SAND2019-0238PE

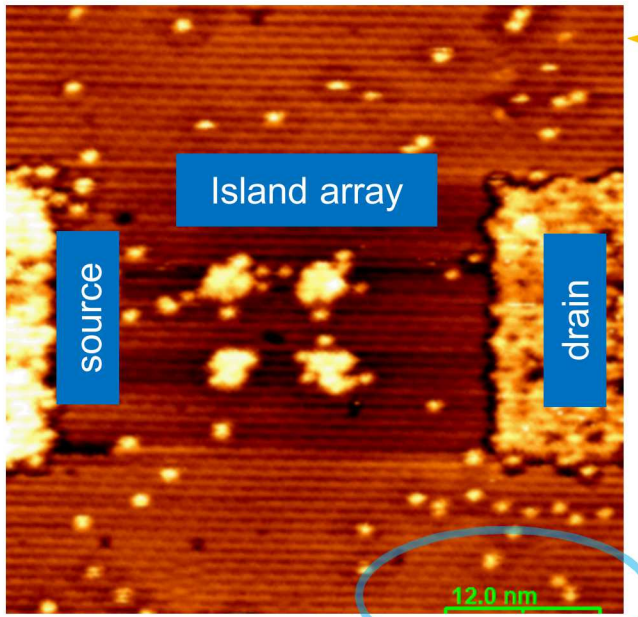
FAIR DEAL GC Project Programmatic Overview

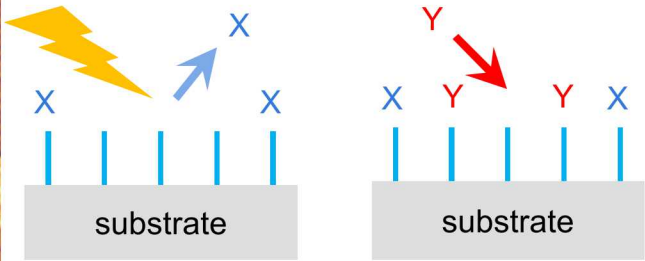
Robert Koudelka and Rick Muller

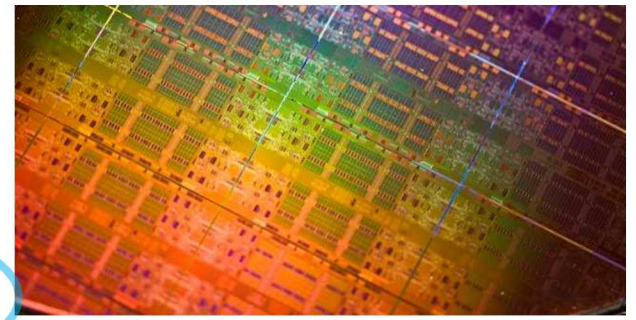
Co-PMs

First EAB Meeting

January 15, 2019







U.S. DEPARTMENT OF ENERGY

NNSA National Nuclear Security Administration

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Why Digital Electronics at the Atomic Limit (DEAL)

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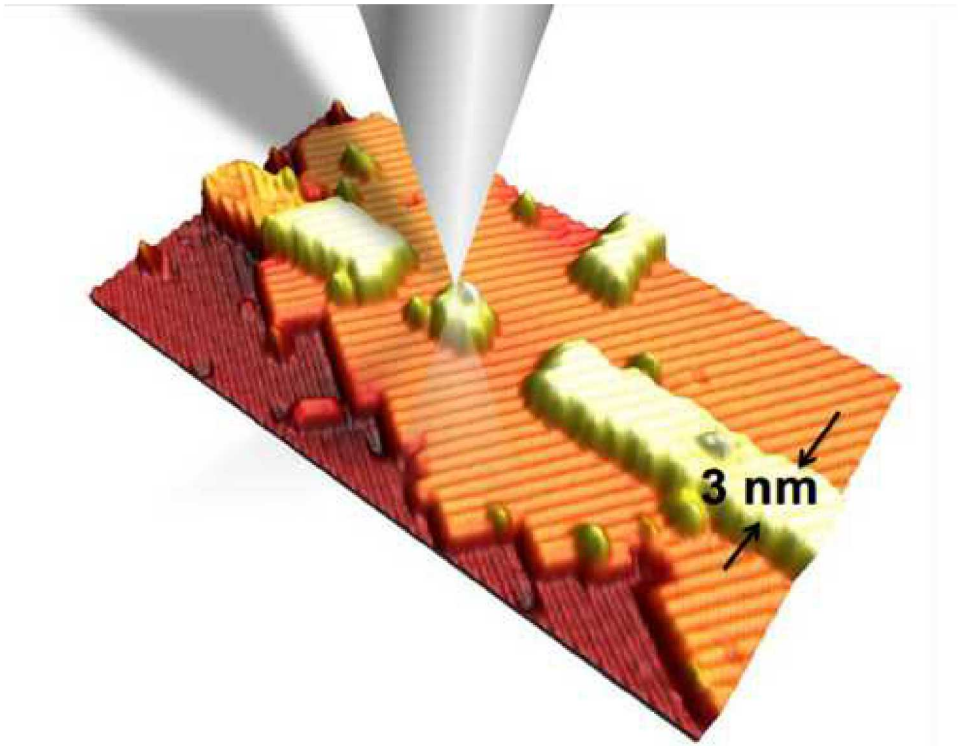
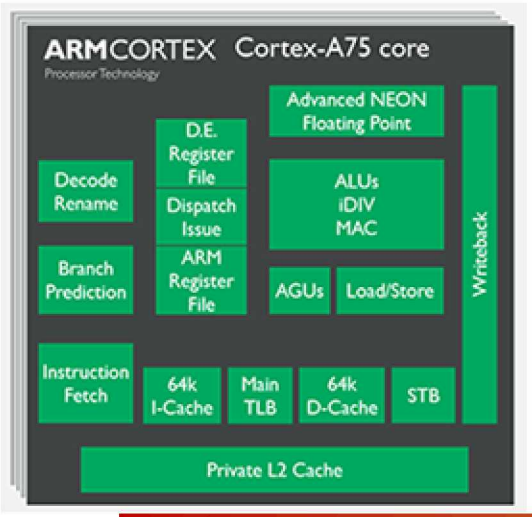
- Atomically precise additive manufacturing (APAM) is enabled by selective surface chemistry methods to define desired microelectronics features.
- Recent developments suggest CMOS compatible APAM processes are possible.
- Microelectronics – exponentially hard to approach the atomic scale
- Four technical thrusts guide this research
  - Device fabrication
  - Modeling materials, devices, and circuits
  - Integration with CMOS
  - Application to scalable manufacturing



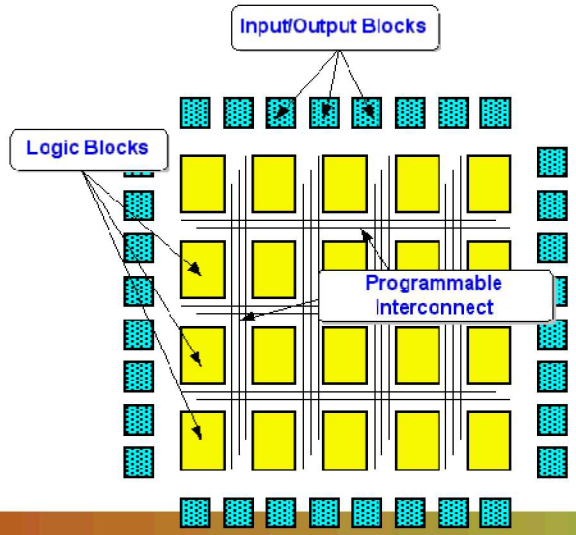
Government's need for microelectronics

- Constrained size, weight and power (SWaP)
- Mission flexibility
- Supply-chain assurance

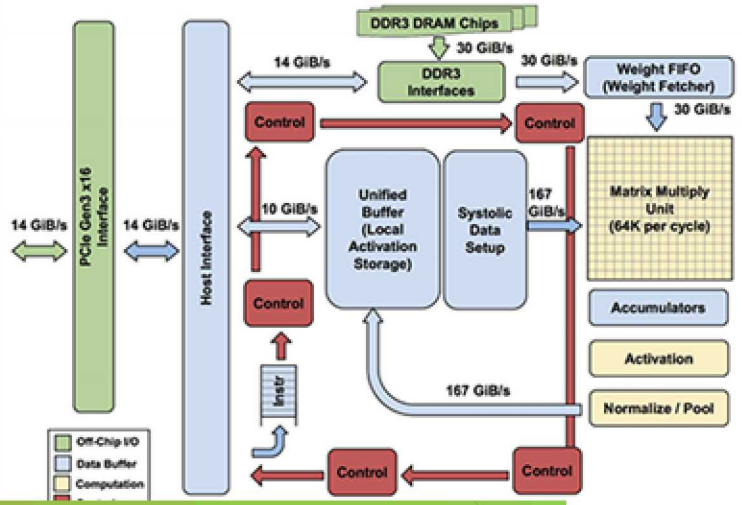
CPU



FPGA



ASIC



Flexibility

Performance

Applications and Implications of APAM

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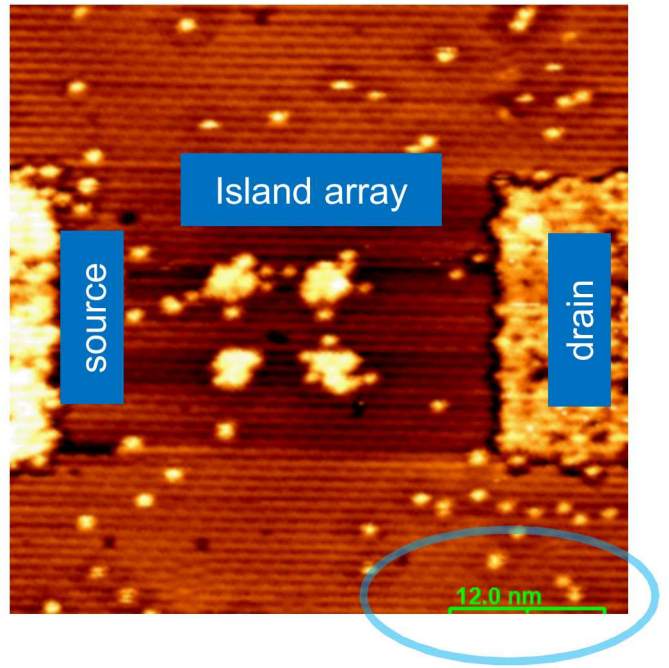
- APAM enables
  - Understanding new devices from the physical limit
  - Processing pathways that leverage atoms / molecules
- Far reaching applications & implications at the physical limit of atoms
  - Devices: new device physics that enable reconfigurable circuitry
  - Processing: promise of potential trust and assurance applications for DOE, DoD (e.g. supply chain assurance, component provenance, etc.)

	Commercial driver	Opportunity for gov't.
Reconfigurable circuits	Different approach to scaling logic density	Size, weight & power vs. Mission flexibility
Atom-inspired processing	New resist/dopant toolkits	Supply chain assurance

Why Sandia?

- Perform advanced R&D on strategically important capabilities relevant to the national interest as an USG FFRDC
- Support DOE NNSA, DoD, and other government agencies' national security mission needs as an USG trusted advisor for microelectronics technologies
- Enable the critical mass of effort and infrastructure needed to meaningfully pursue this research with sustained GC-LDRD investment
- Capitalize on SNL's multi-disciplinary methodology to integrate a broad spectrum of capabilities for unique project approach
- Leverage and build upon SNL's prior investments, e.g.,
  - MESA and CINT semiconductor fabrication capabilities
  - DOE supercomputing facility for modeling
  - Development of Si:P STM lithography as part of quantum information sciences programs



GC-LDRD Measures of Success and Key Qs

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- Successfully perform technical pathfinding
  - Is surface chemistry device fab a viable way to extend lithography to atomic scales?
  - Can understanding be advanced sufficiently to hand off for further technology development?
- Broadly assess the risk/opportunity space
  - Can the technical implications for national and economic security be assessed before broad commercial development and adoption?
  - Can we establish semiconductor risk assessment tools at the atomic level to stop playing catch up to successive generations of technical improvements in device fabrication?

GC Leads' Focus Questions to EAB

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- What is your view of our project strategy (vision)?
- What is your evaluation of our project scope (Too much? Too little? Just right?)
- What changes, if any, would you recommend for our project plan?