



EU - SOUTH KOREA – Joint Researchers Forum  
on Semiconductors



# 2D Materials for Neuromorphic Computing

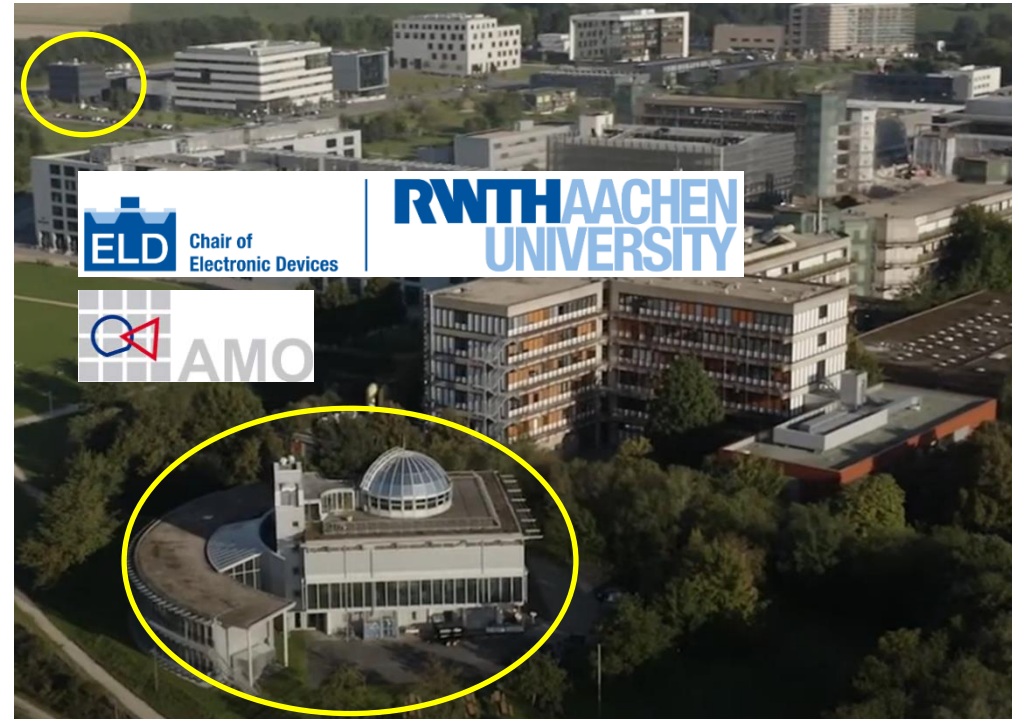
Jimin Lee, PhD candidate  
RWTH Aachen University



 Brussels (Belgium)  
March 25-26, 2024

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Jimin Lee

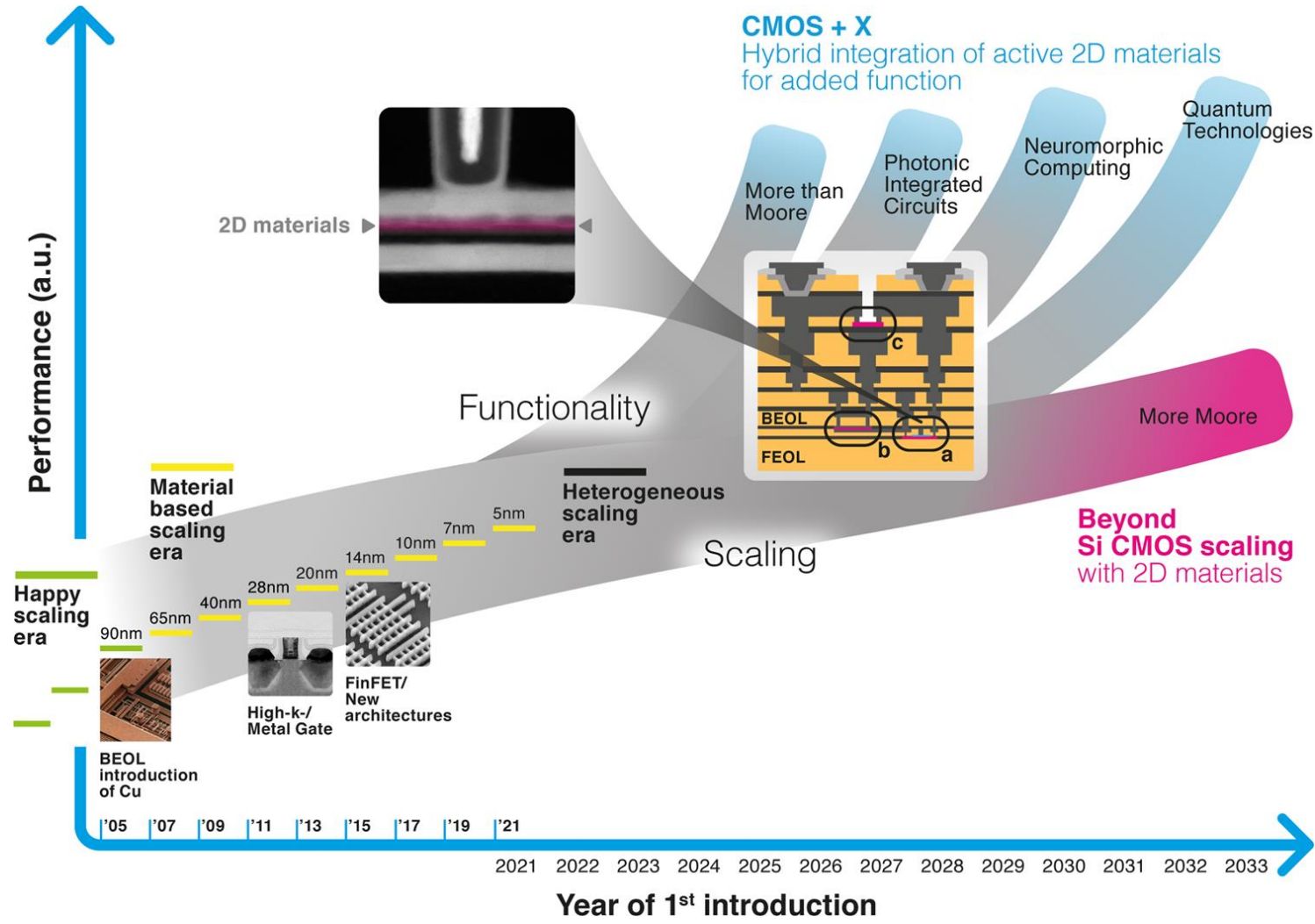


### Prof. Dr.-Ing. Max C. Lemme

- . Head of the Chair of Electronic Devices (ELD)
- . CEO of AMO GmbH
- Dr.-Ing. Jan van den Hurk
- . Deputy Head of Chair



- 2D Materials for Future Microelectronics
- Neuromorphic Computing
- Projects: NEUROTEC II / NeuroSys Cluster
- 2D Material-based Memristors
- Outlook



Lemme, M.C., Akinwande, D., Huyghebaert, C. *et al.* *Nat Commun* 13, 1392 (2022).

# Today: Computers are everywhere

Workstation computers,  
Laptops,  
Tablets



Server

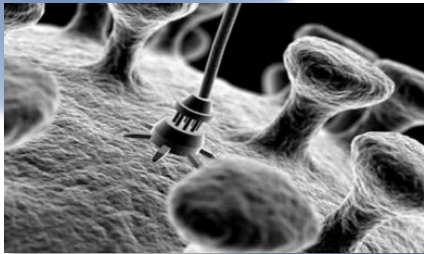


Supercomputer  
& Data center

Smart-  
phones

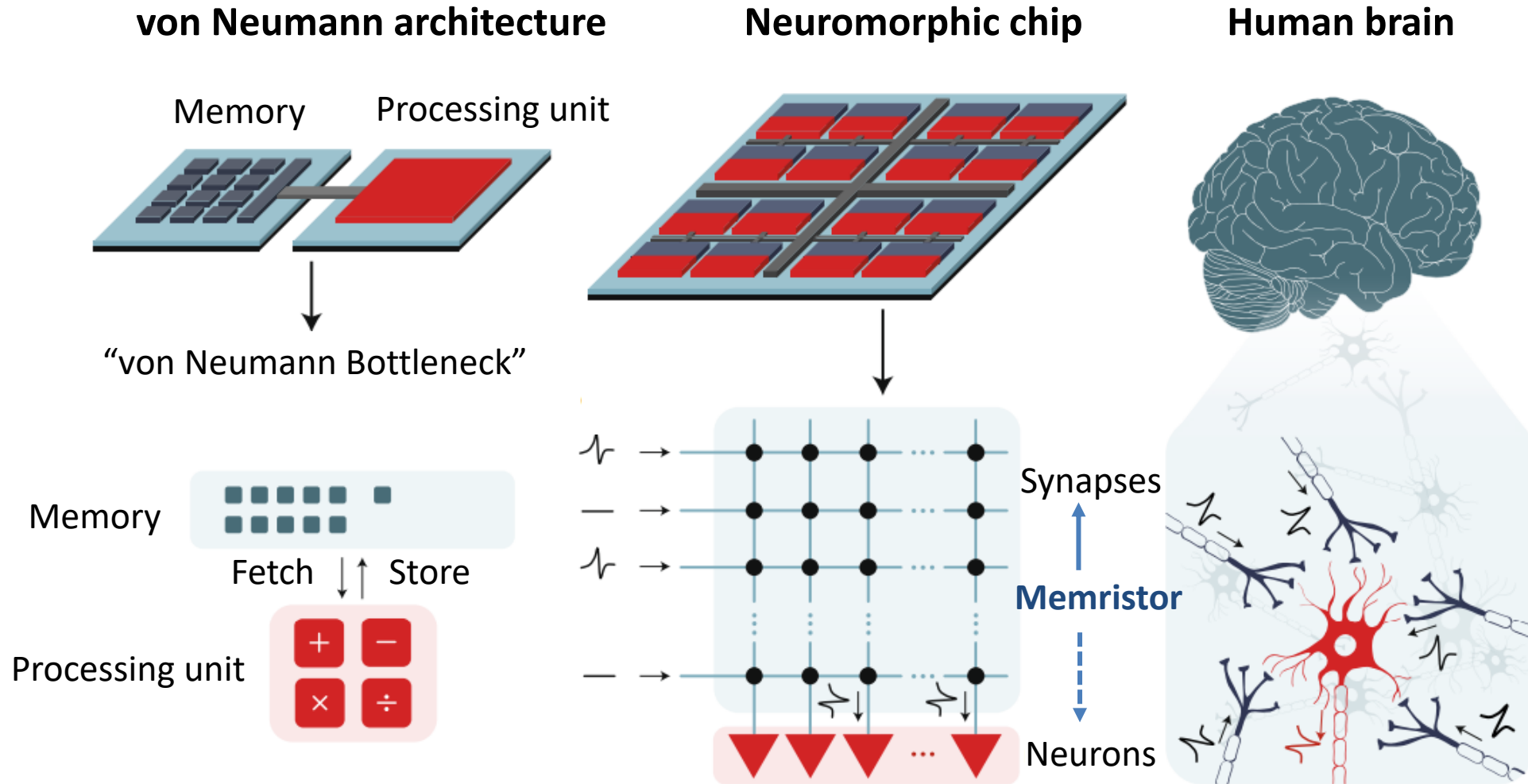


Autonomous  
microsystems,  
Smart dust



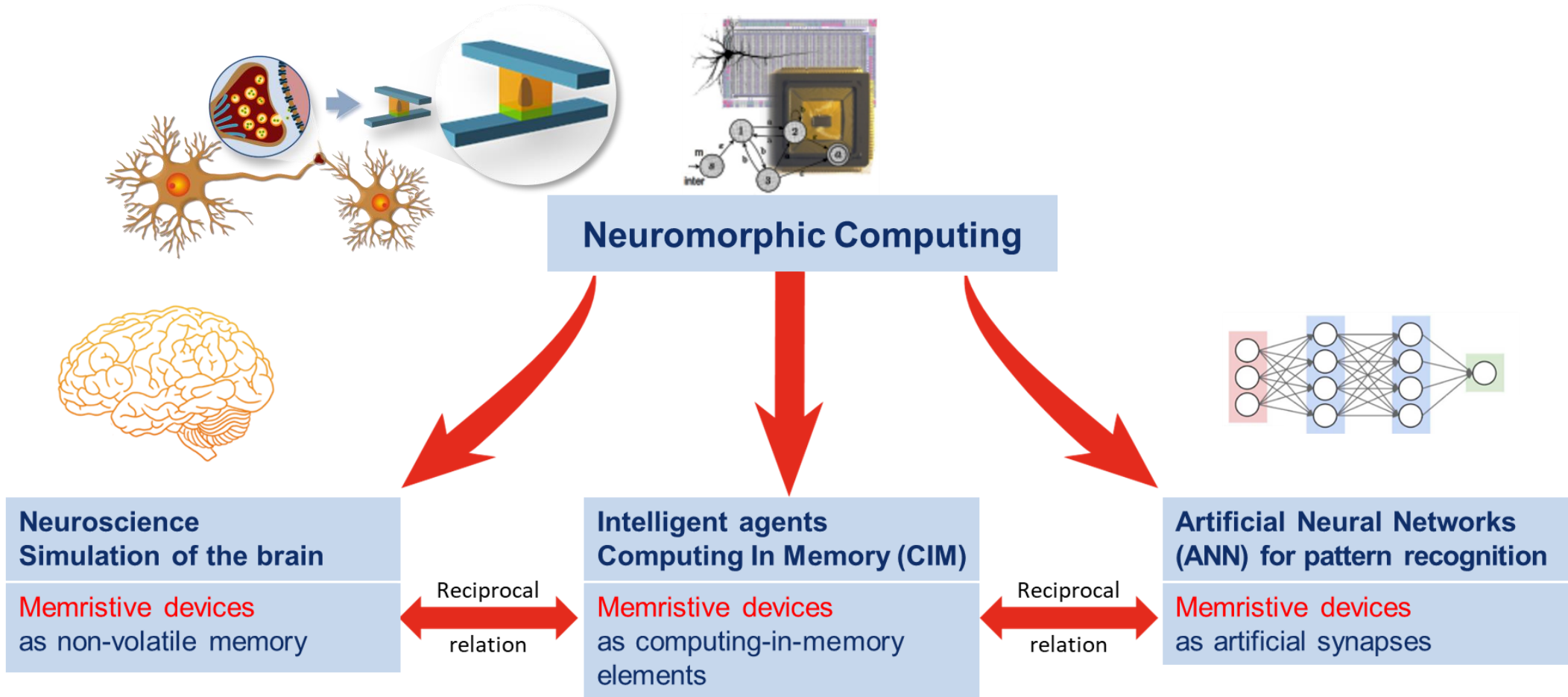
- **Economy**
- **Industry**
- **Science**
- **Entertainment**
- **Healthcare**
- **Transport**
- ...

# Neuromorphic Computing



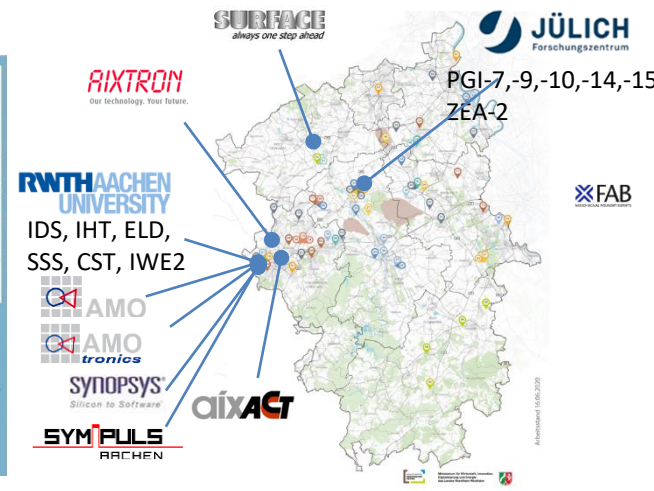
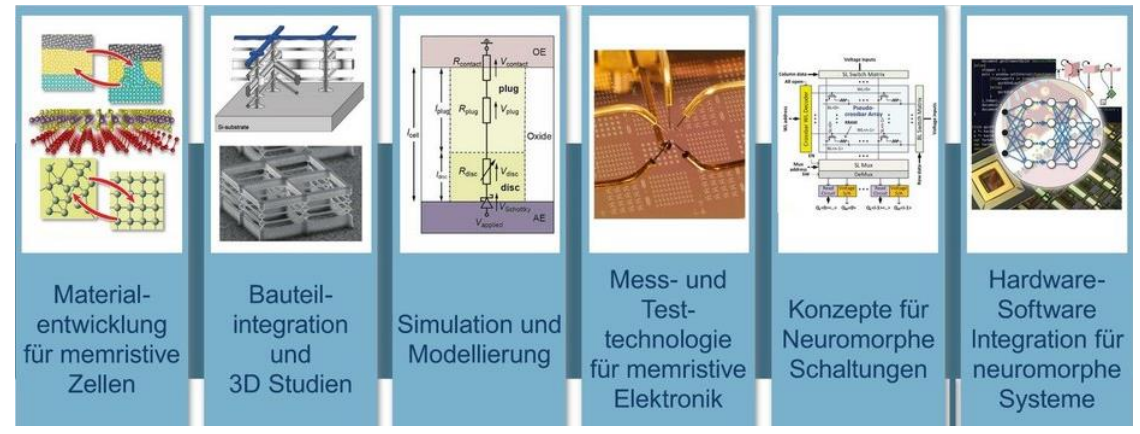
Zhang, W. et al. *Nat Electron* 3, 371-382 (2020).

# Neuromorphic Computing

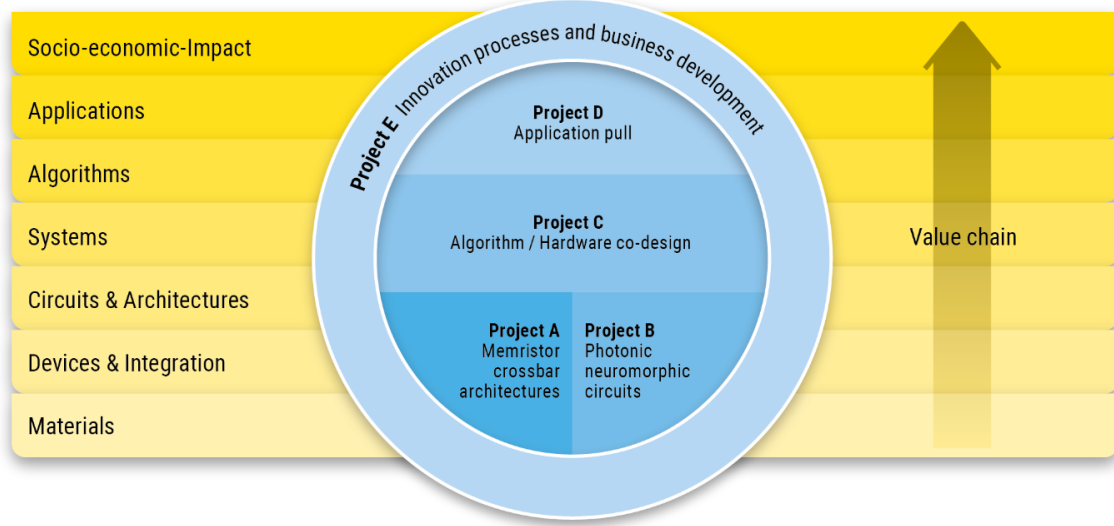




Neuro-inspired Technology of Artificial Intelligence for Future Electronics

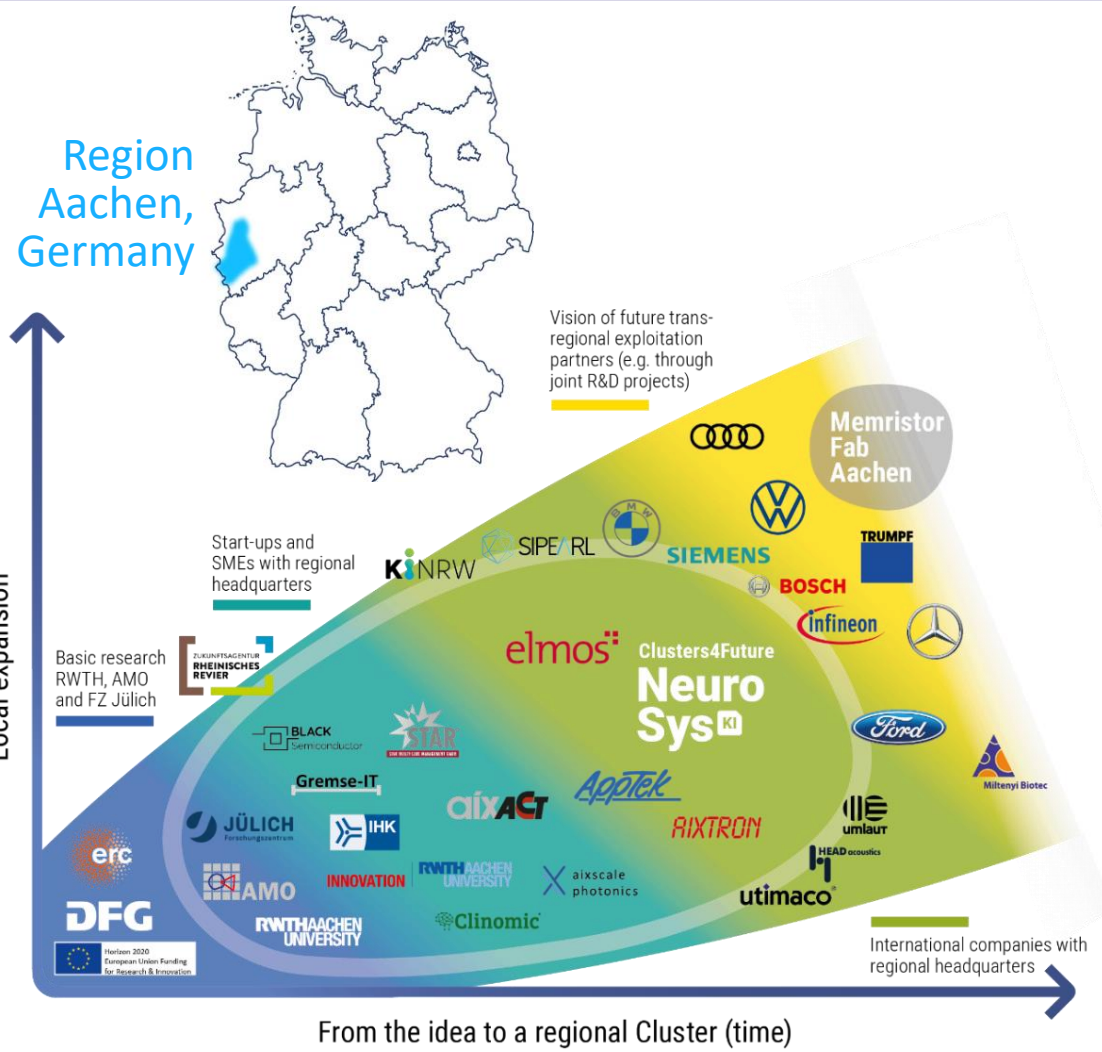
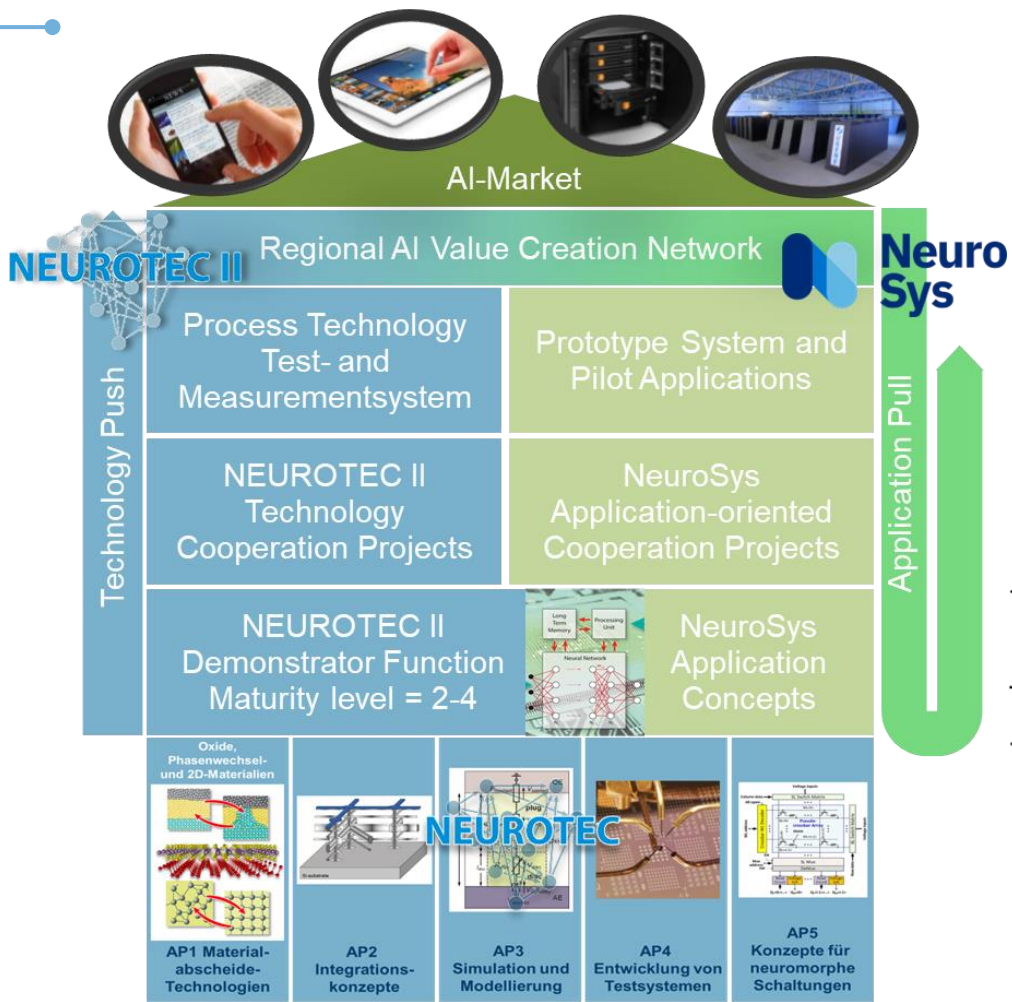


Neuromorphic Hardware for Autonomous Artificial Intelligence Systems



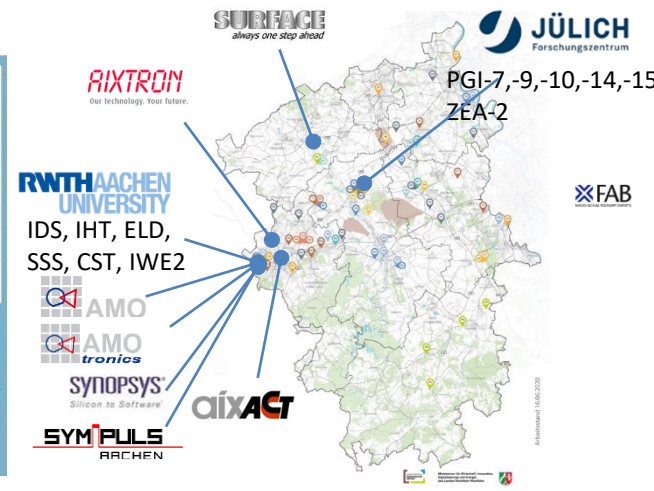
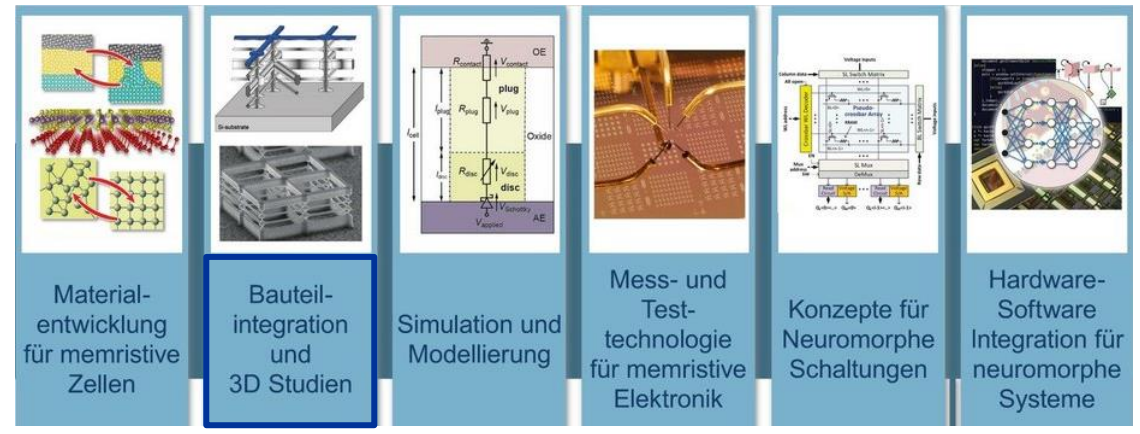


# NEUROTEC II and NeuroSys Cluster

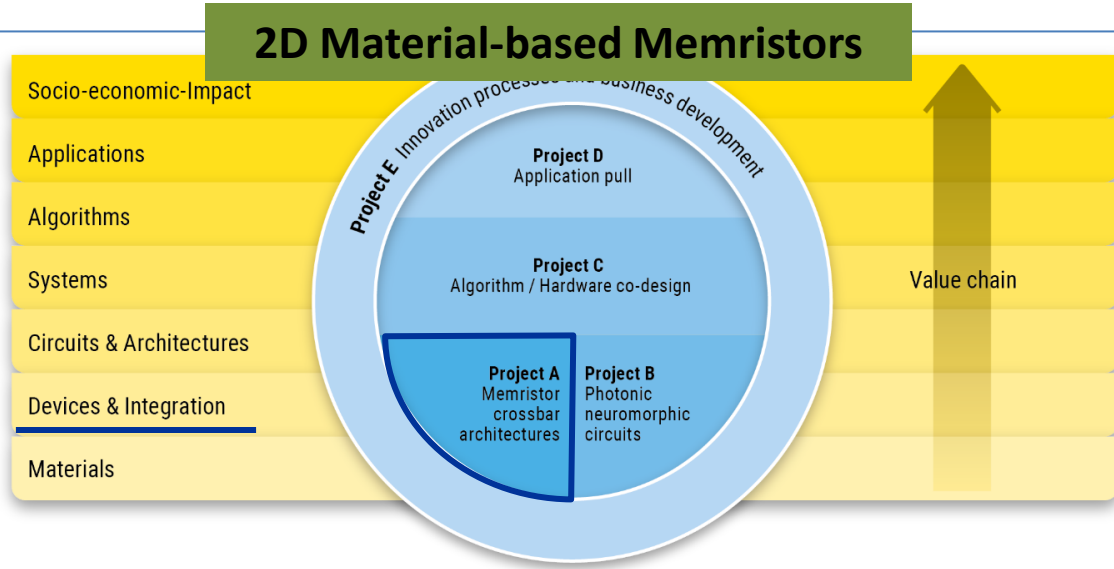




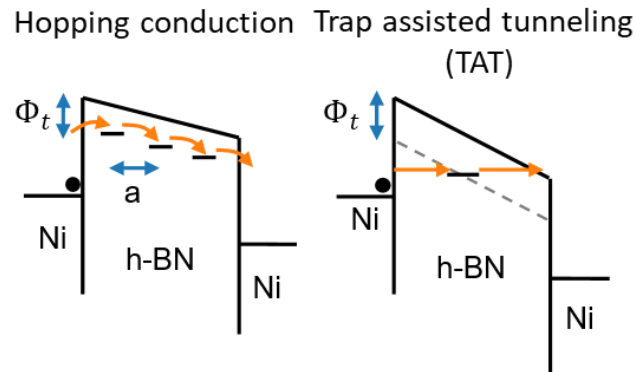
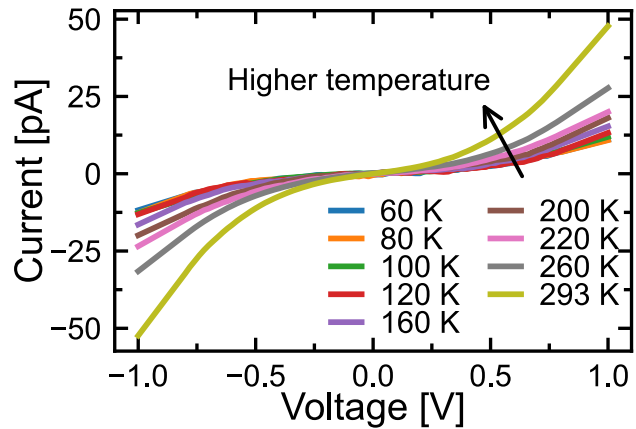
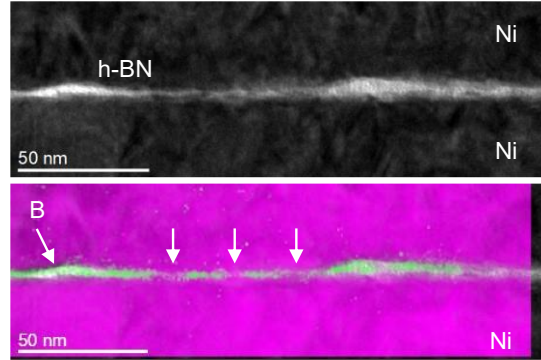
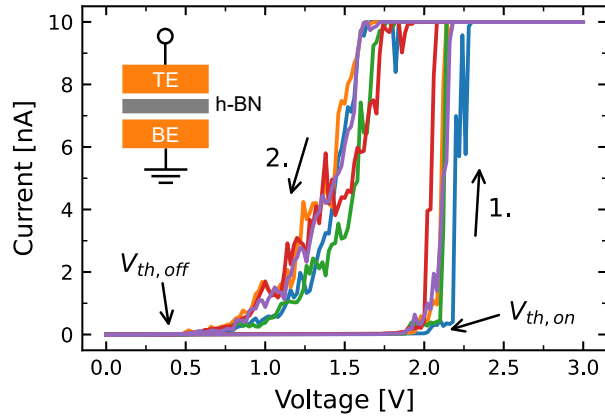
Neuro-inspired Technology of Artificial Intelligence for Future Electronics



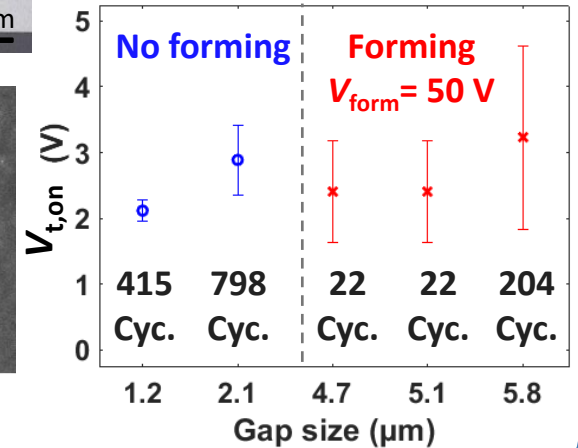
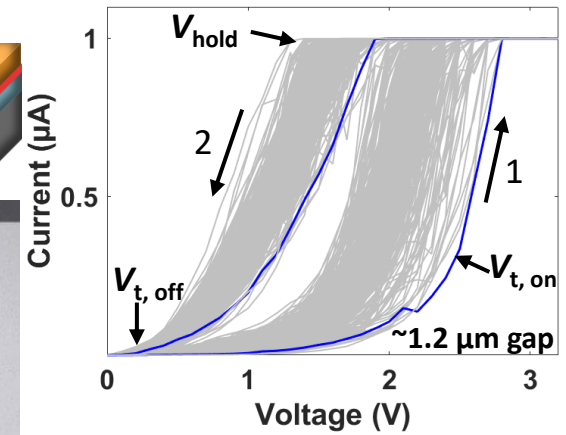
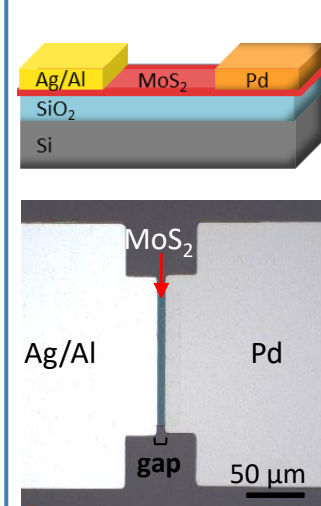
Neuromorphic Hardware for Autonomous Artificial Intelligence Systems



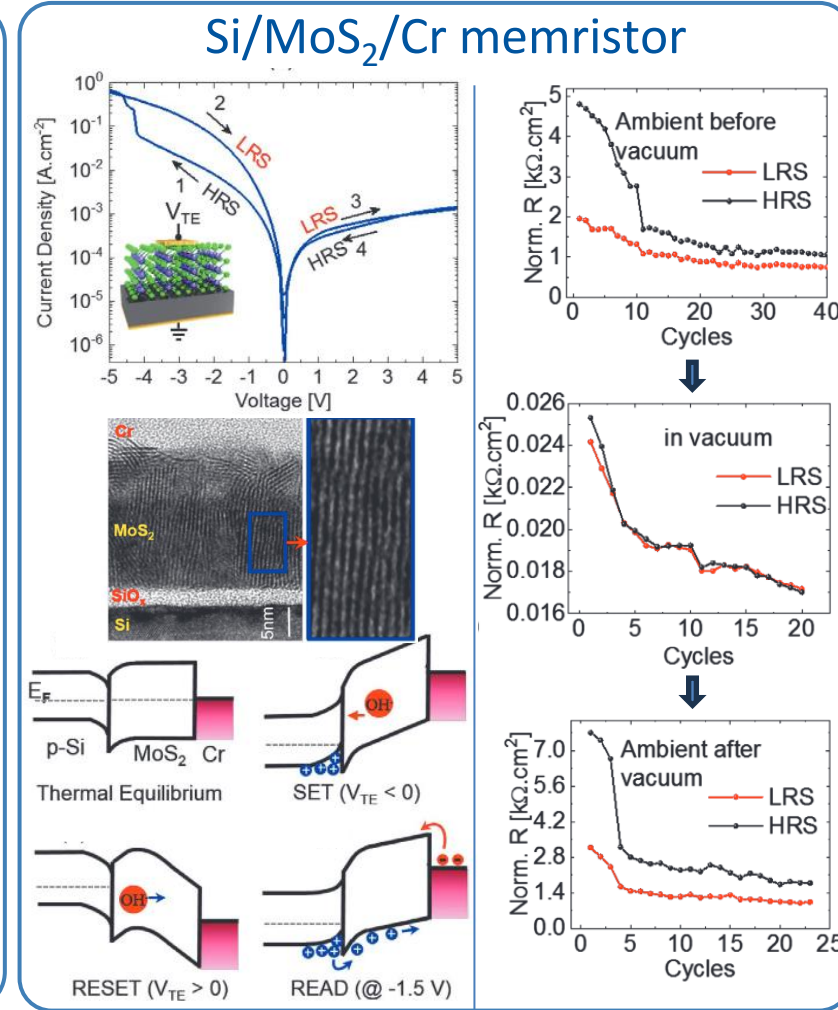
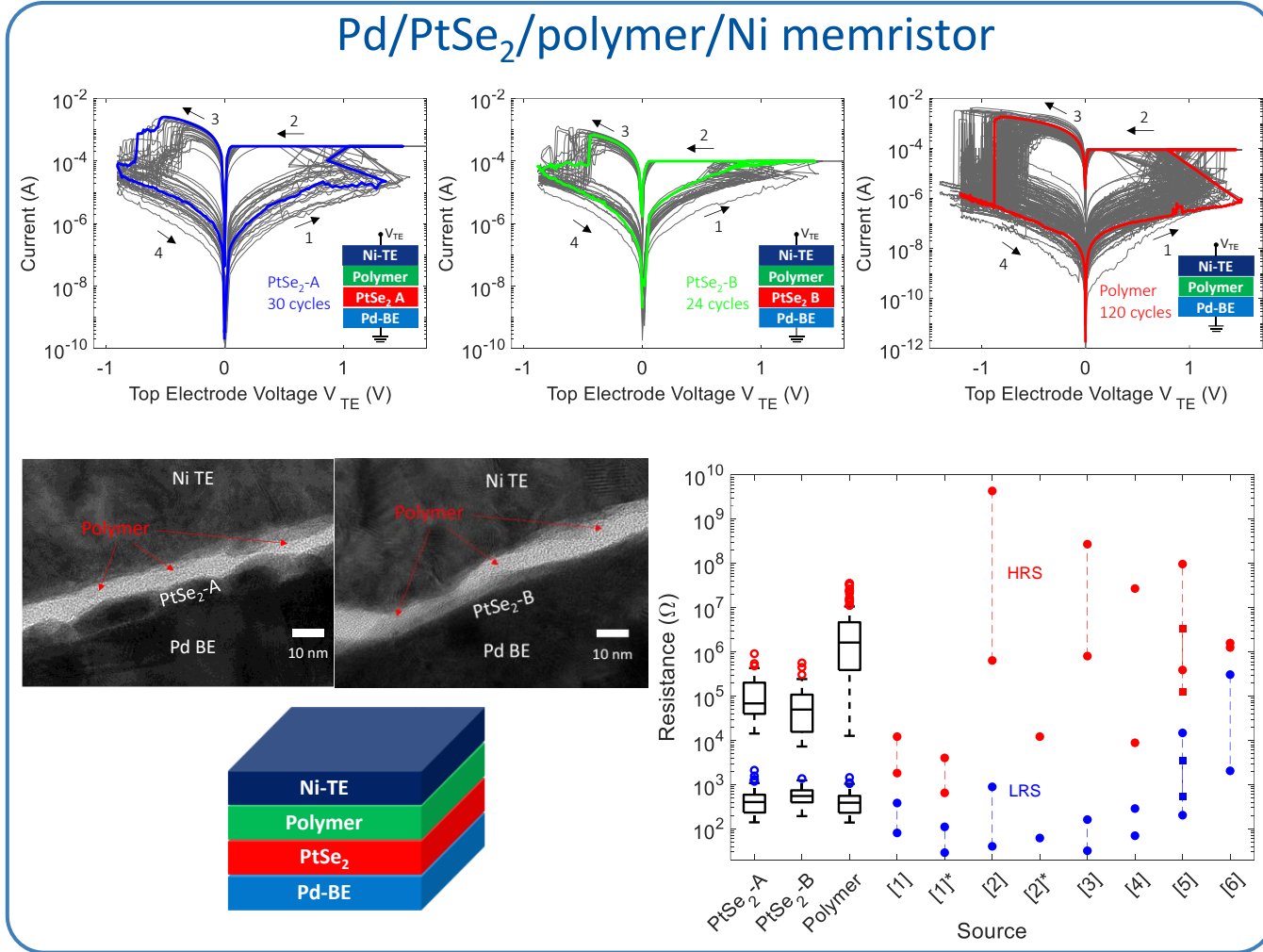
## Ni/h-BN/Ni memristor



## Pd/MoS<sub>2</sub>/Ag/Al memristor



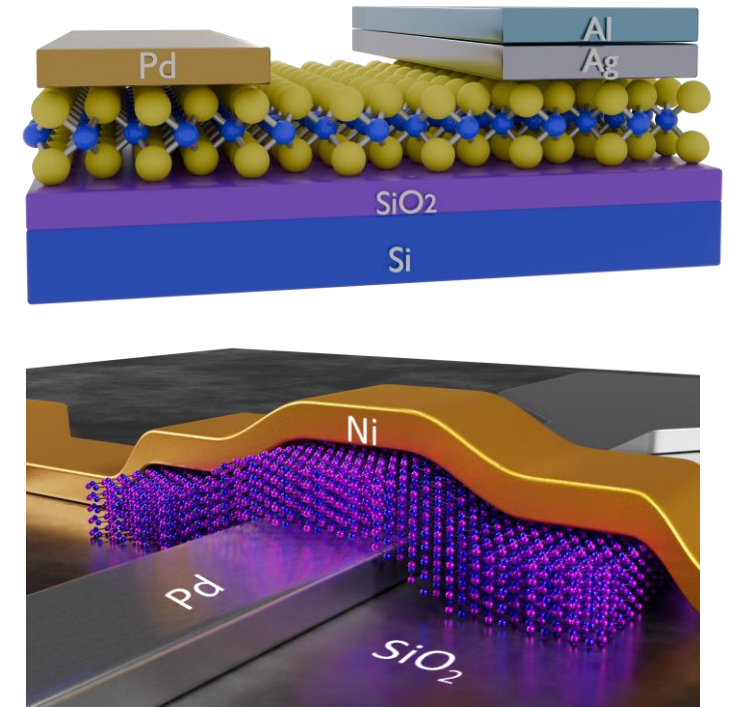
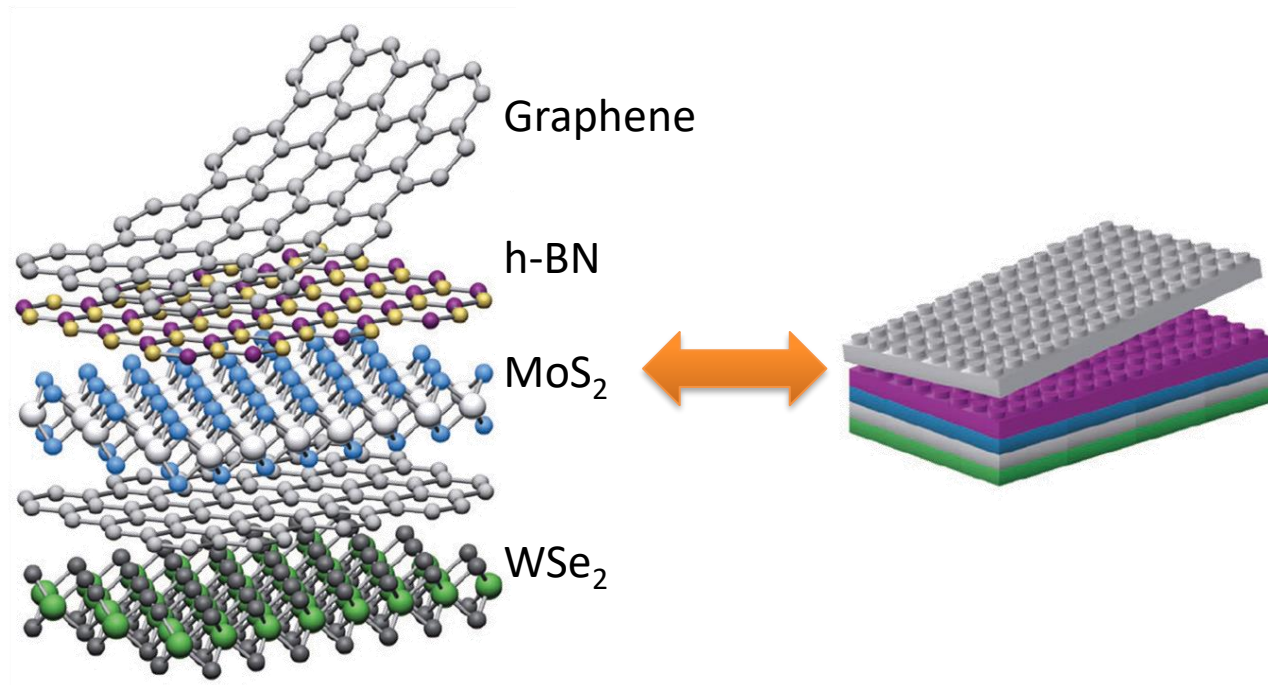
# 2D Material-based Memristors



\*asterisk indicates polymer-free fabrication

[1]Pan, C. *et al. Adv. Funct. Mater.* 27, 1604811 (2017). [2]Ge, R. *et al. Nano Lett.* 18, 434–441 (2018). [3]Wu, X. *et al. Adv. Mater.* 31, 1806790 (2019). [4]Gu, Y. *et al. Adv. Electron. Mater.* 2100515 (2021). [5]Li, Y. *et al. Nat. Electron.* 4, 348–356 (2021). [6]Li, Y. *et al. Adv. Mater.* 34, 2201488 (2022).

- 2D materials as a "modular system"
  - To combine diverse material properties
- Integrating 2D materials into silicon technology
  - To enhance memristor performance



Geim, A. K. & Grigorieva, I. V., *Nature*, 499, 419–425 (2013).



# THANK YOU



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[www.icos-semiconductors.eu](http://www.icos-semiconductors.eu)