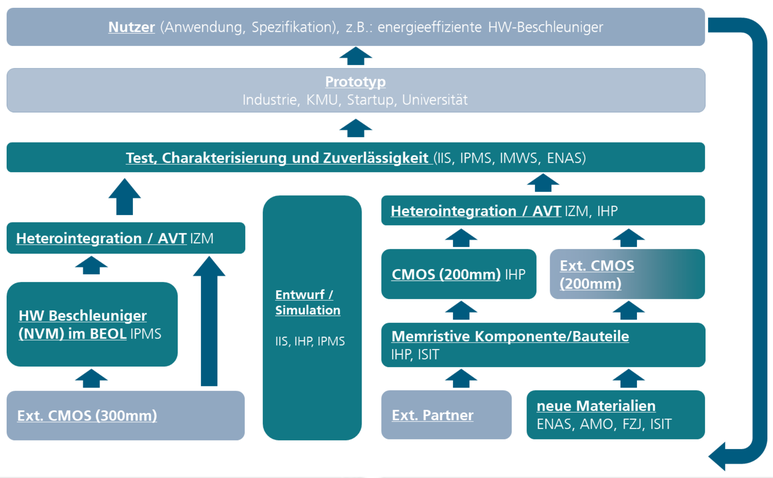
1 Neuromorphic ecosystem in QNC

- Heterogeneous technology landscape bridges the gap between materials science and CMOS production
- Cross-partner cooperation enables application-oriented evaluation of new storage technologies and material systems
- Industry-oriented production environments enable accelerated transfer



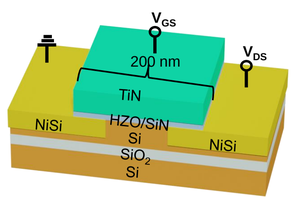
2 Pilot production at wafer level

- Early points of contact with external production environments
- Focusing the partners on different abstraction levels of technology development (material - storage - accelerator)

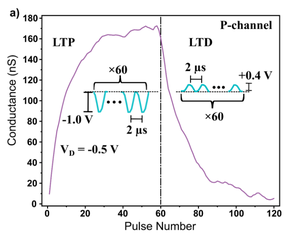


3 New material systems for storage technologies

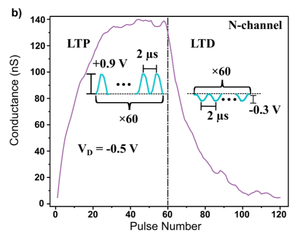
Synapses and Neurons based on Ferroelectric Devices



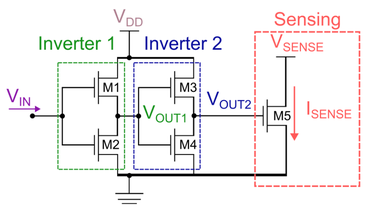
Ferroelectric Schottky FET



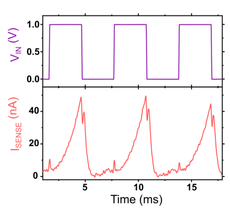
Synapse with p-Channel Fe-SBFET
Holes as neurotransmitters



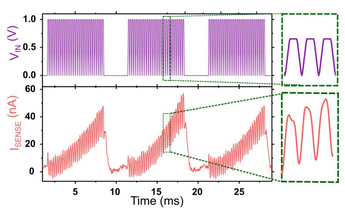
Synapse with n-Channel Fe-SBFET
Electrons as neurotransmitters



5 Fe-SBFETs Thalamus Neuron



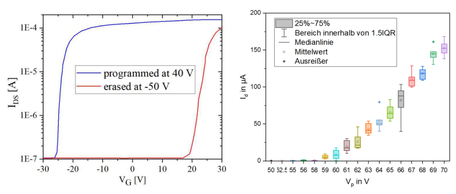
Tonic mode (LiF)



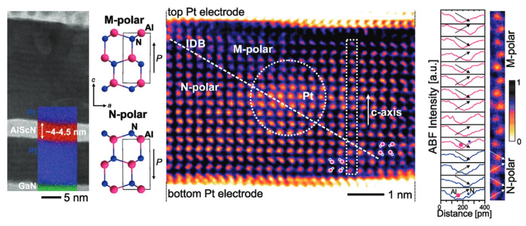
Burst Mode

A. Grenmyr, J. Zhang, K. Moto, Y.-T. Liao, D. Grützmacher, Q.-T. Zhao, *Adv. Funct. Mater., under review*

Integration of ferroelectric AlScN layers in CMOS and III-V technologies

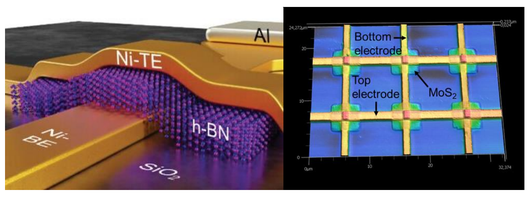


Memory window of AlScN-based BEOL-FeFETs and multilevel statistics for increasing write pulse amplitudes

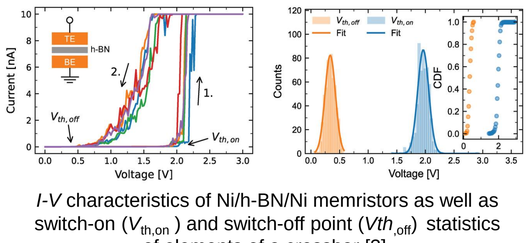


Scaling of the layer thickness of ferroelectric AlScN layers in the sub-10nm range and structural characterization of a domain wall

Micro- and nanoscale memristors based on 2D materials (e.g. MoS2, h-BN)



Schematic representation and implementation of a boron nitride memristor in a crossbar with nickel electrodes [3].

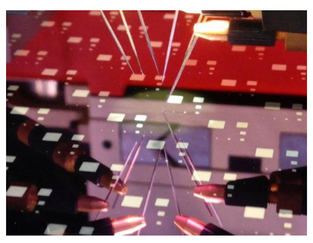


I-V characteristics of Ni/h-BN/Ni memristors as well as switch-on ($V_{th,on}$) and switch-off point ($Vth_{,off}$) statistics of elements of a crossbar [3].

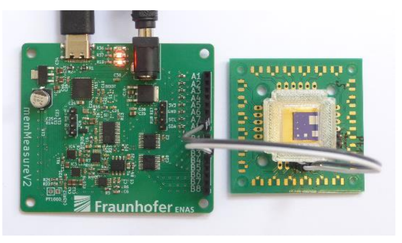
[3] L. Völkel, *et al*, Resistive Switching and Current Conduction Mechanisms in Hexagonal Boron Nitride Threshold Memristors with Nickel Electrodes. Adv. Funct. Mater. 2024, 34, 2300428. doi: 10.1002/adfm.202300428

5 Outlook

- Establishment of a development path from material systems to neuromorphic accelerators
- Harmonization of characterization methods for a uniform benchmark of new, promising approaches
- Increased development speed through the use of synergies



Wafer level test with different Electrode geometries



MemMeasure board for transient characterization memristive components for neuromorphic circuits

For inquiries, email us at experts@module-qnc.de

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