ATLANT 3D®

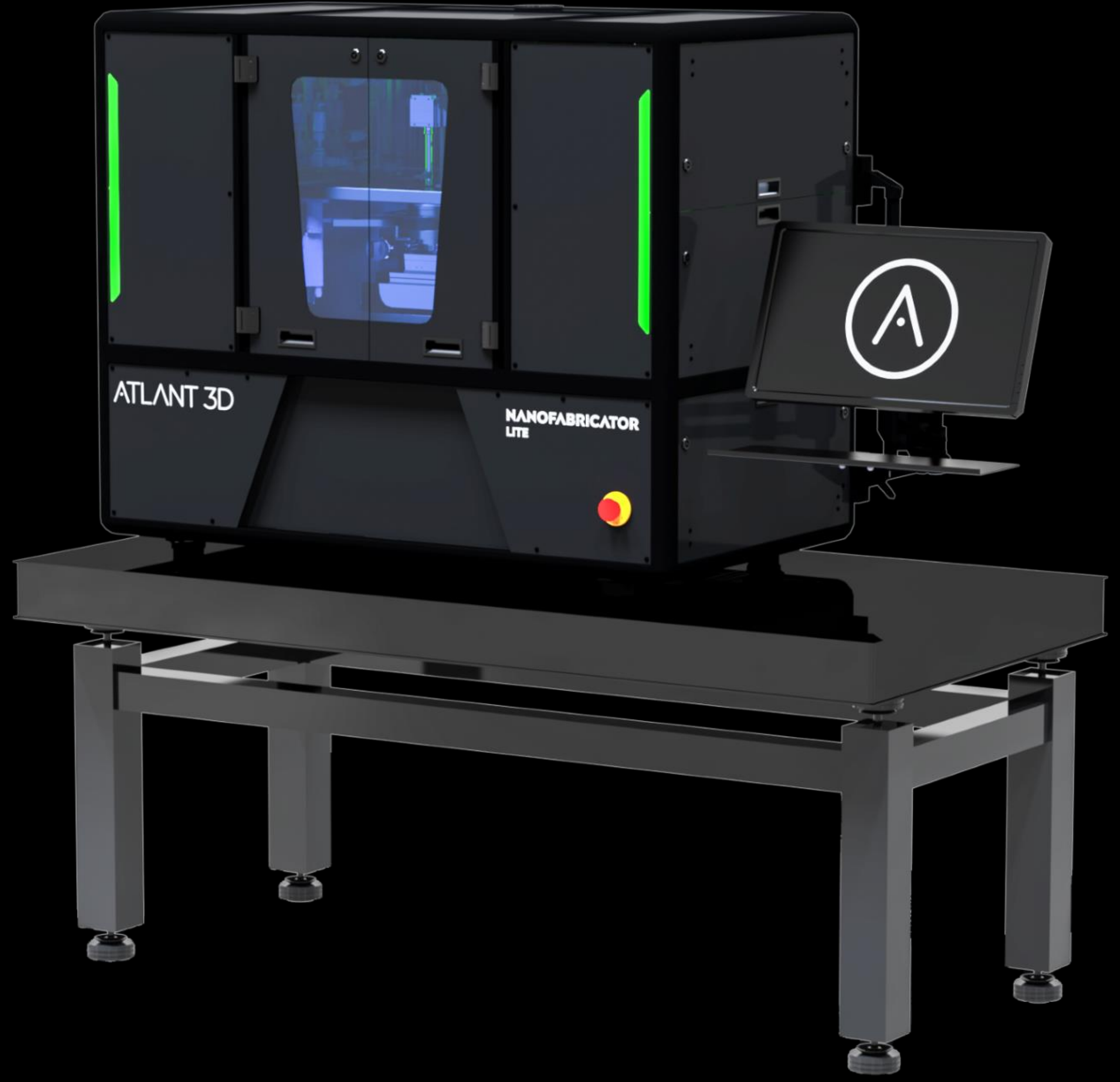
DRIVING ADVANCED TECHNOLOGY INNOVATION. ATOM BY ATOM®.

sales@atlant3d.com

NANOFABRICATOR LITE

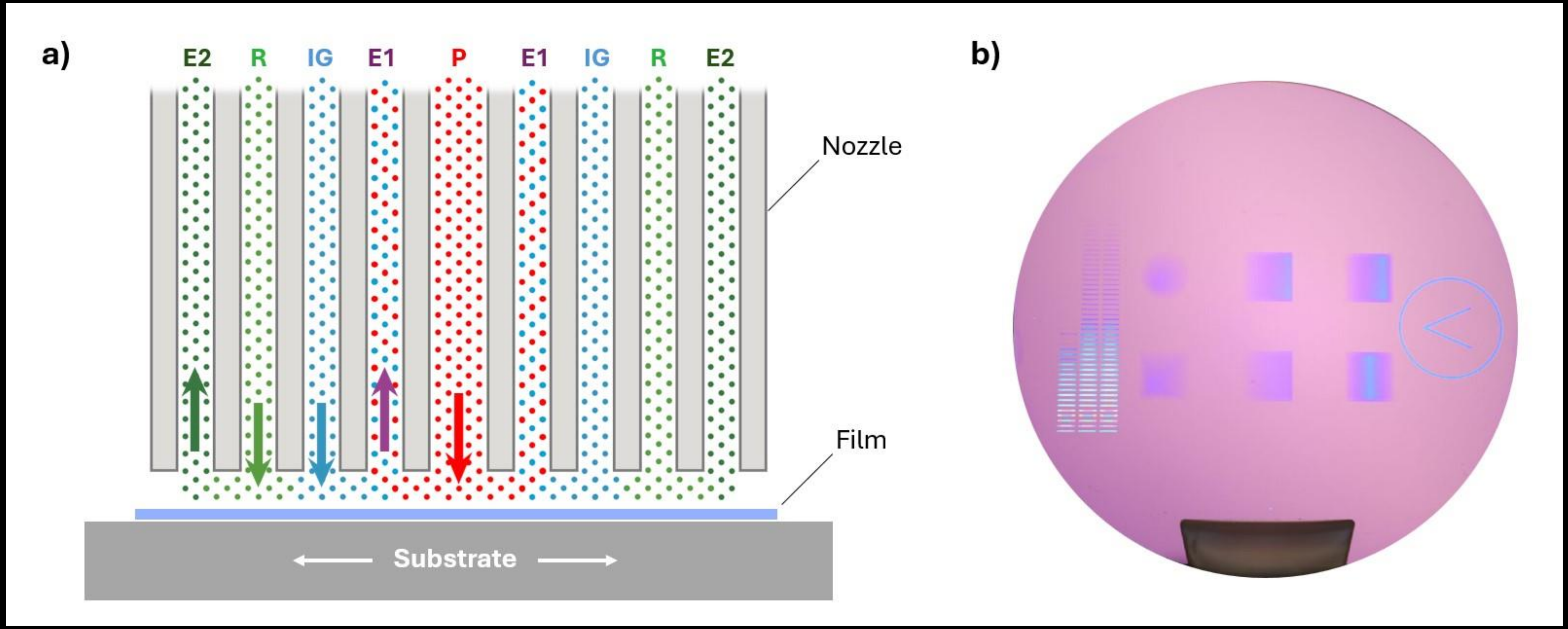
Create knowledge - Atom by Atom.

The path towards Data-Driven Innovation in Material Science.



*Specifications and quotation available upon request

DIRECT ATOMIC LAYER PROCESSING

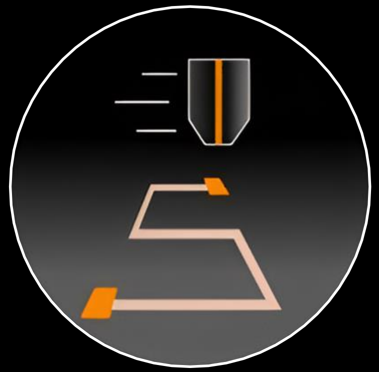


Local deposition of semiconductor-quality devices.

You can continue using your familiar materials or explore new ones, while bypassing the lithography steps to accelerate your discoveries.

LITHOGRAPHY-LESS ATOMIC CONTROL OF MATERIAL GROWTH.

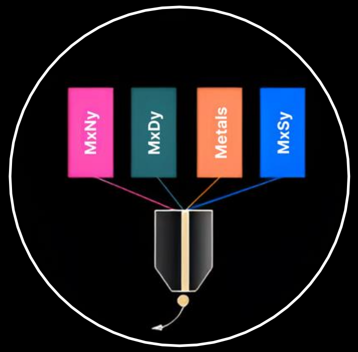
ATLANT 3D®



DIRECT WRITE ATOMIC LAYER DEPOSITION

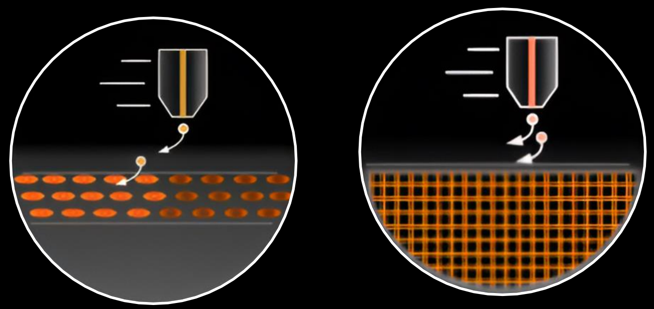
Local growth of materials with ALD quality.

ALD Based process



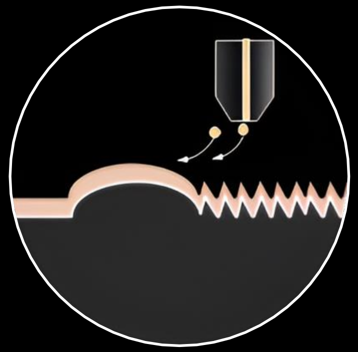
VERSATILE MATERIALS PLATFORM

Choice from 450+ materials.
Currently available: 10 materials can be sequentially processed.



CONTROL OF MATERIAL MICROSTRUCTURE

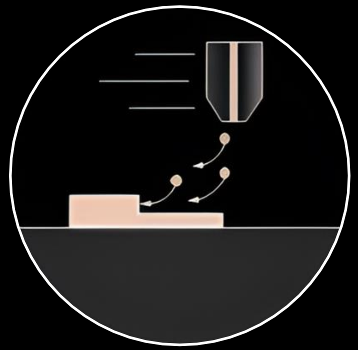
From 6 nm nanoparticles to 1 cm fully dense pinhole-free layers passing by nanoporous layers.



TRUE CONFORMALITY TO SUBSTRATE GEOMETRY

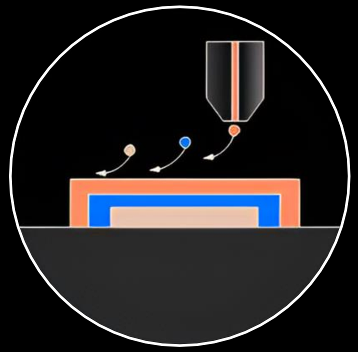
Processing on 90° walls and conformal coatings in cavities and around nanostructures
Currently available: 60 microns depths conformal coatings

The Unfair Advantage



ARBITRARY PARAMETERS GRADIENTS

Multidirectional linear, quadratic and exponential growth over the gradient.
The minimal step height of 0.3 nm with a minimal step width of 2 microns.



MULTIMATERIAL STACK PRINTING

Multiple materials can be deposited sequentially to create multilayer structures such as Bragg mirrors, MIM capacitors or diodes.

ALD MATERIALS TESTED WITH DALP

#	MATERIAL	PREC. A	PREC. B	GROWTH RATE (Å/PASS)	CHARACTERIZATION	USE
1	Pt [(a)]	$(MeCp)PtMe_3$	O_3	0.55 – 1	IE, SEM, EDX, TEM, XRD, XPS, LEIS, R(T)	Mirrors
2	Al_2O_3	TMA	H_2O	0.4	IE, SEM, EDX, TEM, XPS	Dielectric, Barrier, Protection
3	TiO_2 [(a)]	$Ti(O^iPr)_4$	H_2O	0.1 – 0.6	IE, SEM, EDX, TEM, XPS, transistor	Optical, Dielectric, Barrier, Protection
4	ZnO [(b)]	$Zn(dmap)_2$	H_2O	0.7 – 1.5	IE, SEM, EDX, AFM, XRD, XPS, transistor	Optoelectronics
5	CuO	$Zn(dmap)_2$	H_2O	0.06	IE, SEM, EDX, XRD	Photovoltaic
6	Ir	(EtCp)Ir(CHD)	O_3		IE, SEM, EDX, XRD	Conductor
7	IrO_2	(EtCp)Ir(CHD)	O_3		IE, SEM, EDX, XRD	Electrochromic devices
8	HfO_2	$Hf(NMe_2)_4$	H_2O	1.1 – 1.6	IE	Dielectric
9	SnO_2	TDMASn	H2O		Validated	Gas sensors, Transparent electrodes, solar cells
10	V_2O_5	TEMAV	H2O		Validated	thermochromic windows; Electrochromic device
11	WO_3	Wawona™	O_3		Upcoming	anti-bacterial & self-cleaning surfaces
12	MgF_2	Magna™	O_3		Validated	Anti-reflective coatings, UV optics
13	Ga_2O_3	Galai™	O_3		Upcoming	Power Electronics
14	Nb_2O_3	Nautilus2™	O_3		Upcoming	Batteries

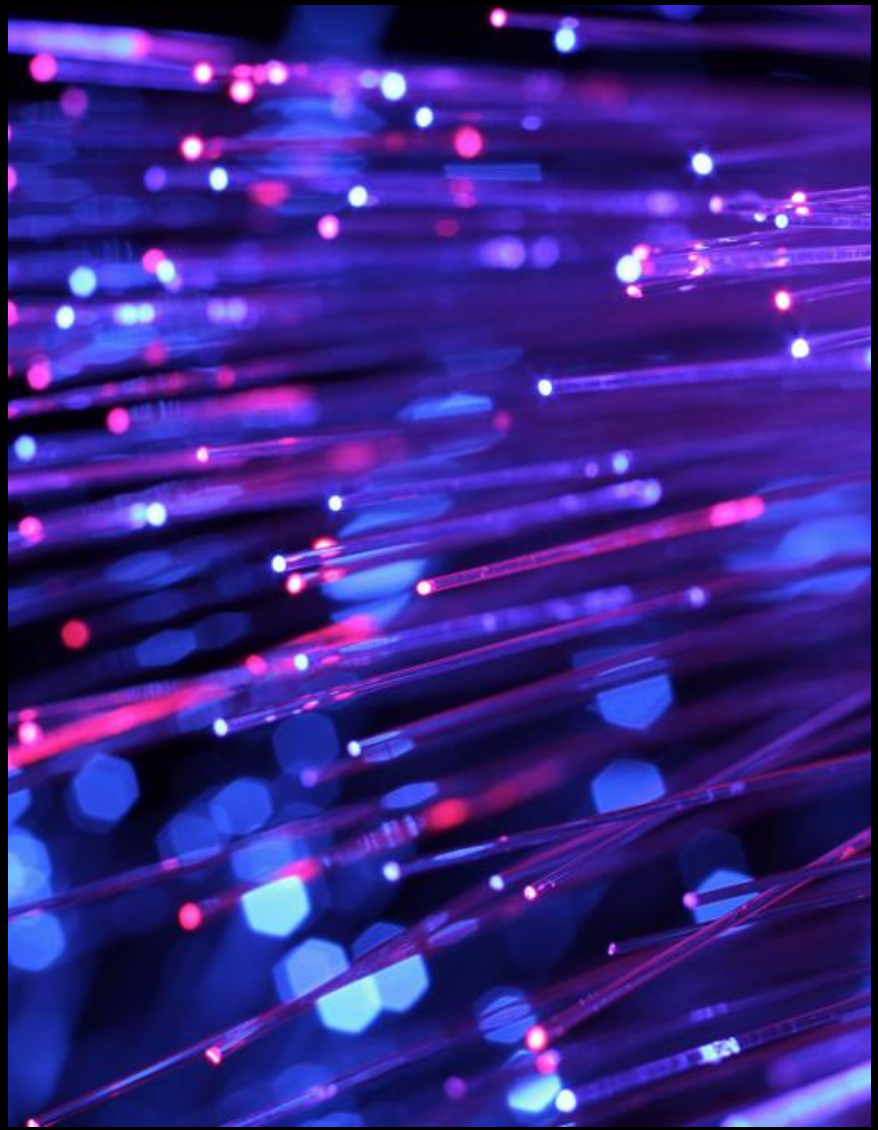
(a) *Small Methods* **2022**, 2101546; (b) *Small* **2023**, 2301774

Super-charge RnD in RnD Intensive Markets

MEMS and SENSORS

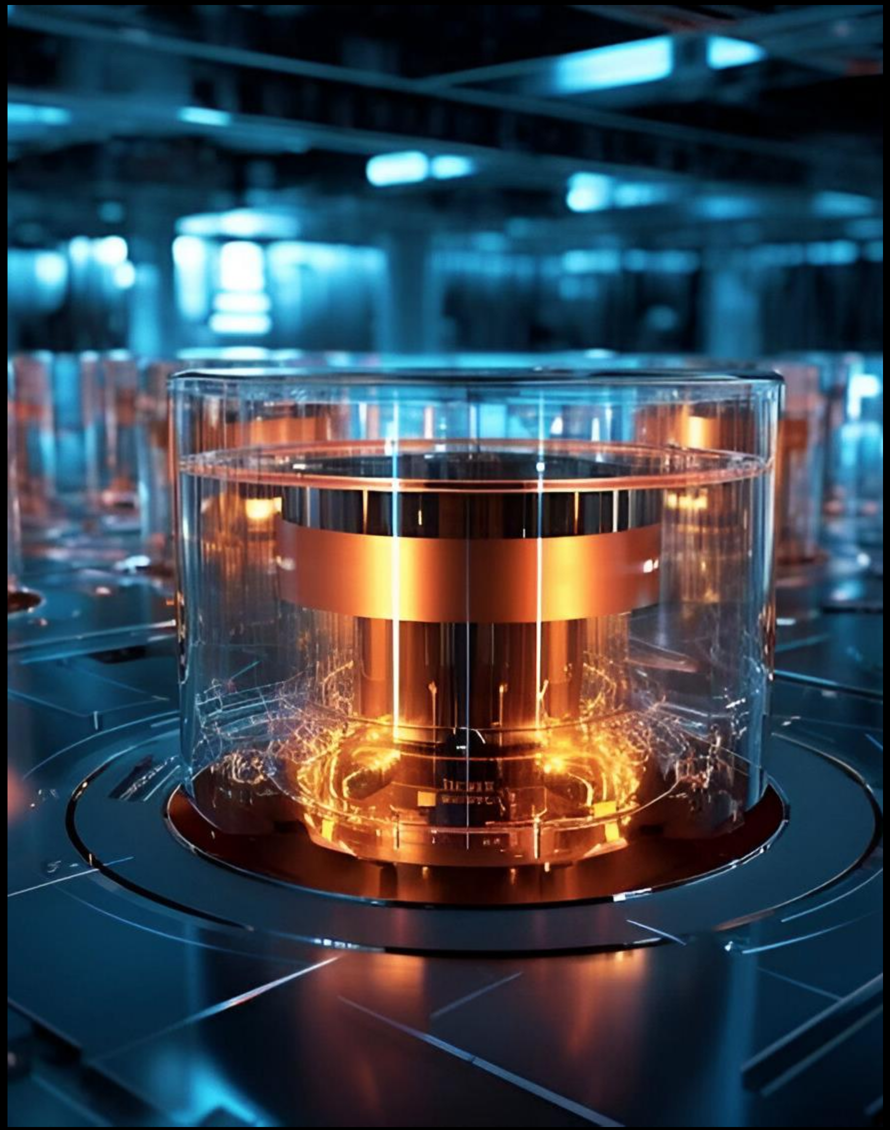
- Local encapsulation and functionalization of MEMS
- Ion and Gas sensors in Microfludics
- New design rules for multifunction neuromorphic arrays

OPTICS & PHOTONICS



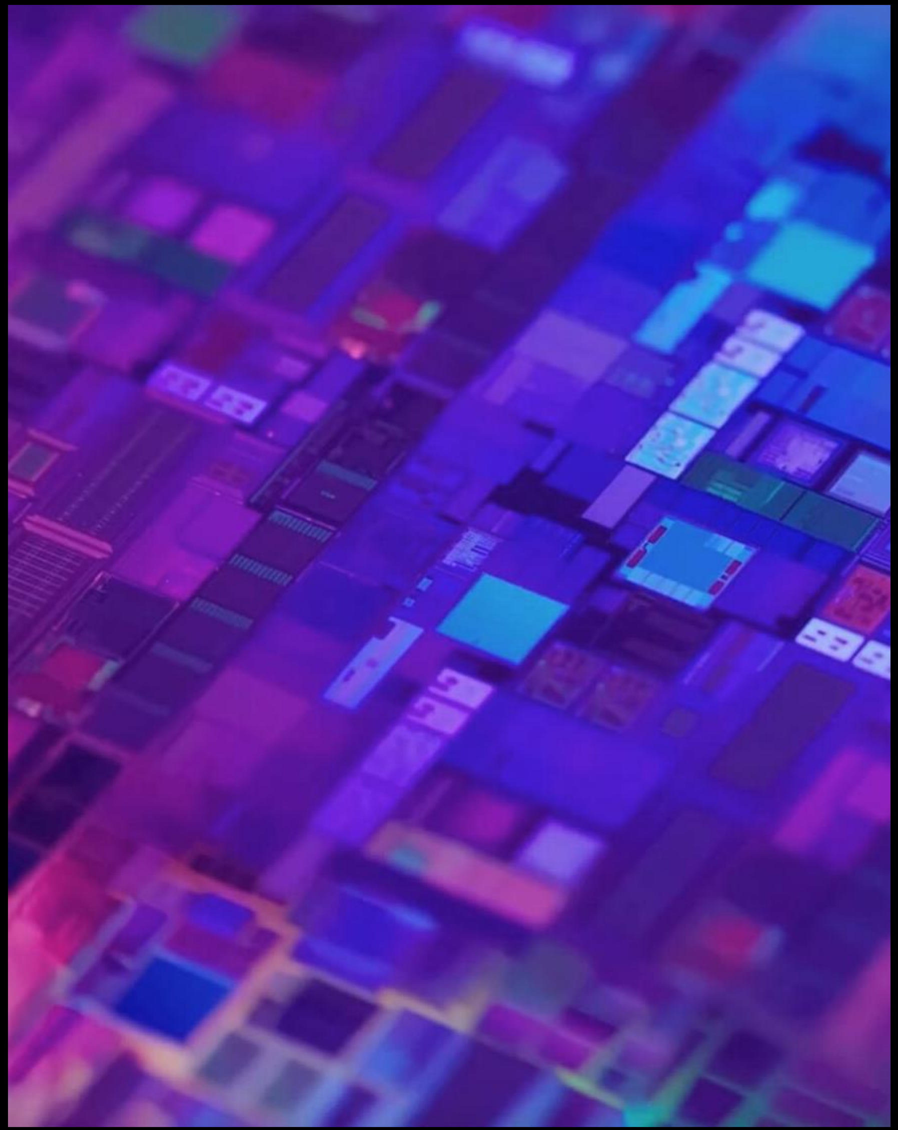
- From Optical coatings to Bragg Mirrors
- Functionalisation of diffractive optics
- Local deposition to boost Photonics Integrated Circuits

FUEL CELLS AND BATTERIES



- Controlled growth of nanoparticles and nanoporous electrodes in microfluidics
- Next generation batteries

MICROELECTRONICS

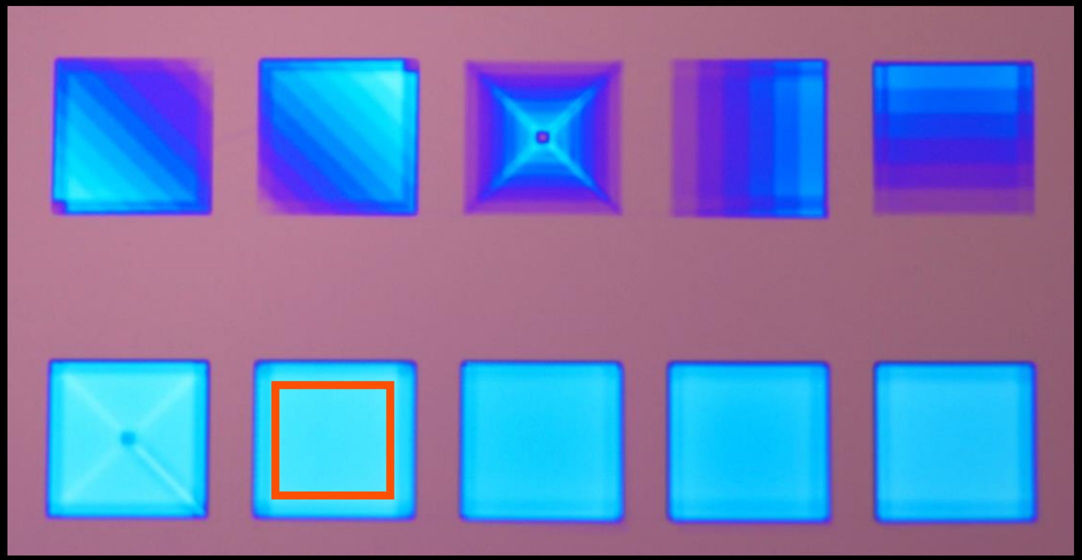


- Vertical Capactiors in Trenches
- MLCC
- Passives printing

THE ORIGIN OF SUPER-CHARGED RnD - Gradients

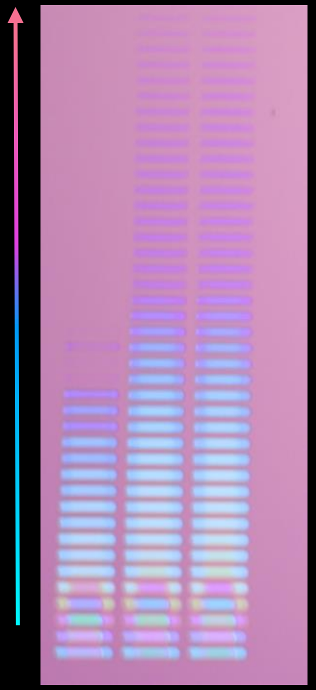
Step layers

Thickness rasters



15 nm

150 nm



Lines for characterization calibration

What is the freedom?

- Geometry
- Materials
- Thickness
- Composition
- Microstructure
- Step density
- Raster density

Discover new process steps and Optimize material stacks:

- Integrate with standard processes: Electroplating, Etching,
- Locally functionalise: Encapsulation, Nanoparticles deposition,
- Innovative devices: Material gradients
- Novel integration paths: Vertical devices, vertical interconnects, ..

Creating Data-Rich Gradients for Next-Gen Device Design

MULTI-ORDER COMPLEXITY DEVICES

Resistor RC circuit Spring

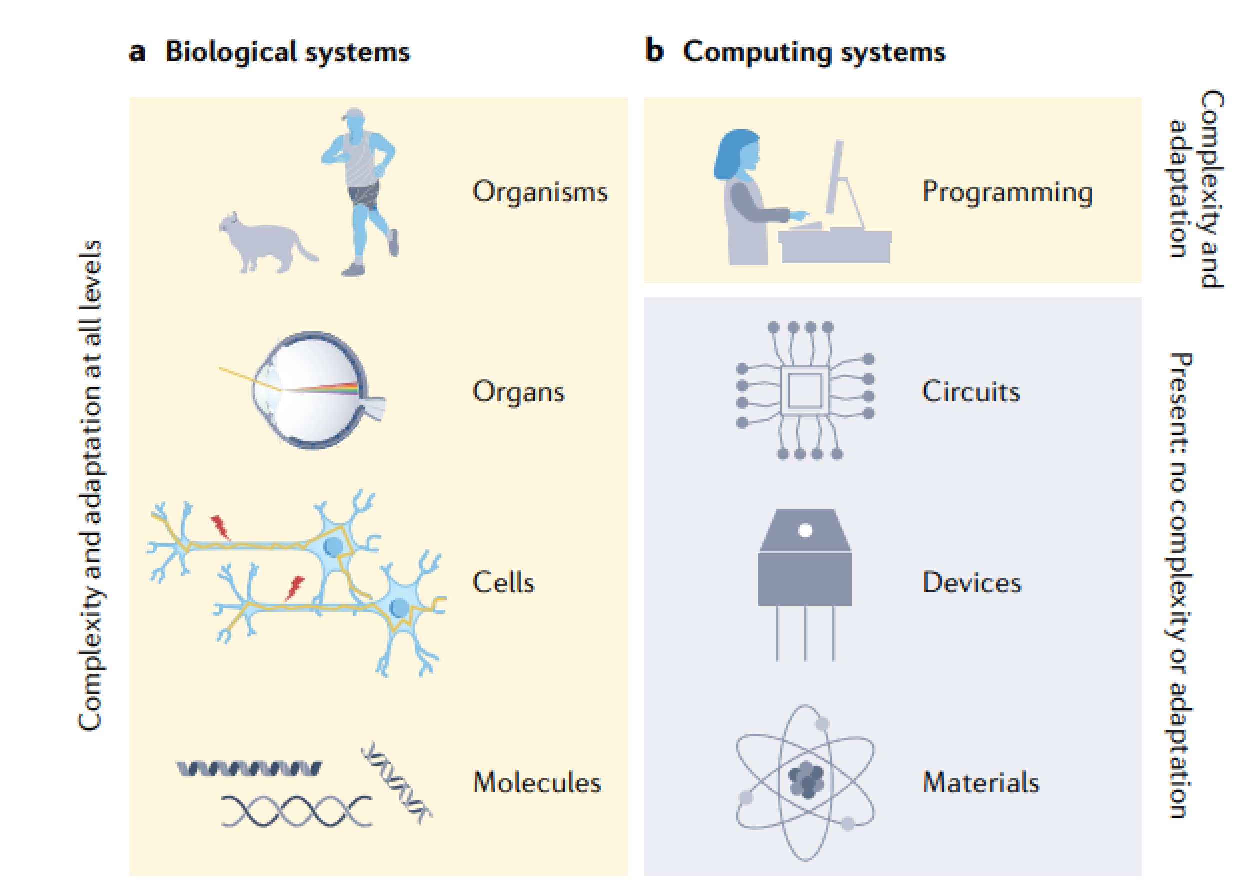
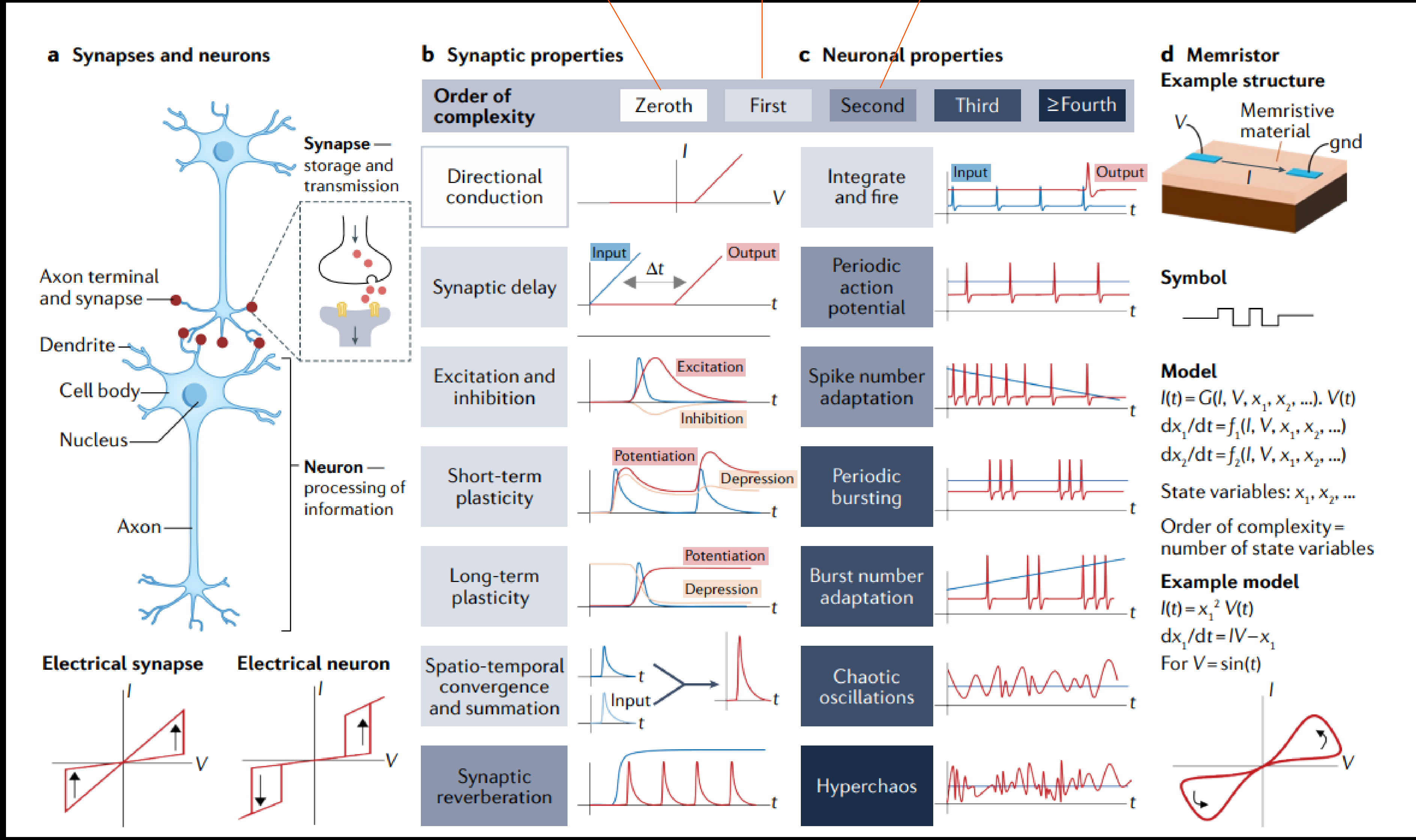


Fig. 1 | **Biological and computational adaptation and complexity. a** | Complexity and the resulting adaptation appear at all levels of biological organization, illustrated here with hierarchical systems and their expressions. **b** | In the hierarchy of current computer stacks, nearly all layers are unintelligent and contain no adaptation or complexity, and intelligence is provided by the programmer encoding the software.



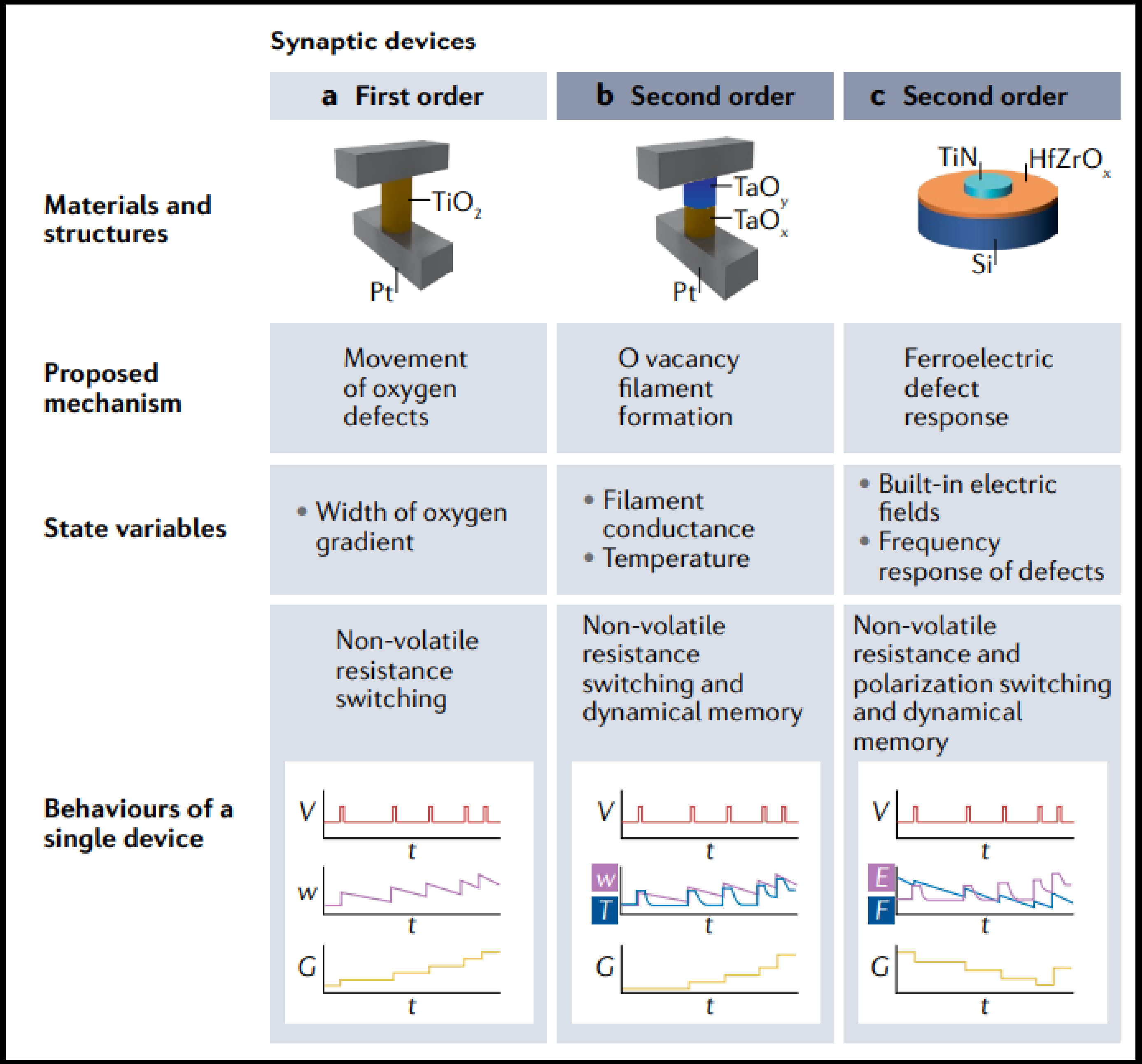
Neurons, the core information-processing elements in biological systems, express over 20 different dynamical behaviours driven by electrochemical stimulation from their history and environment

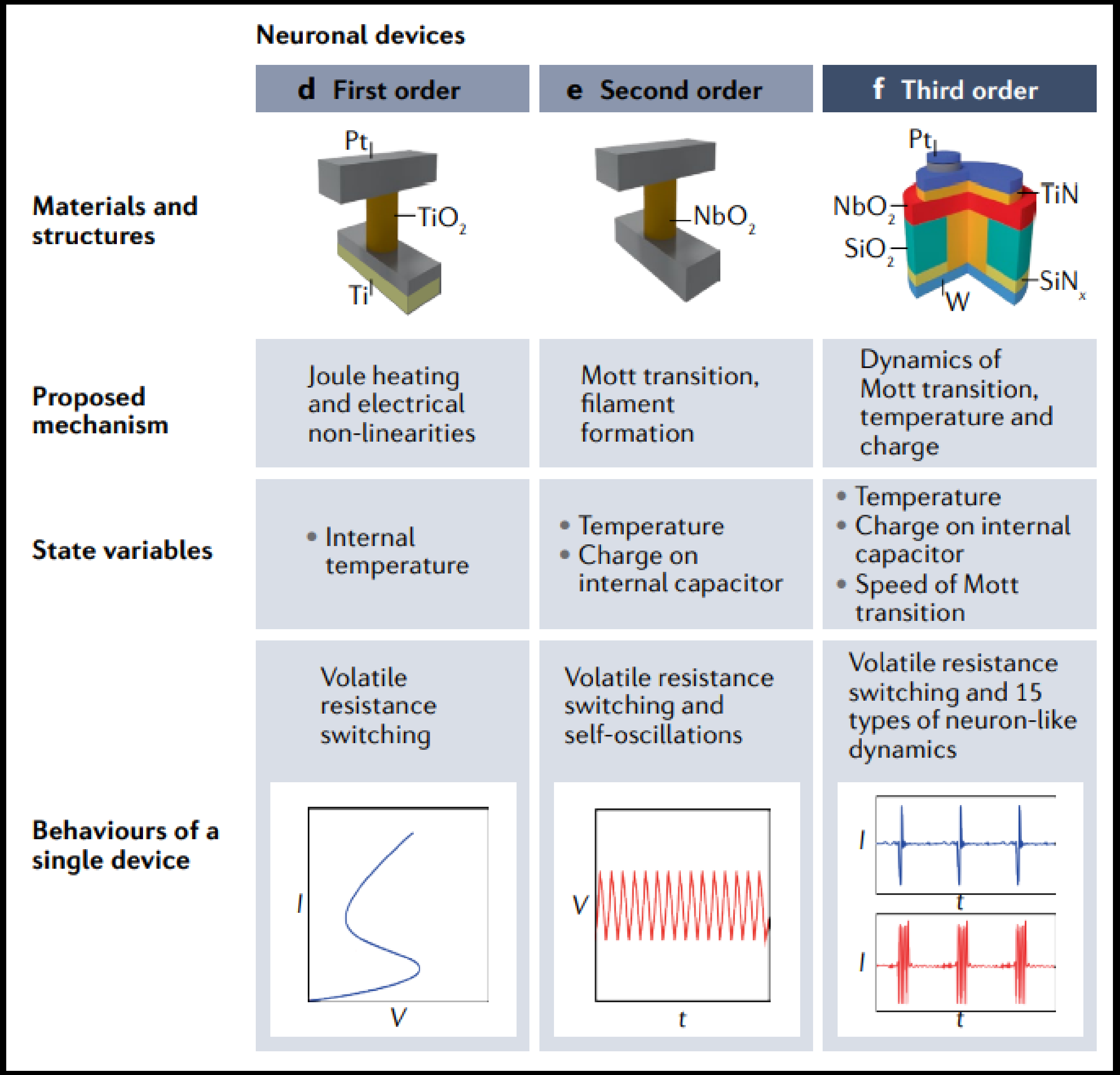
By contrast, modern computing systems are built on top of static elements with zeroth-order complexity

The next breakthrough will come from incorporating a capability for adaptation and complex dynamics within the hardware layers themselves. This idea offers an exciting path to increased computational parallelism, scalability (such as from mobile electronics to supercomputers), higher energy efficiency and increased robustness to hardware and environmental variability and defects

Kumar, S. et al. , *Nature Reviews Materials*, *7*(7), 575-591 (2022).

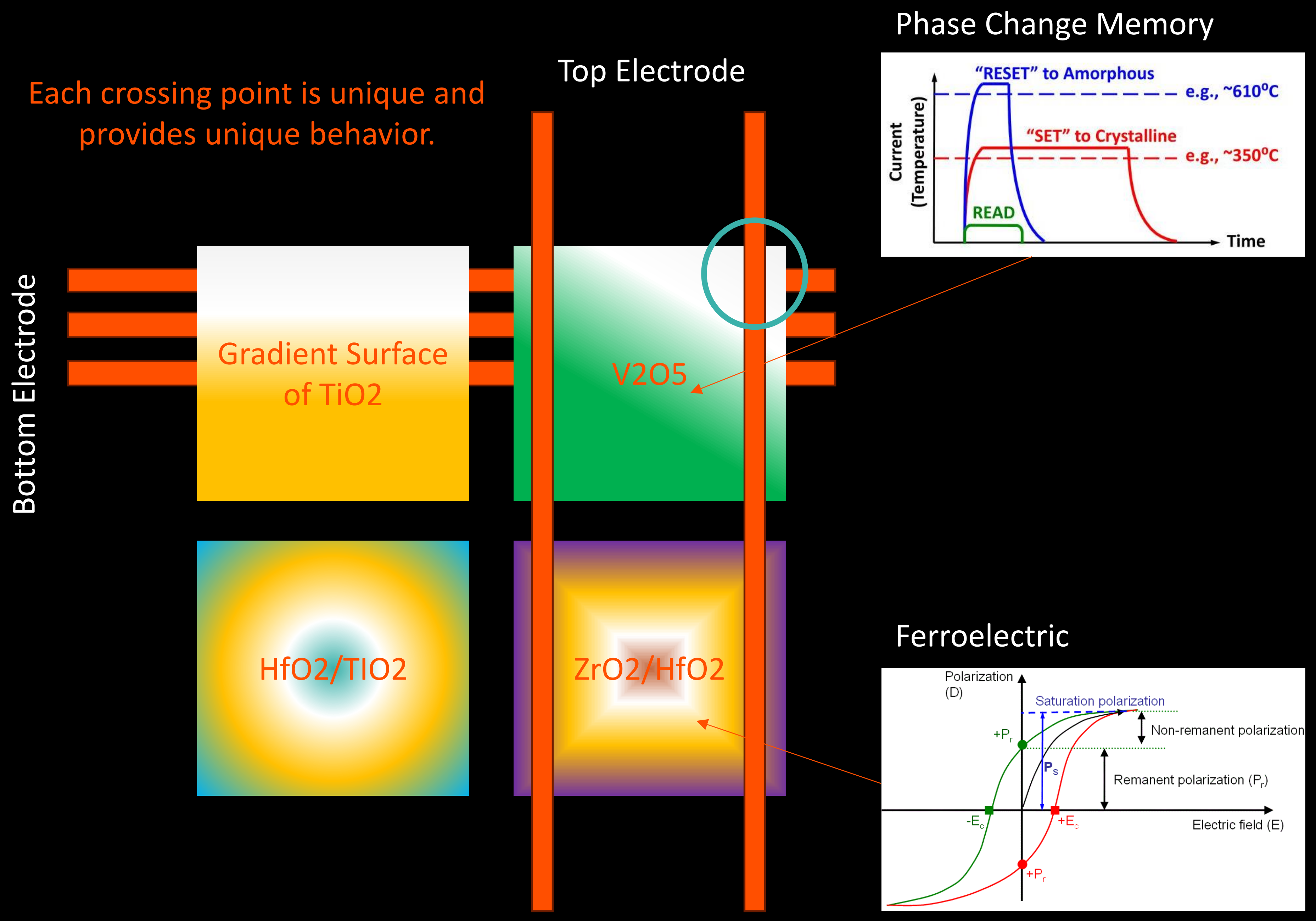
TYPES OF DEVICES





A. Sebastian, Nature Nanotechnology, 15, 7, 2020

LEVERAGING GRADIENTS TO BUILD HIGH COMPLEXITY DEVICES



On a 1x1 cm^2 sensor, fully process 625 unique nodes!

Integration with standard lithography can provide a route for significant scalability and freedom of design.

A reduction of the electrode width can provide up to 1,000,000 unique computation points on a 1x1 cm^2 surface!

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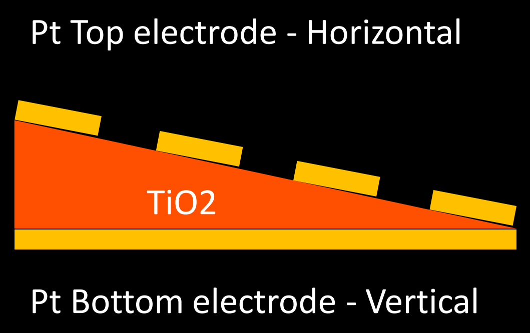
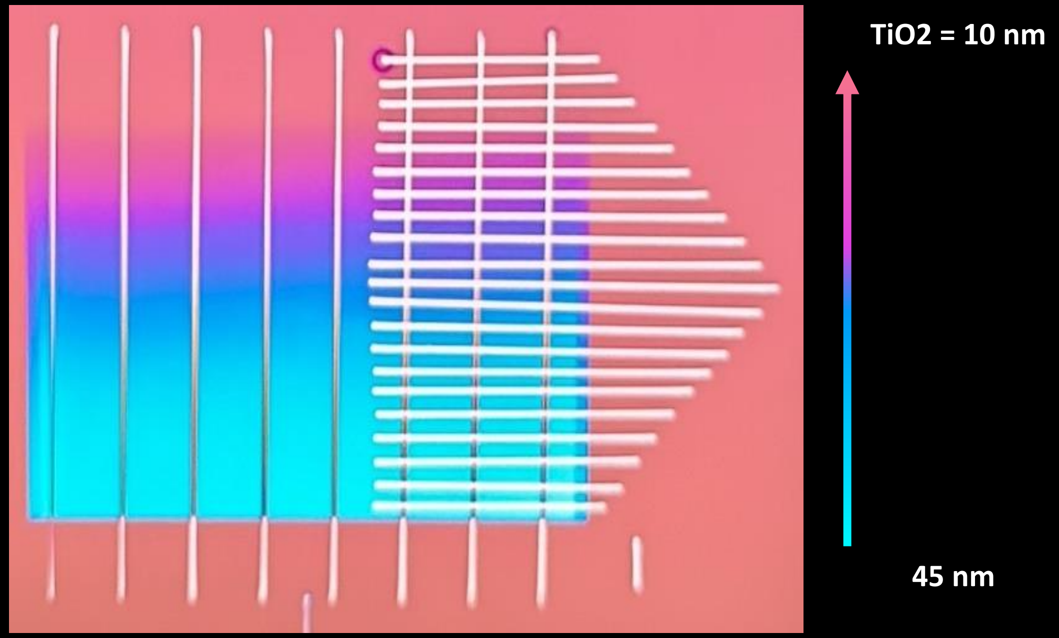
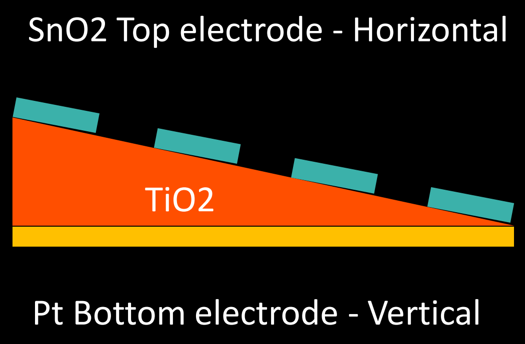
FIRST DEMONSTRATORS

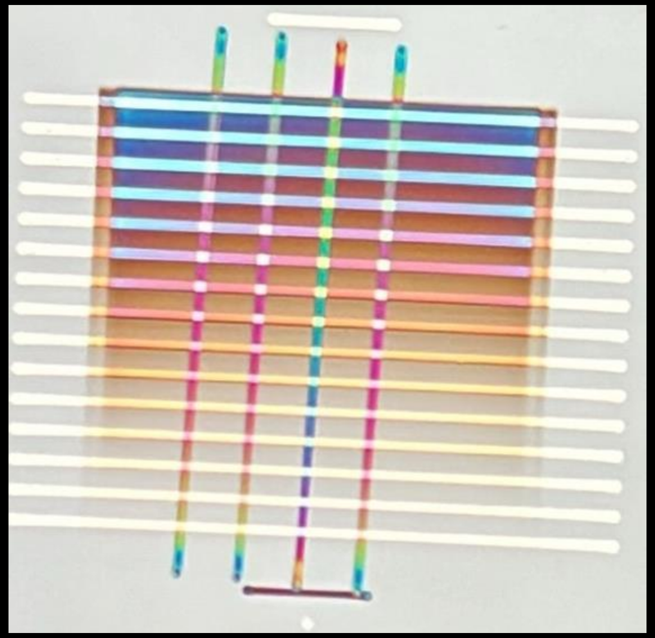
Capacitive Array Pt/TiO2/Pt





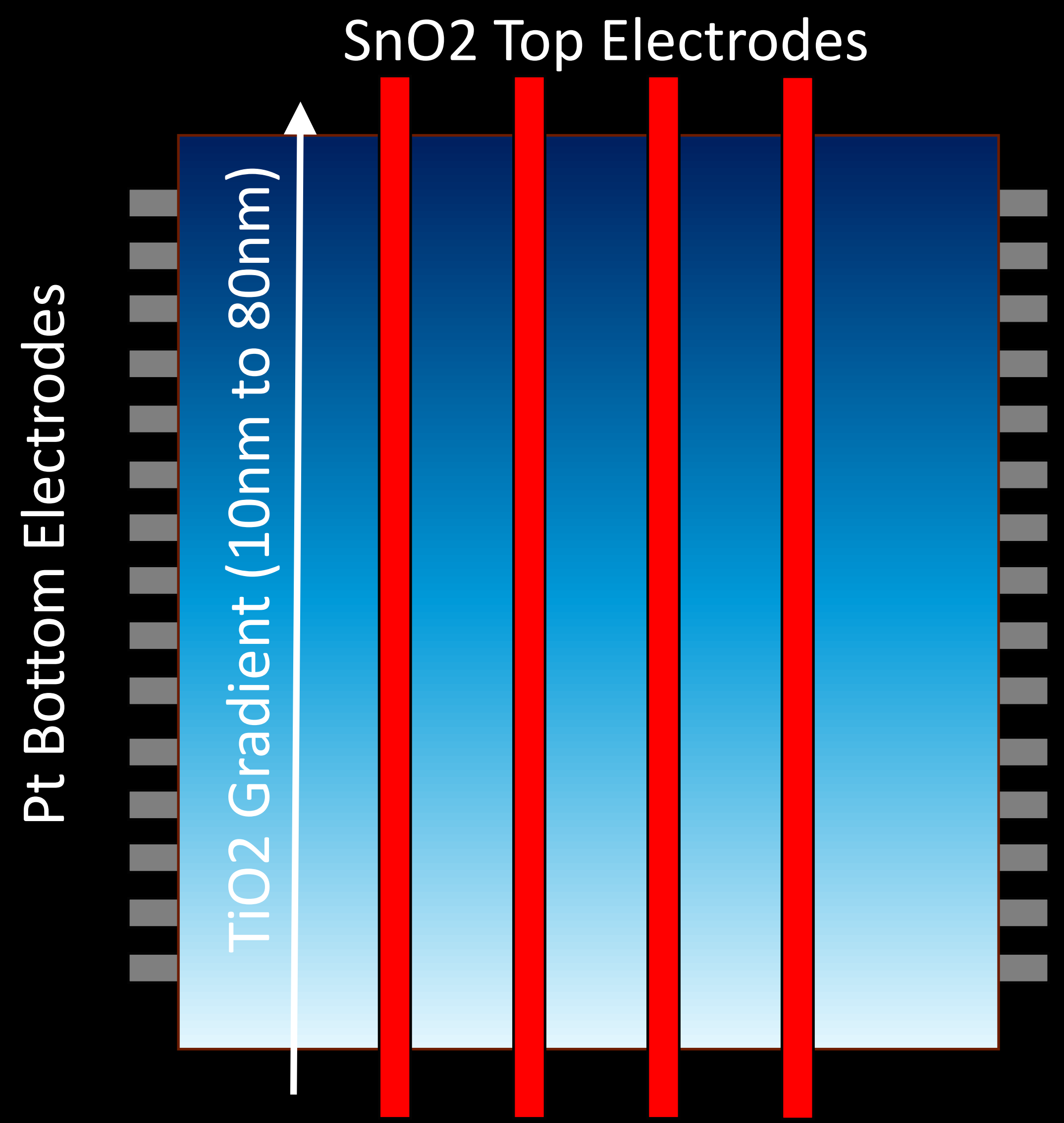
Capacitive Array Pt/TiO2/SnO2

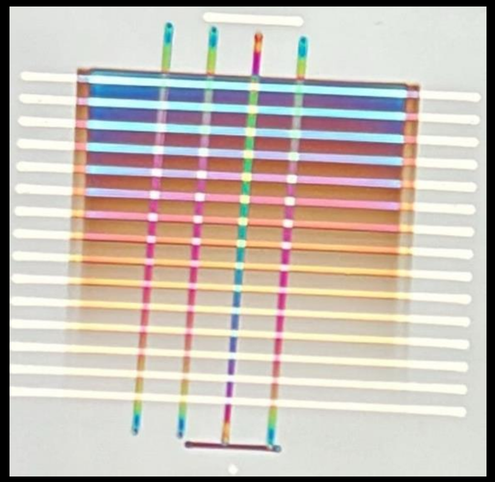




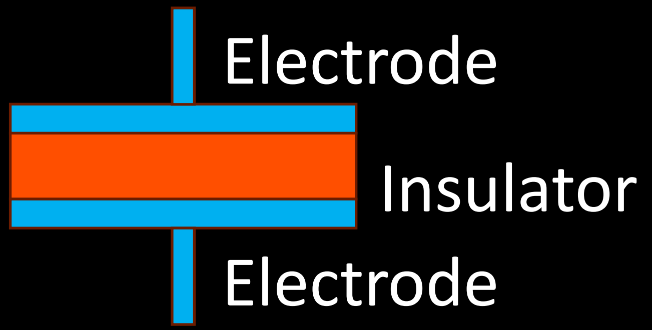
Gradients are integrated in fully functional tri-layer capacitive structures.

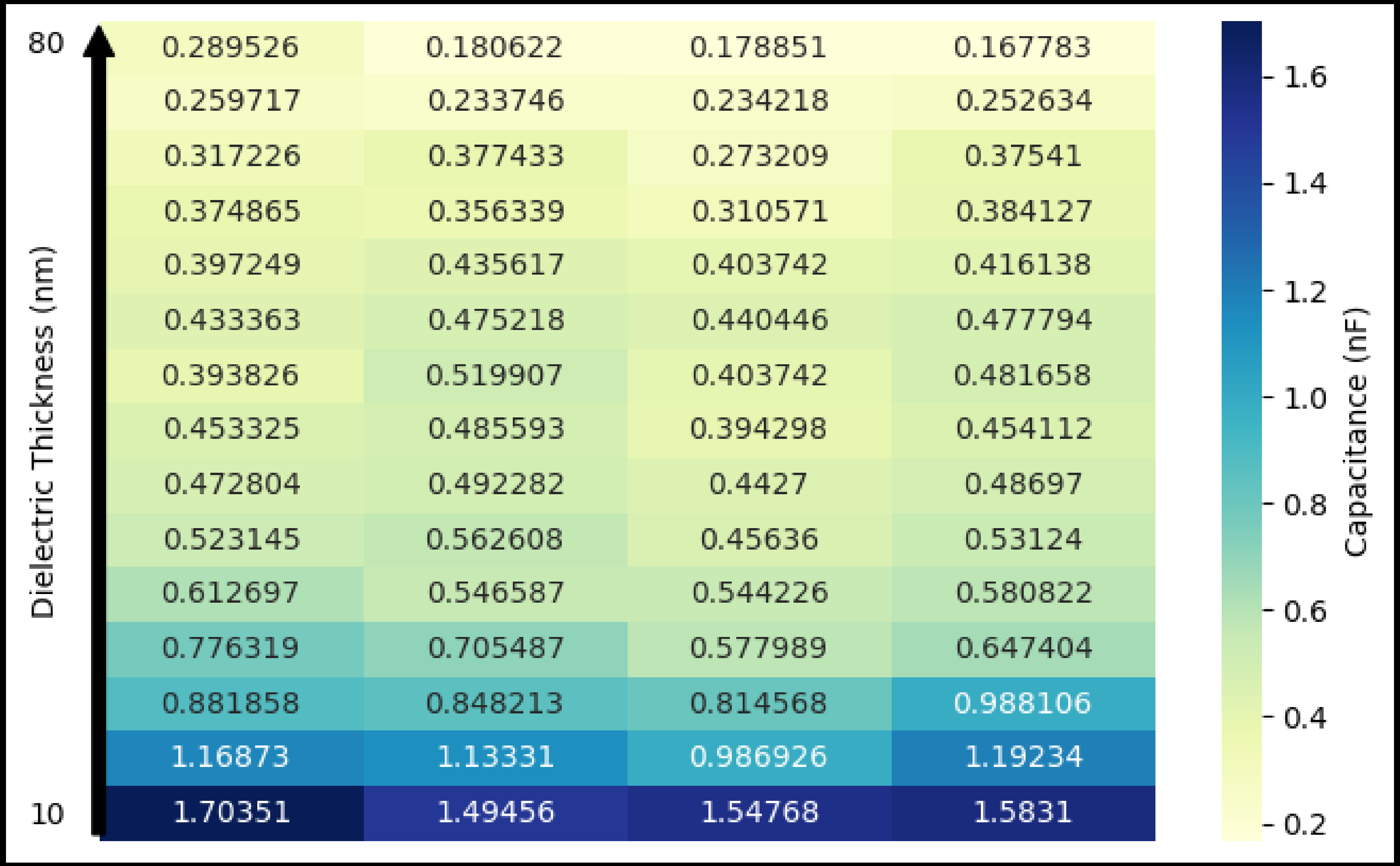
INITIAL RESULTS





MIS capacitor





0.289526	0.180622	0.178851	0.167783
0.259717	0.233746	0.234218	0.252634
0.317226	0.377433	0.273209	0.37541
0.374865	0.356339	0.310571	0.384127
0.397249	0.435617	0.403742	0.416138
0.433363	0.475218	0.440446	0.477794
0.393826	0.519907	0.403742	0.481658
0.453325	0.485593	0.394298	0.454112
0.472804	0.492282	0.4427	0.48697
0.523145	0.562608	0.45636	0.53124
0.612697	0.546587	0.544226	0.580822
0.776319	0.705487	0.577989	0.647404
0.881858	0.848213	0.814568	0.988106
1.16873	1.13331	0.986926	1.19234
1.70351	1.49456	1.54768	1.5831

Providing large data sets to material science and to designer of Neuromorphic chips.

[redacted]

ATLANT 3D®

TESTIMONIALS

“We are excited to leverage the unprecedented capabilities of the ATLANT 3D Nanofabricator Lite (NFL) to explore atomic-scale engineering of complex thin-film materials and interfaces. This cutting-edge tool will play a pivotal role in advancing our research into next-generation batteries, materials for analog neuromorphic computing, high-power GaN electronics, and active layers for perovskite solar cells, pushing the boundaries of what’s possible in material science and device innovation.”

Alexander C. Kozen,
Assistant Professor, Dep. Of Physics

The University of Vermont

“ATLANT 3D’s DALP technology completes our inkjet process by enabling precise, localized conformal functionalization of nanostructures and MEMS with metals and metal oxides. This capability allows us to integrate multiple materials into a single sensor platform, significantly boosting the performance and detection capabilities of our electrochemical sensors, making it an essential component of the sensor technology solutions developed in AMUSENS.”

Renaud Leturq, Lead R&T Associate at LIST,
Coordinator of AMUSENS EU Project

LUXEMBOURG INSTITUTE OF SCIENCE AND TECHNOLOGY LIST

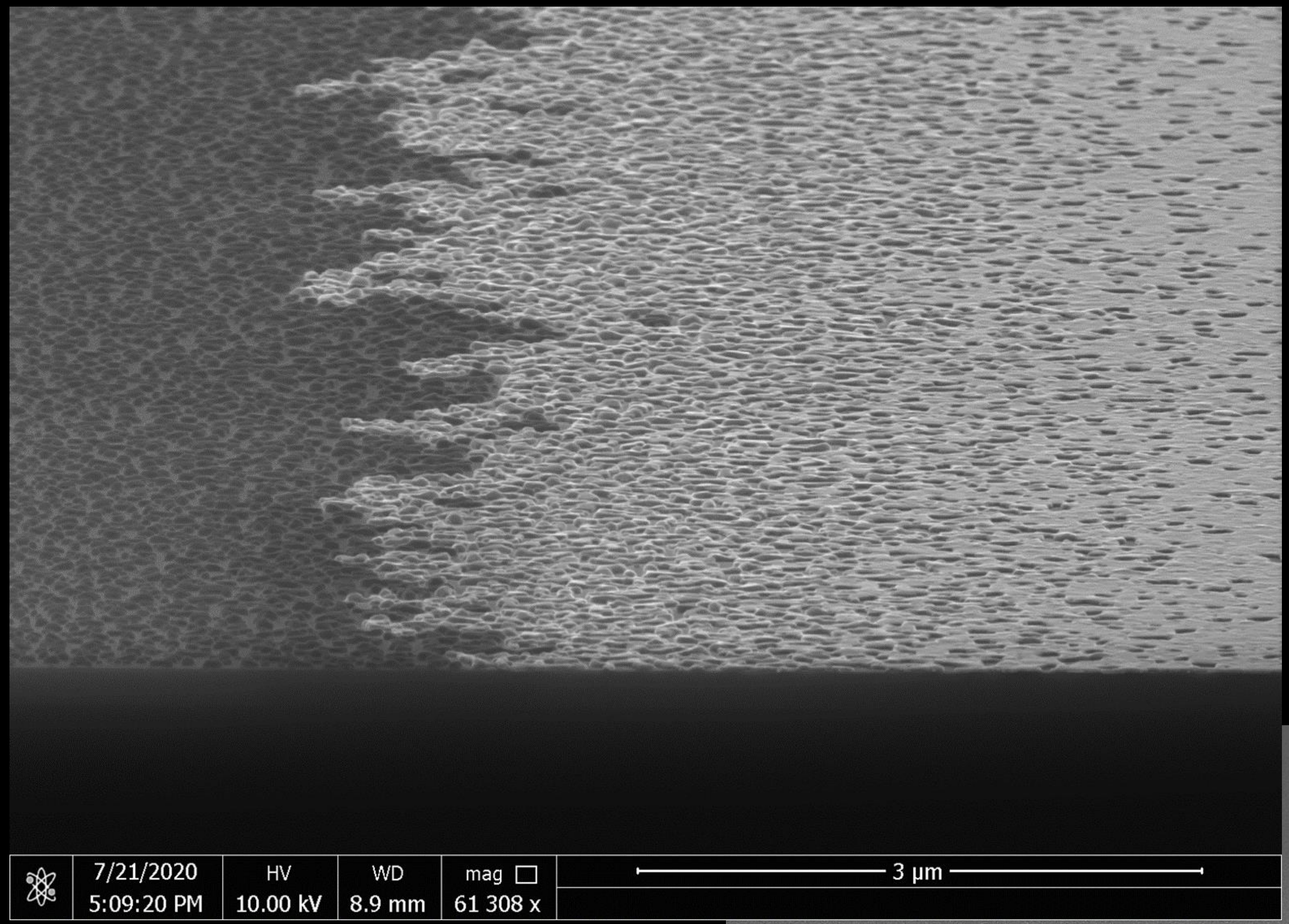
"ATLANT 3D’s direct deposition capabilities have allowed us to overcome the design constraints of lithography, creating novel device designs for electronic devices and sensors, even on complex surfaces. The integration of multiple materials in a single sensor platform has vastly improved our capabilities, making it an invaluable asset in our research.“

Boris Hudec, Scientific Researcher, Institute of Electrical Engineering, Slovak Academy of Sciences

IEE SAS INSTITUTE OF ELECTRICAL ENGINEERING SAS

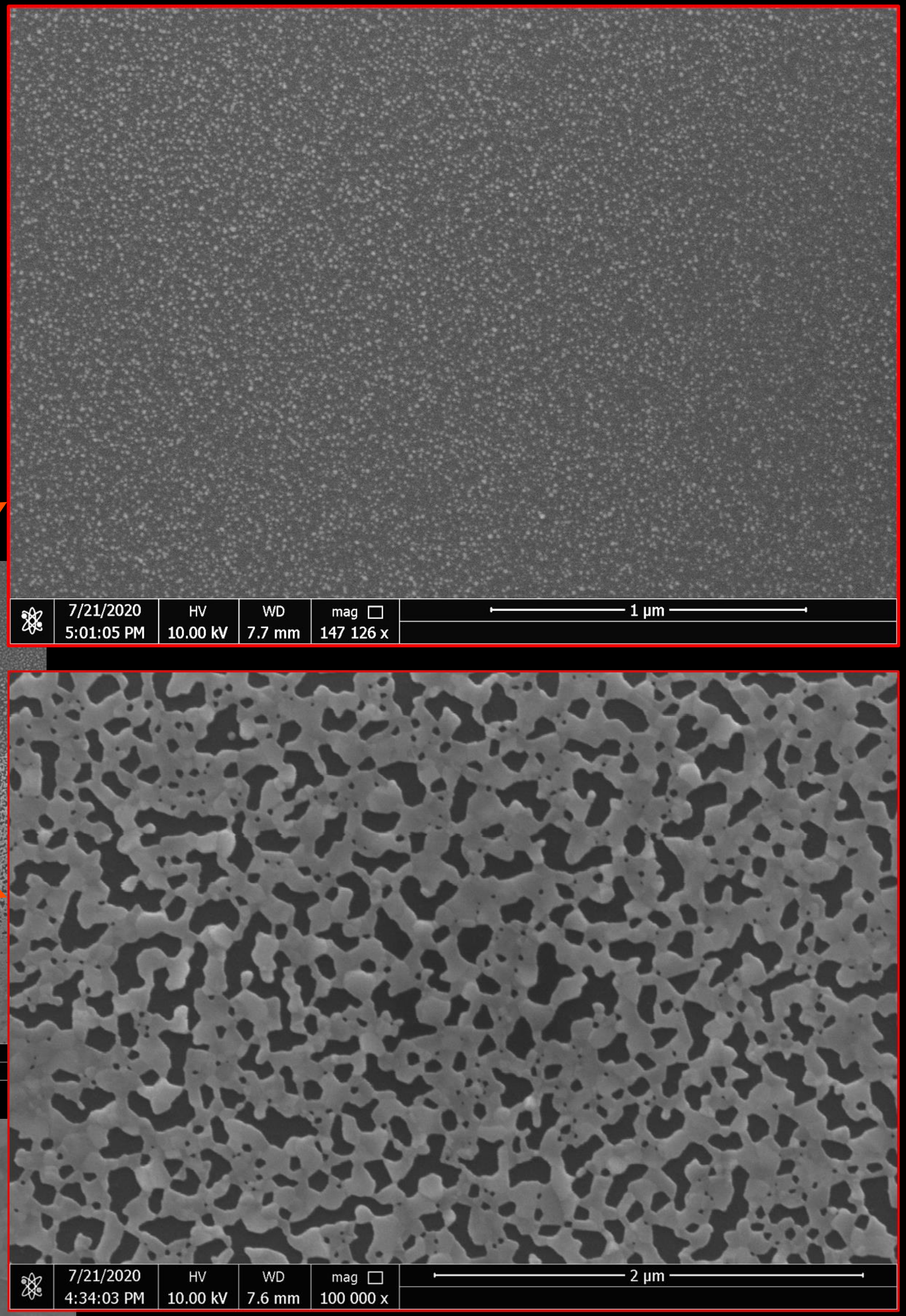
SONY NASA MERCK esa ST life.augmented WEST HILL Innovationsfonden European Commission

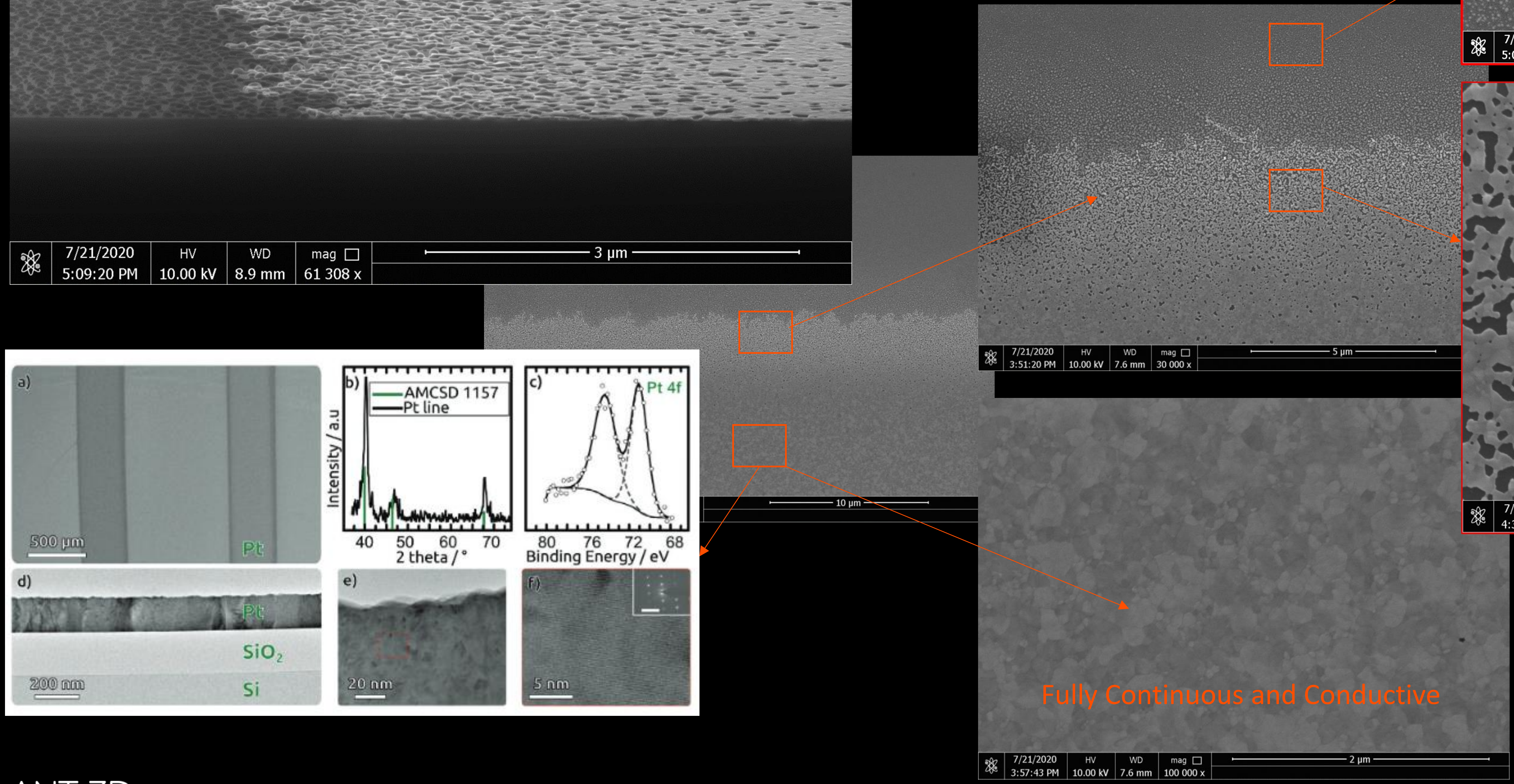
FROM NANOPARTICLES TO NANOPOROUS TO FULLY CONTINUOUS FILMS



Accessing controllably multiple states of microstructure.

Islands and Non-Conductive





Microporous and Conductive

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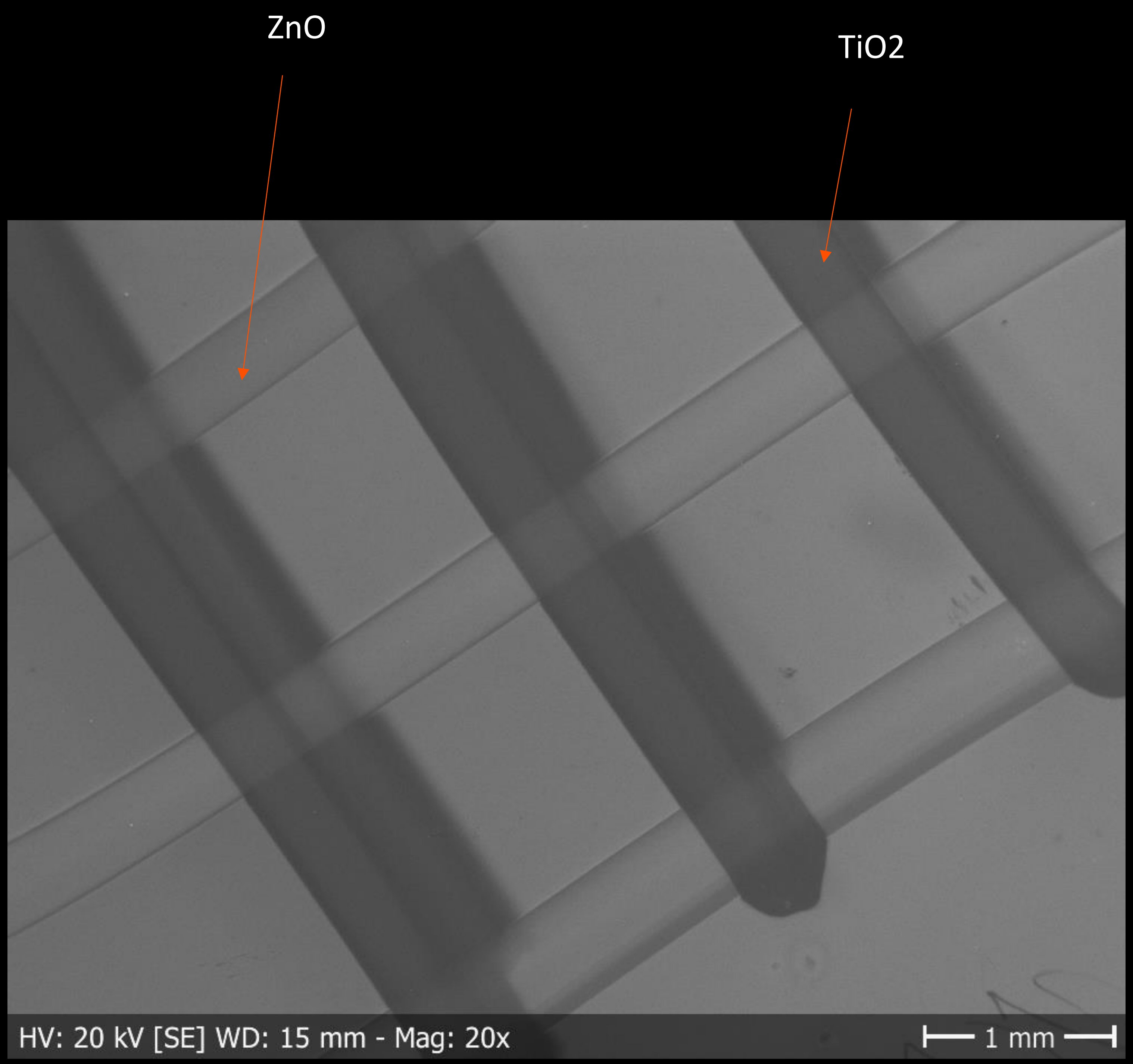
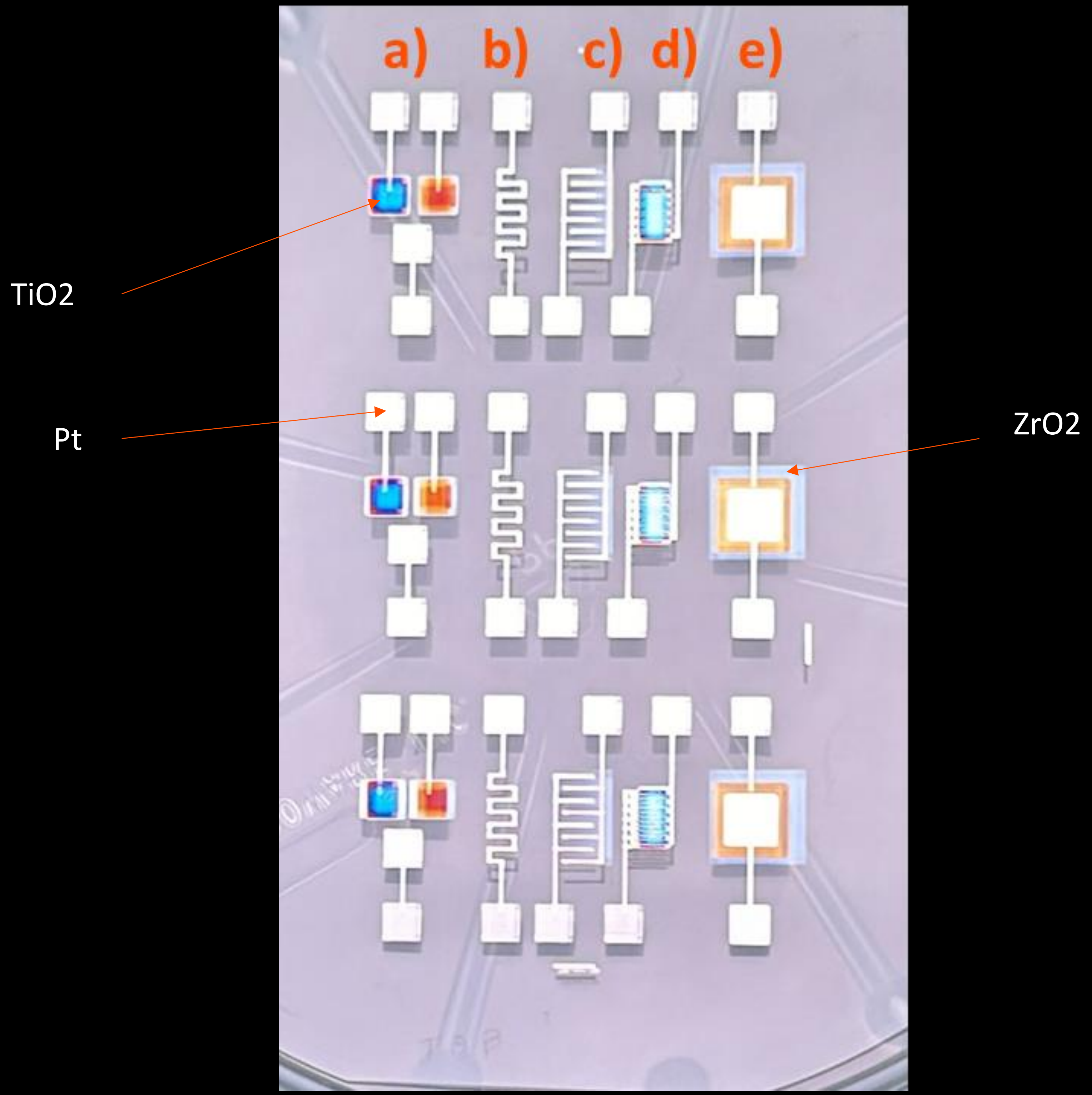
MULTILAYERS – FULLY PRINT FUNCTIONAL SEMICONDUCTOR DEVICES



Multilayer structures to make fully functional devices



CONFORMALITY

- Conformal growth to 3D structures

- Battery pores
- Nanoparticles and nanorods
- Trenches