

Materials, Nano, & Bio Research for Systems

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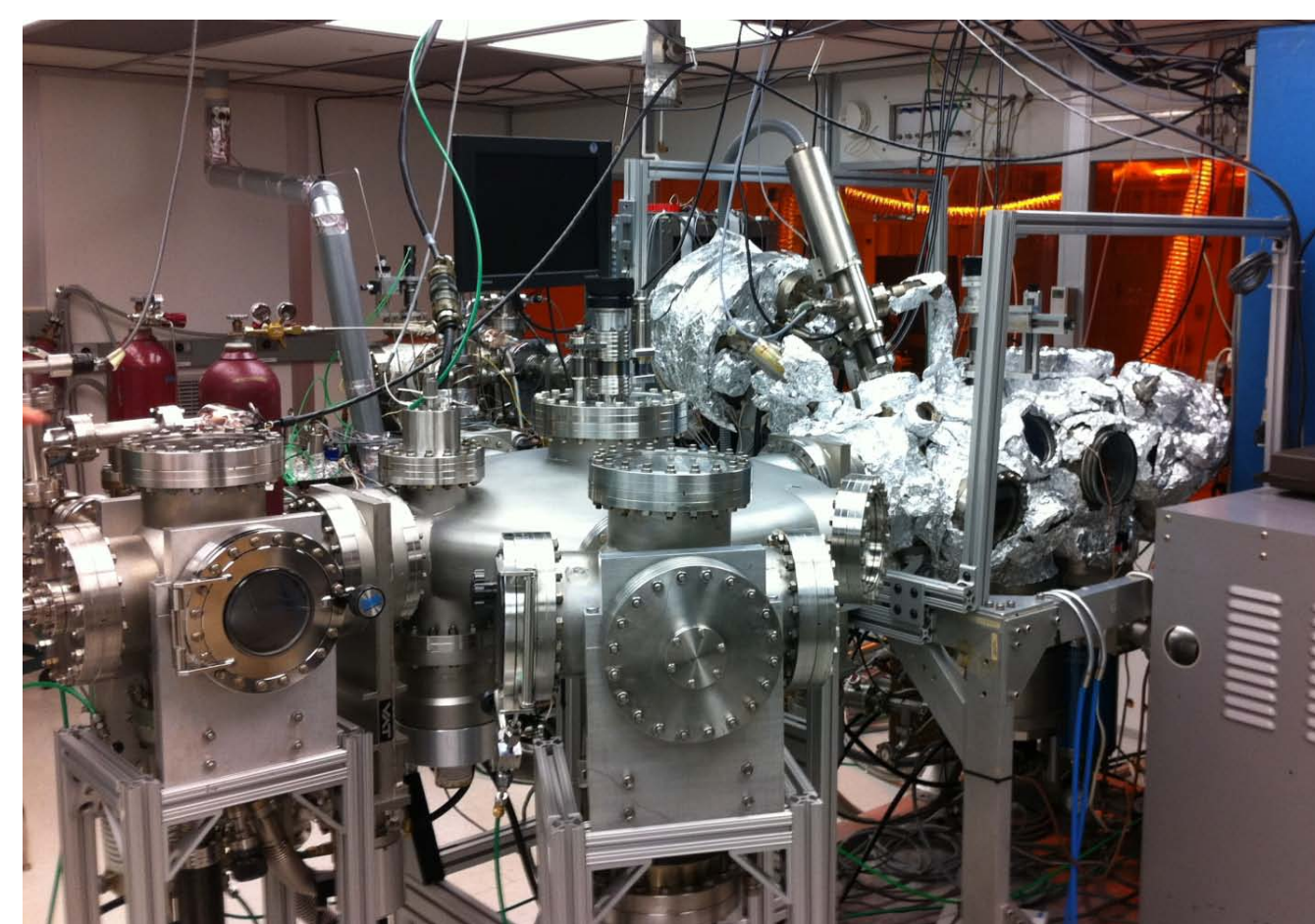
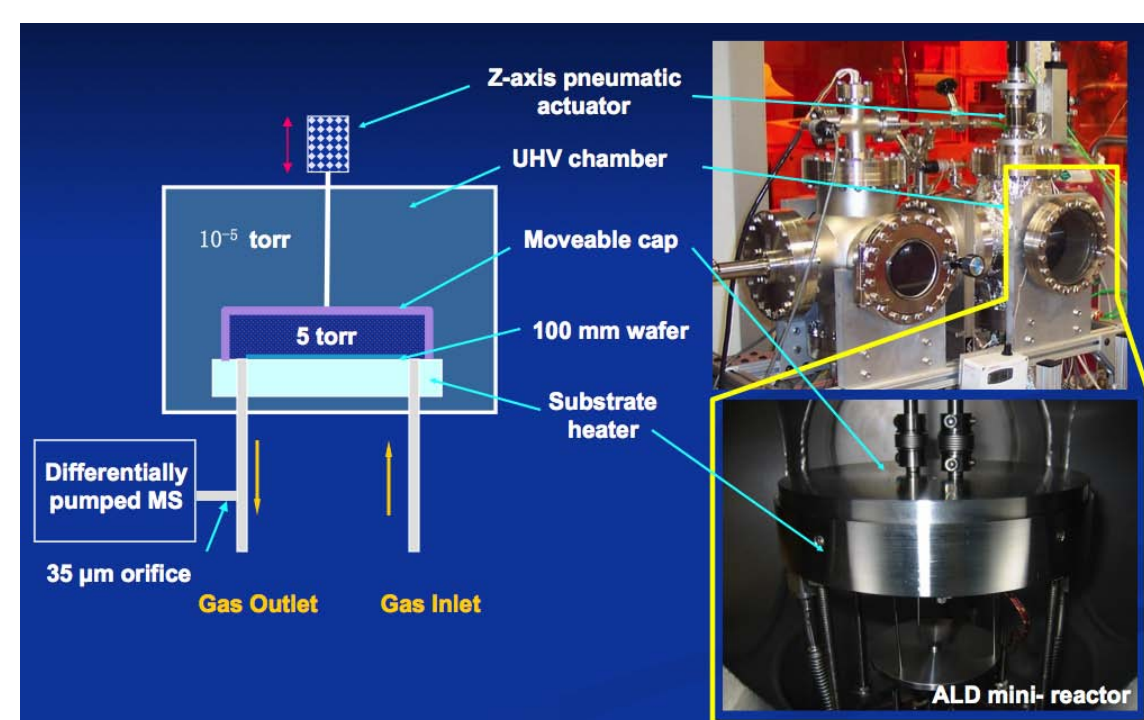
ISR PI collaborators: Jeffrey Herrmann, Steve Marcus, Michael Fu, Ray Adomaitis, Reza Ghodssi

Other PI collaborators: Sang Bok Lee (chem), William Bentley (BIOE/IBBR), Greg Payne (BIOE/IBBR), Ichiro Takeuchi (MSE), Krishna Rajan (Iowa State), Farhang Shadman (U Arizona), Rebecca Zangmeister (NIST), Deborah Partlow et al (Northrop Grumman)

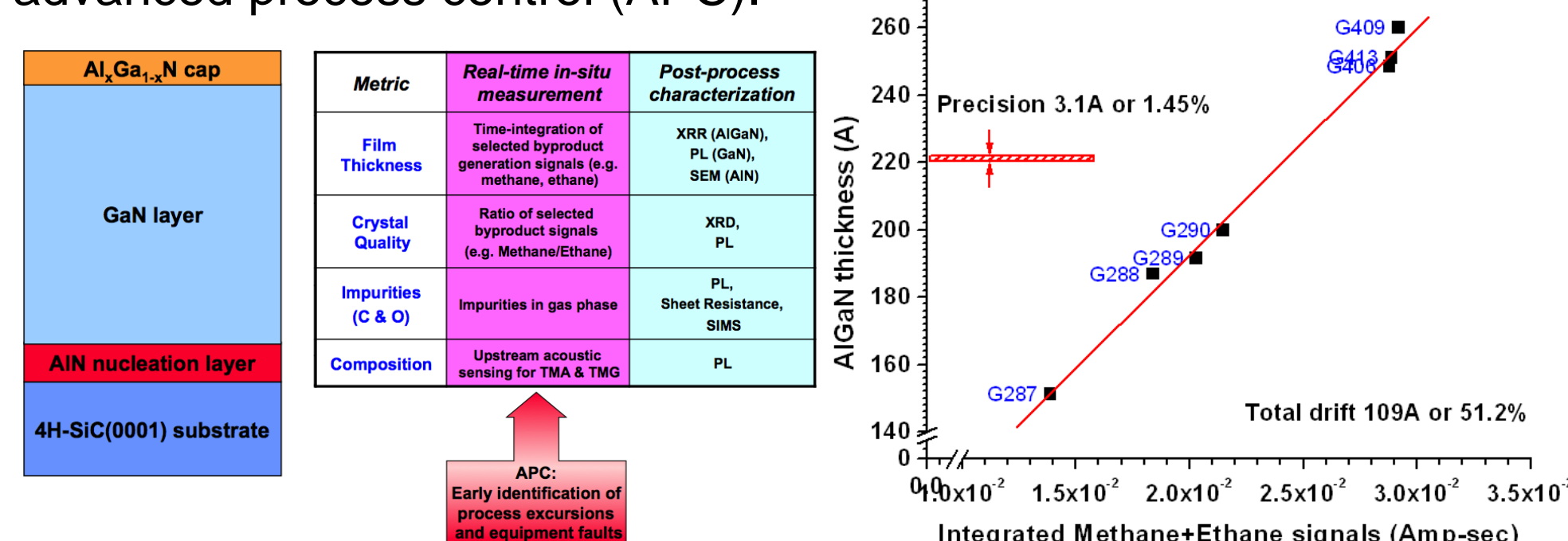


EXPERIMENT: Electronic materials synthesis, process diagnostics, and devices

ISR Goal: provide experimental capability and collaborations to enrich and inform systems research

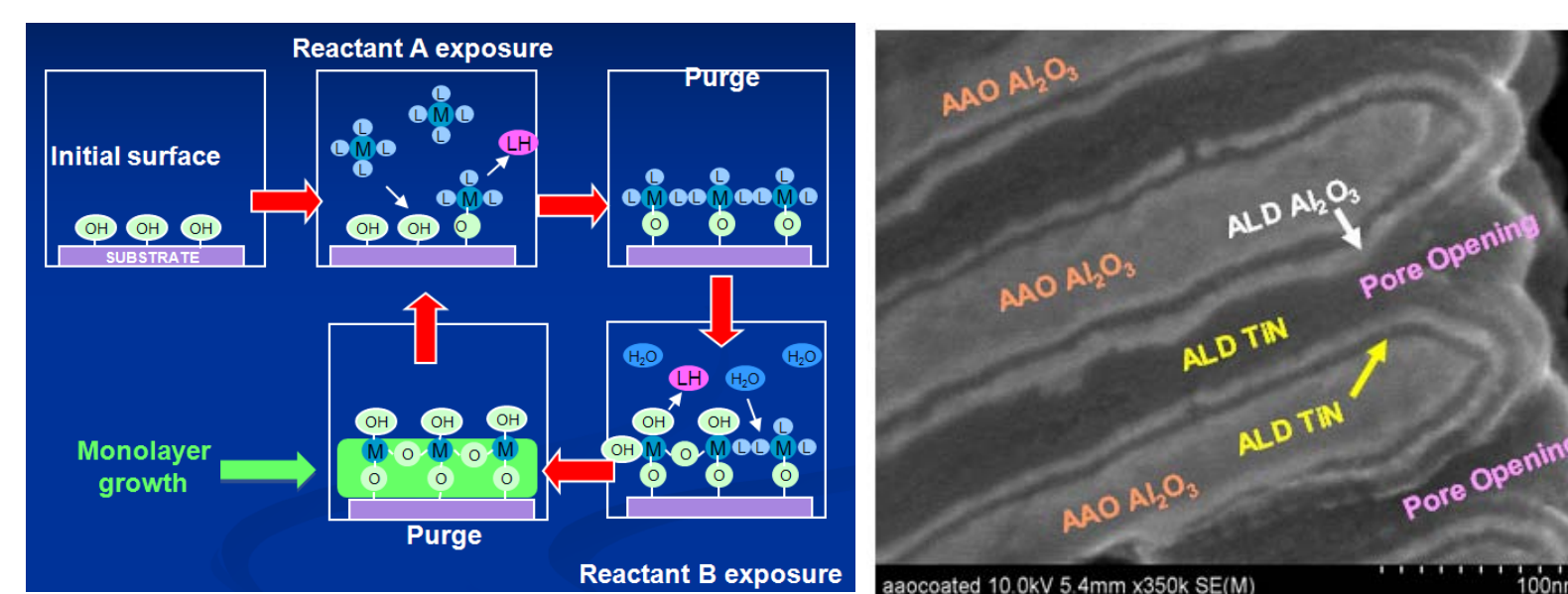


Real-time, in-situ sensing, e.g., downstream mass spectrometry, reveals chemical reaction steps and provides metrology for advanced process control (APC).

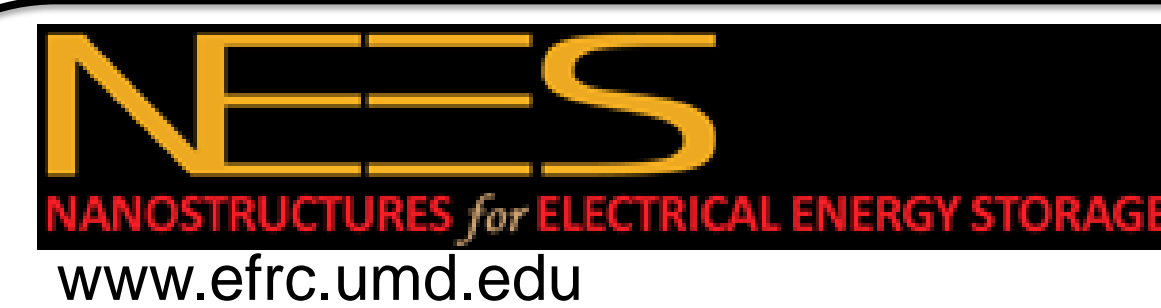


Advanced process control (APC) has been achieved using downstream mass spectrometry in **Northrop Grumman's GaN HEMT program**, controlling a 20nm AlGaN cap layer to <2% thickness for high speed devices.

Ultraclean integrated processing. Multiple process steps and in-situ characterization within ultraclean environment enable observation of process mechanisms.



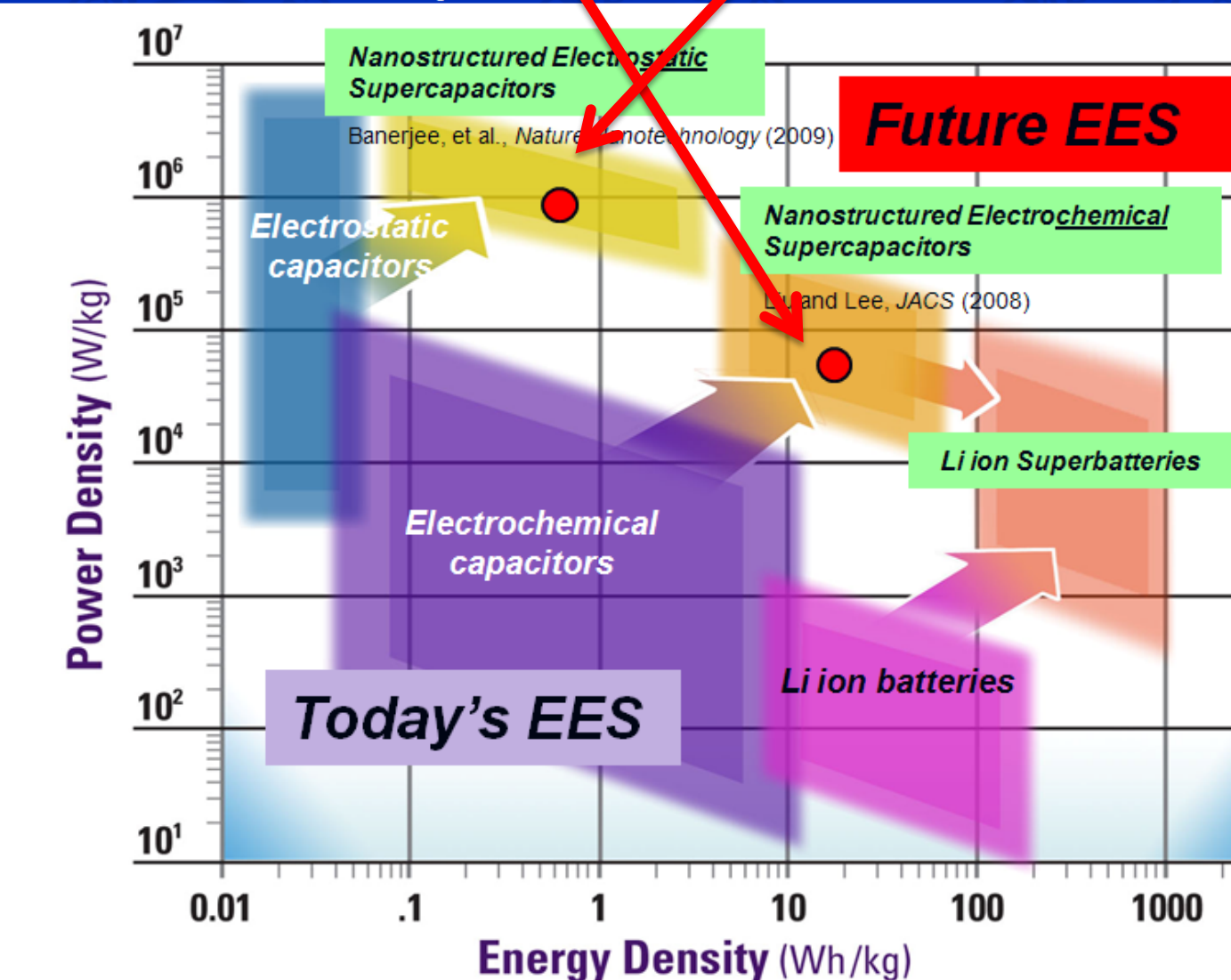
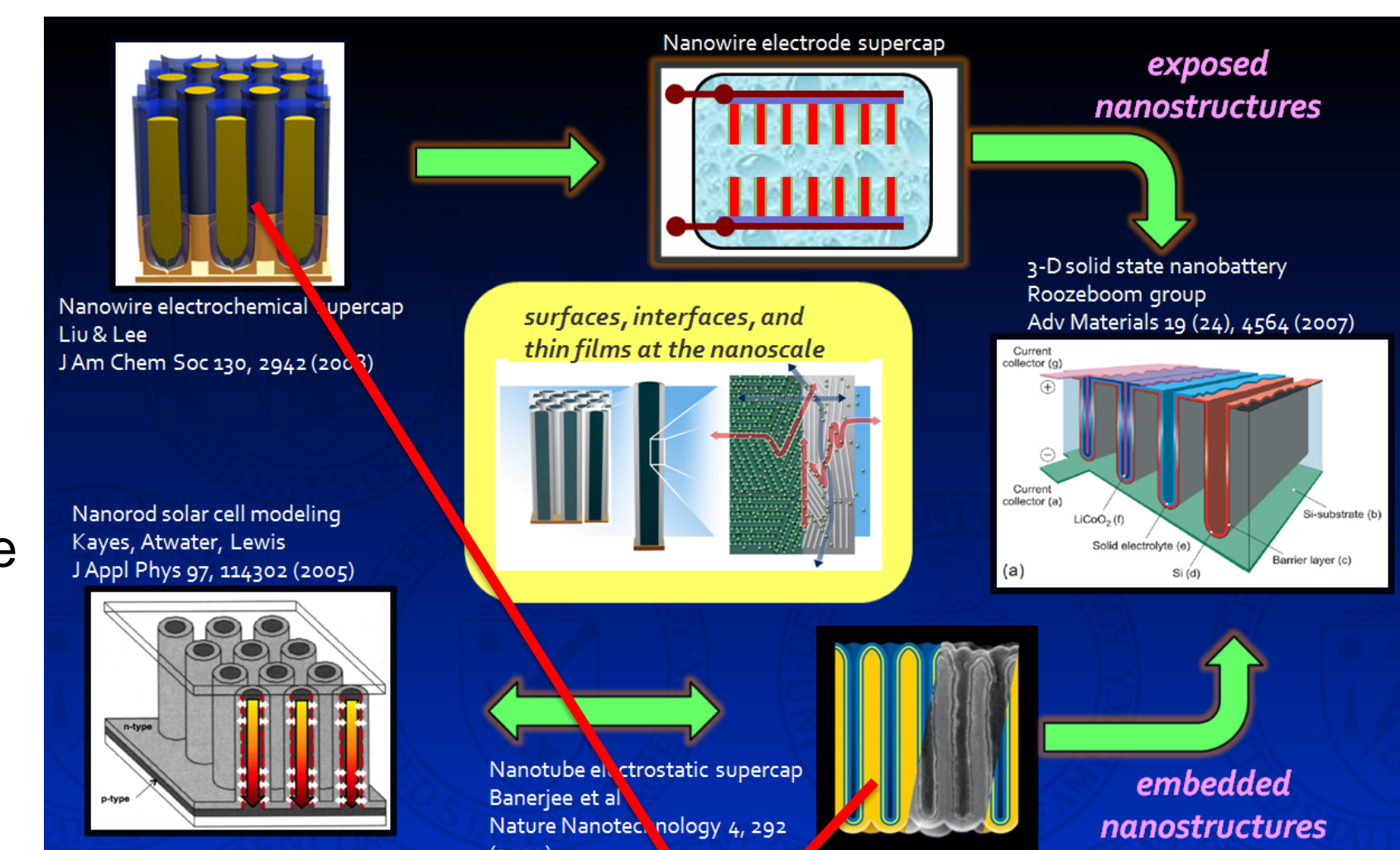
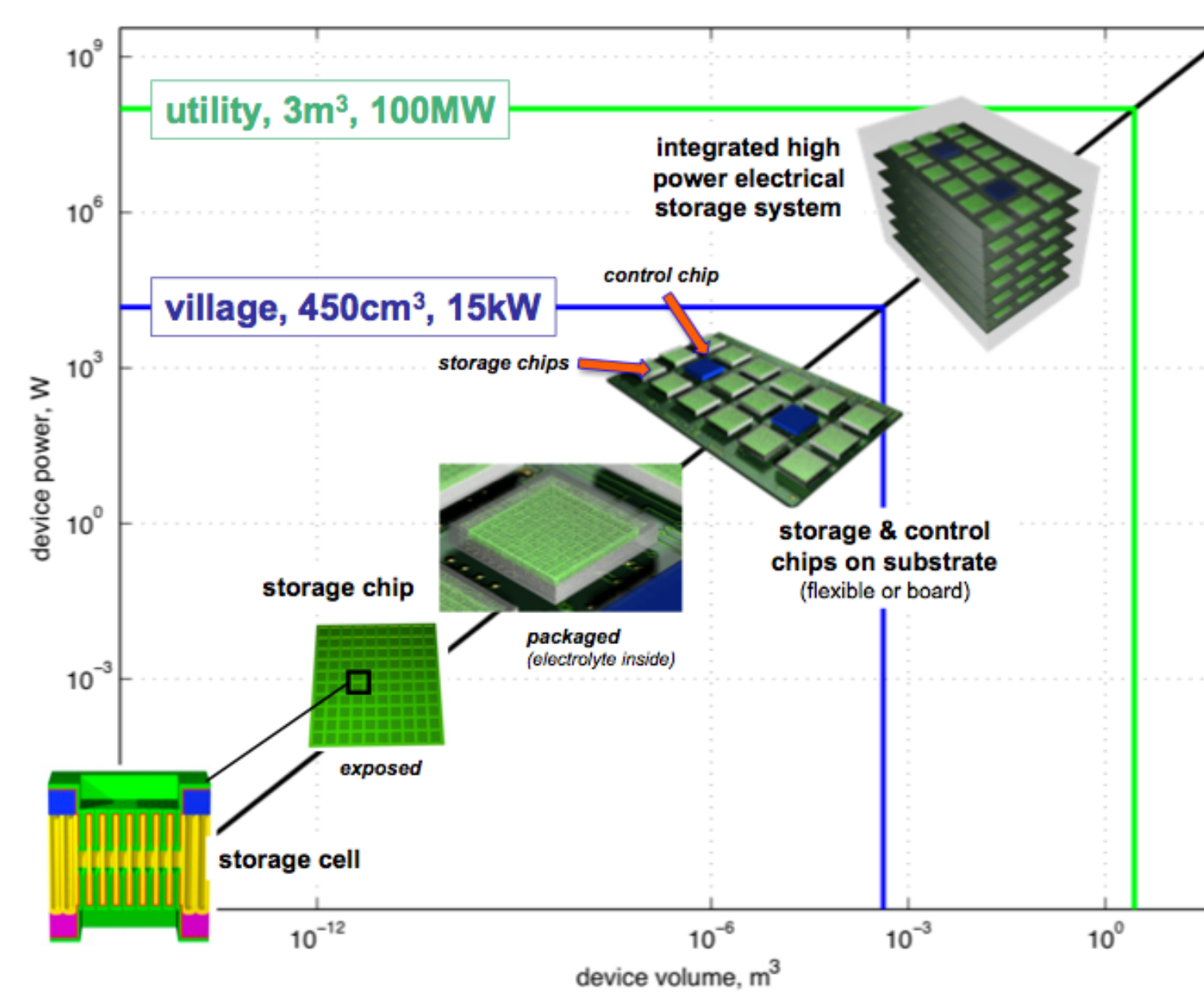
Atomic layer deposition (ALD), providing unprecedented control of materials deposition, one atomic layer at a time even over complex nanotopography, is essential to nanostructure fabrication as sought in NEES, our **DOE Energy Frontier Research Center**.



Nanostructures for Energy

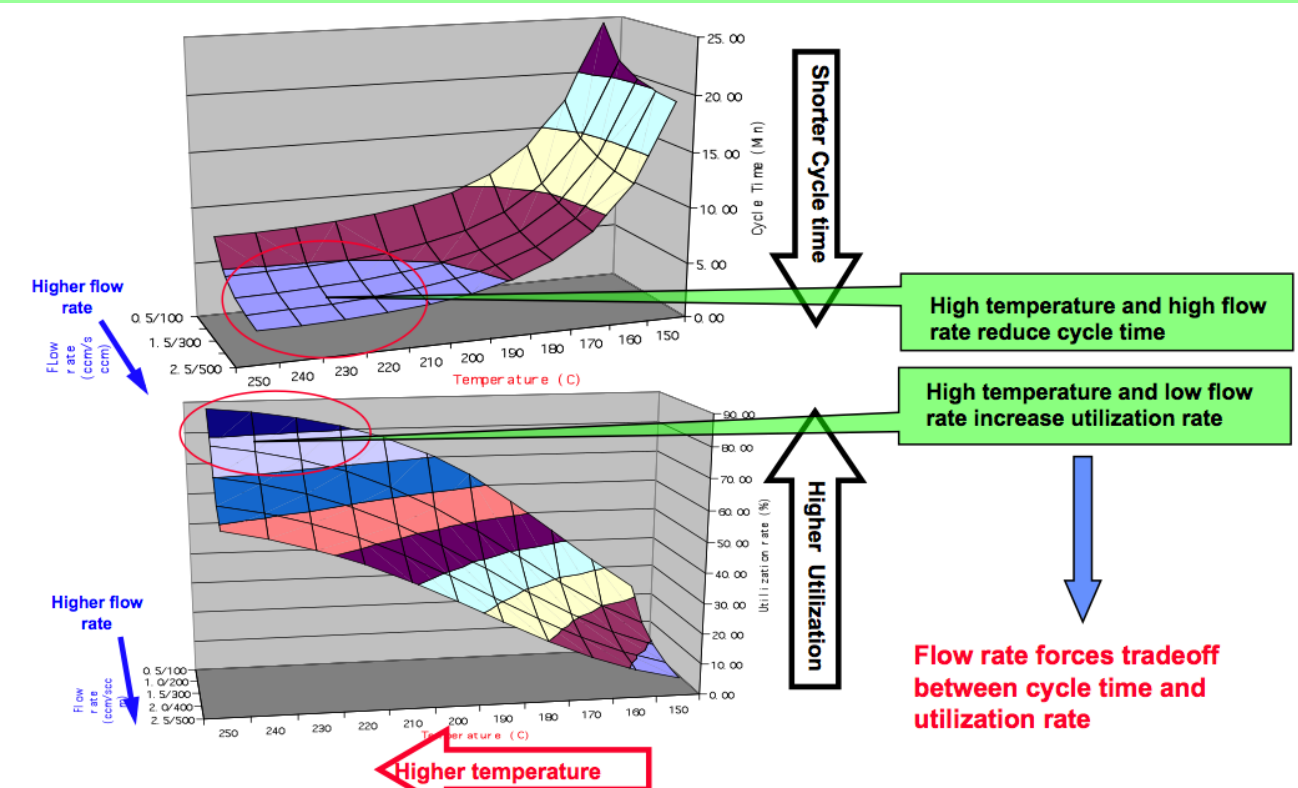
ISR Opportunity: design of multifunctional nanostructures and large systems with on-board control

Nanostructures for electrical energy storage are essential in next-generation energy technology for viable electric vehicles and use of renewable energy sources. **NEES, our DOE Energy Frontier Research Center** (\$14M, 5 yrs) is pursuing the science while ISR researchers expand this to broader energy applications, including solar and vibrational energy sources, integration with the grid level, and off-grid/remote applications.

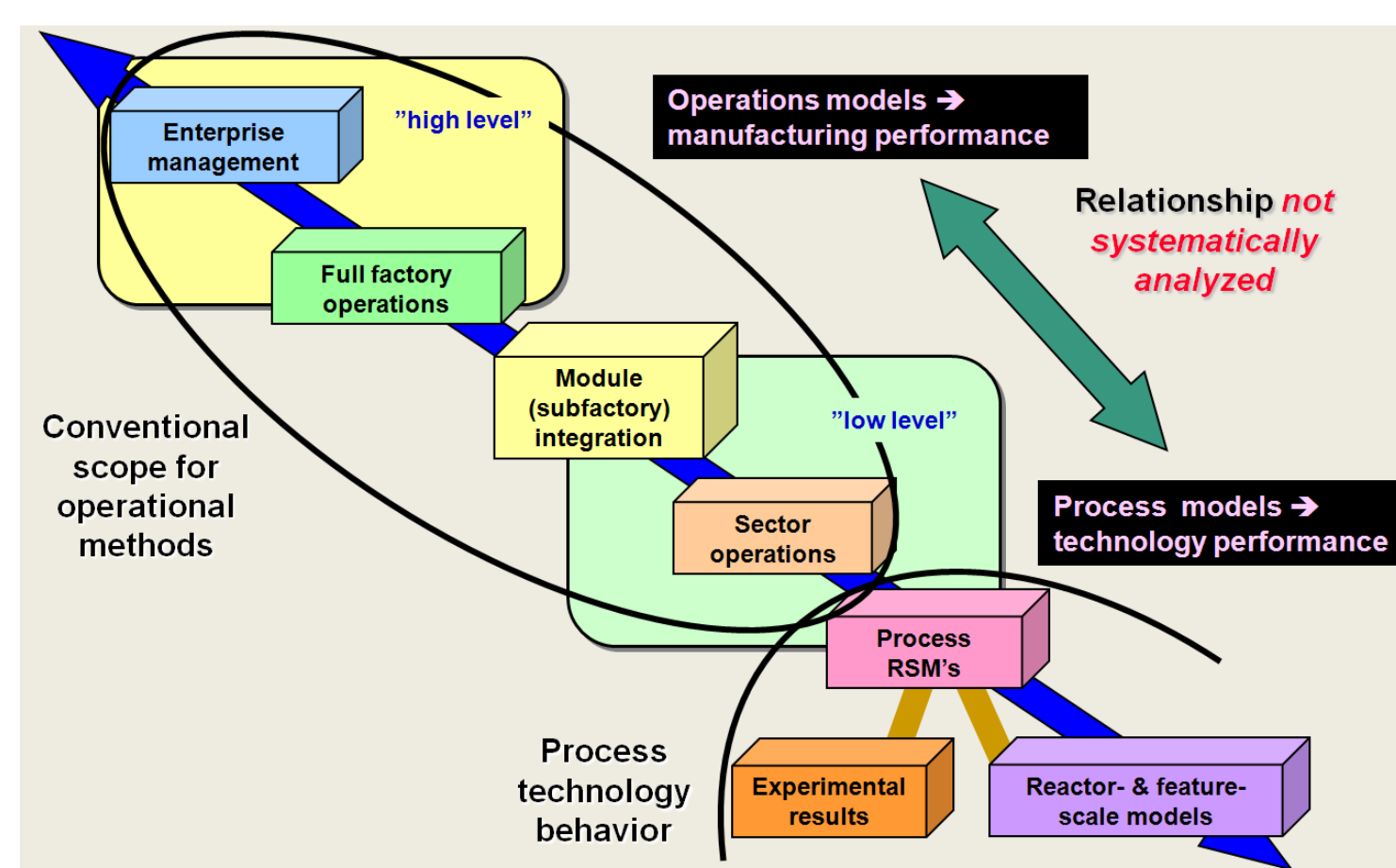
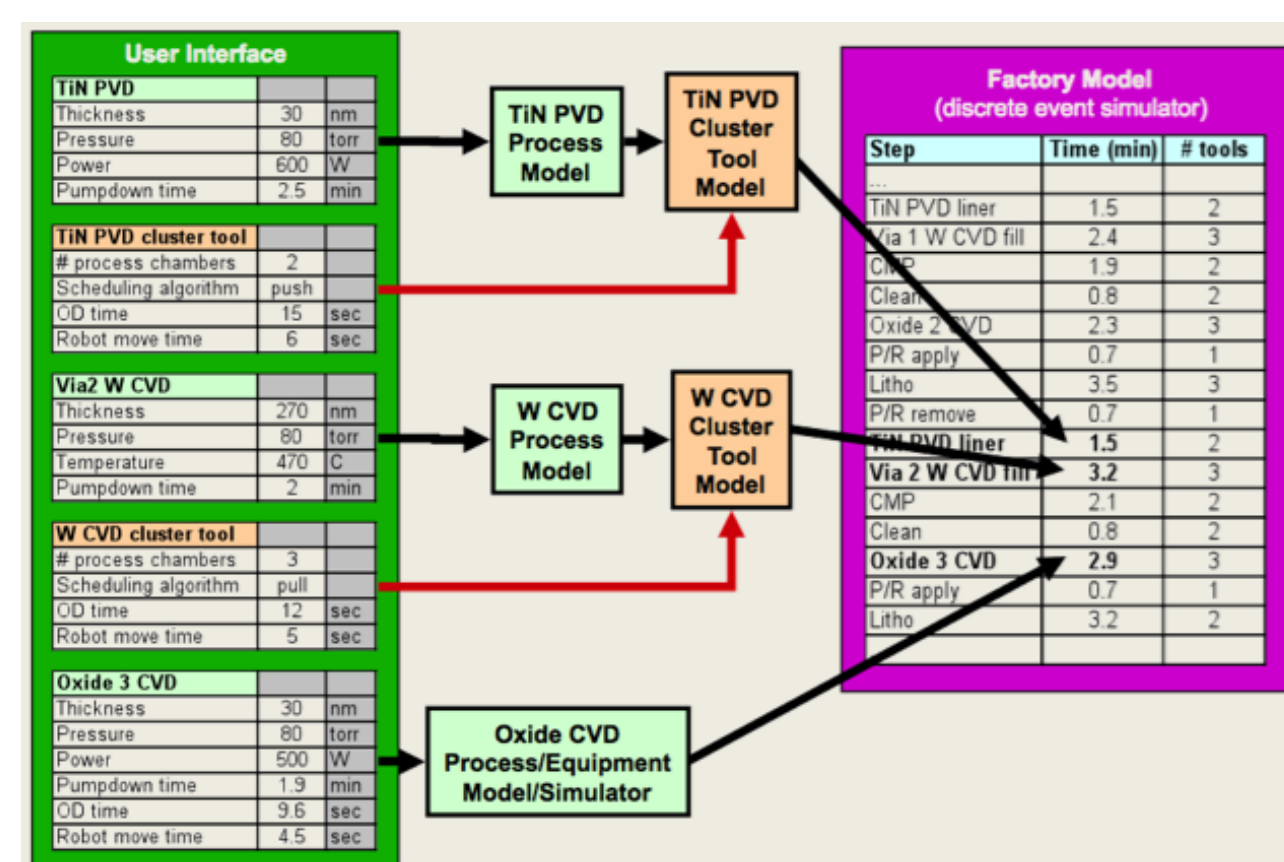


MODELING & DYNAMIC SIMULATION: Equipment, process, and factory

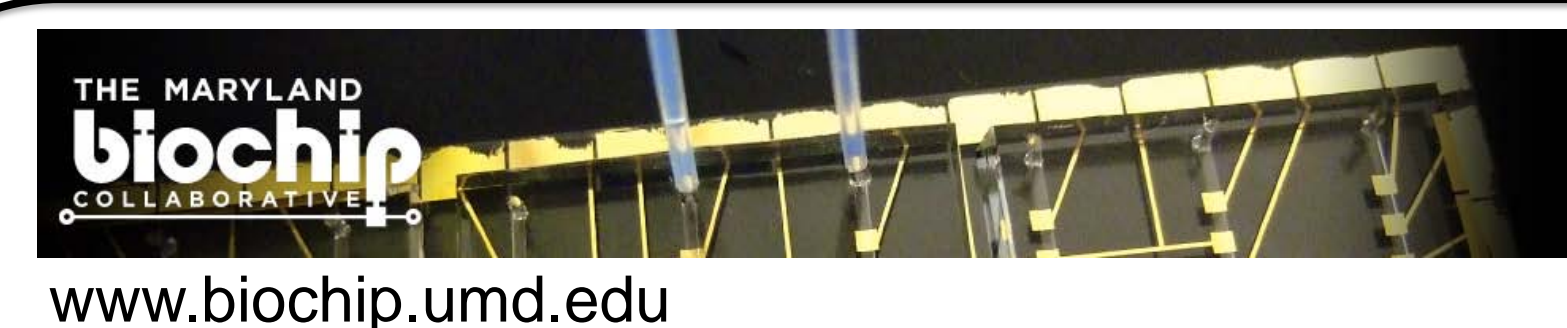
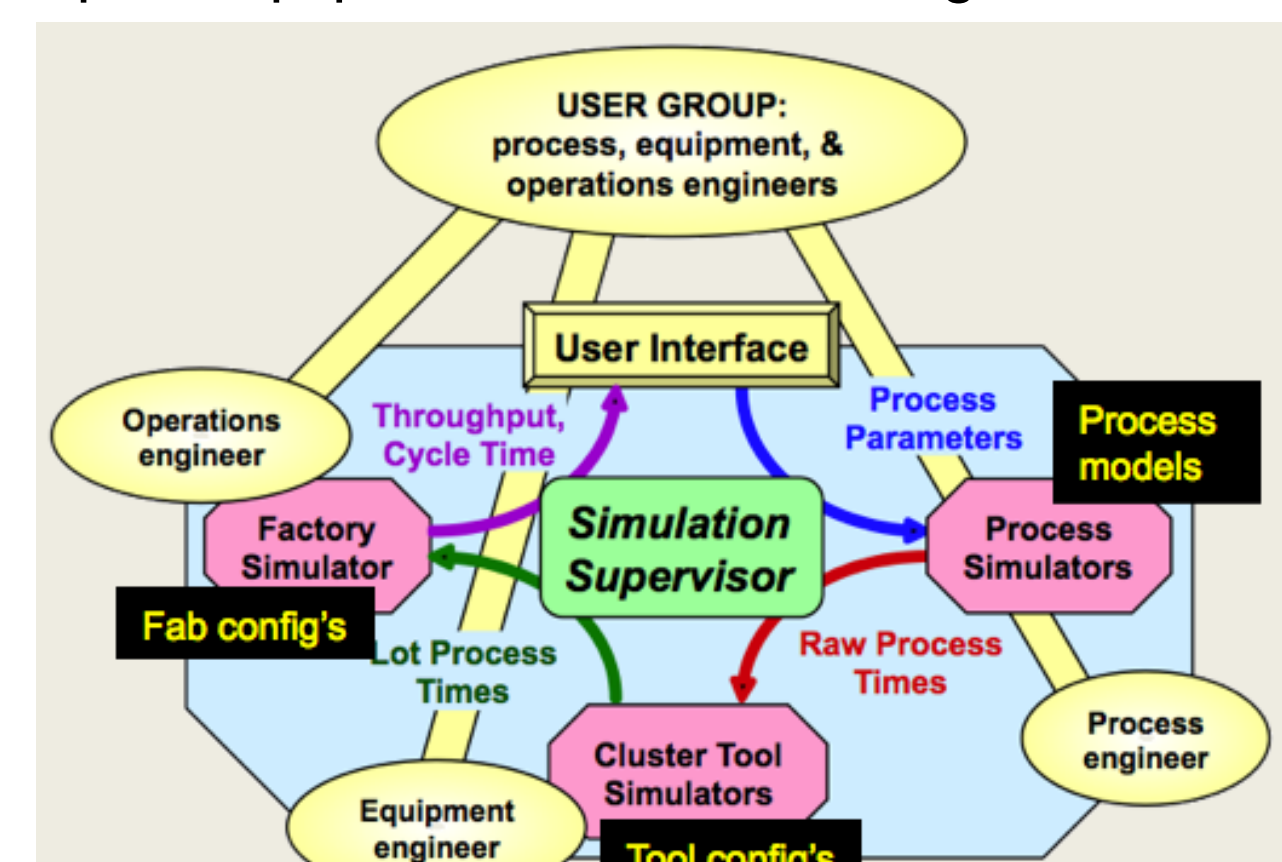
ISR Goal: contribute and collaborate to simulation-based research for knowledge capture and system design



Continuous parameter simulation enables understanding of dynamics, system design and optimization at level of equipment and process.



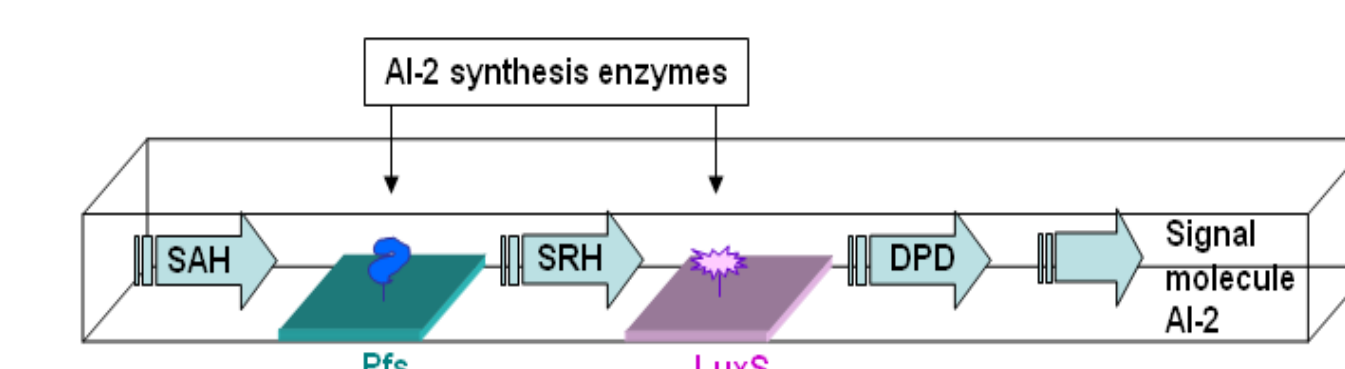
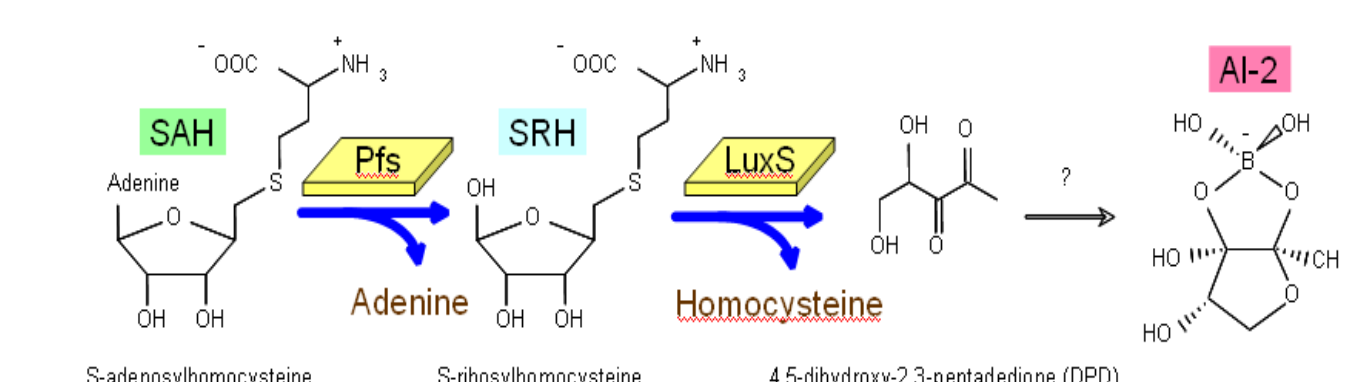
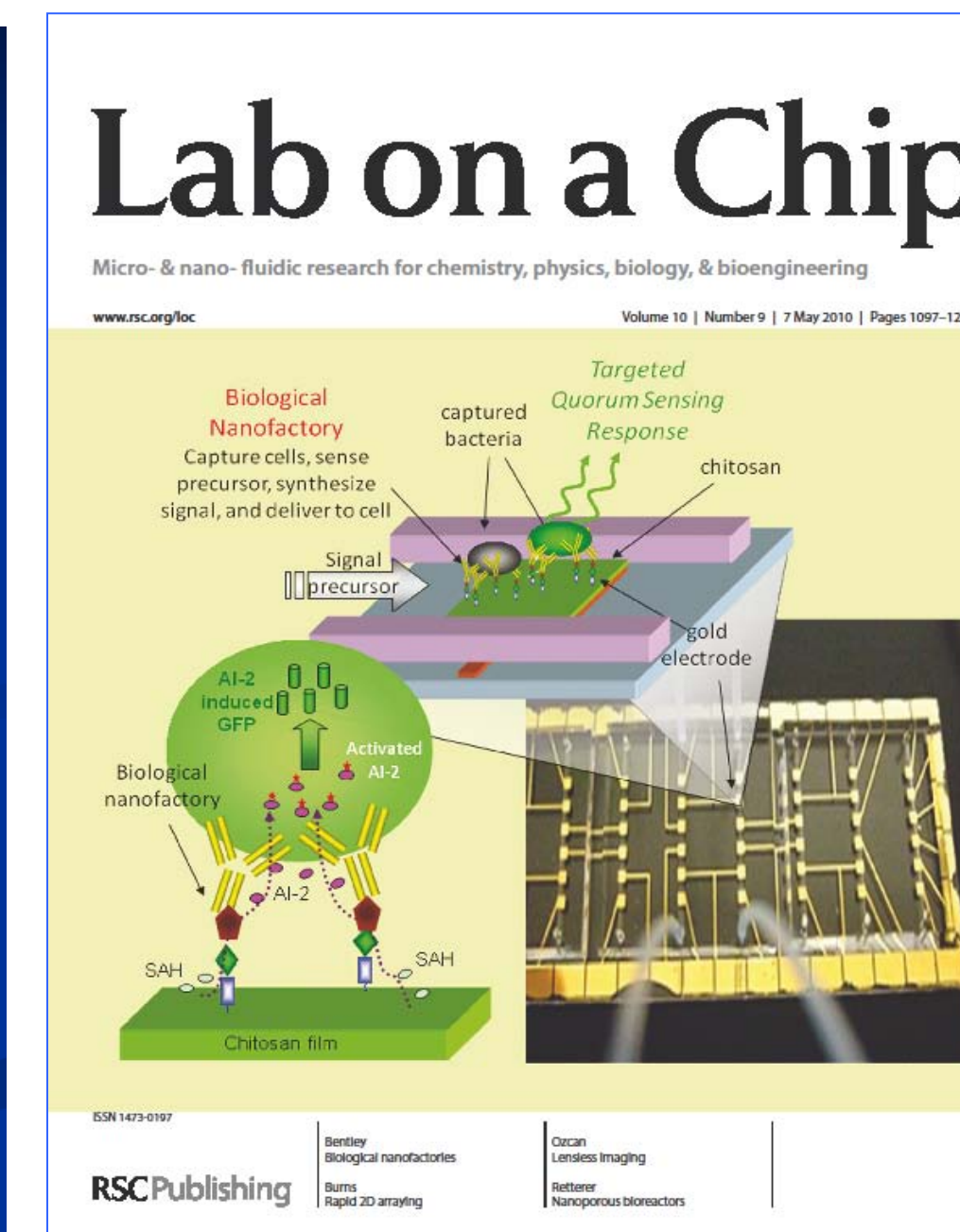
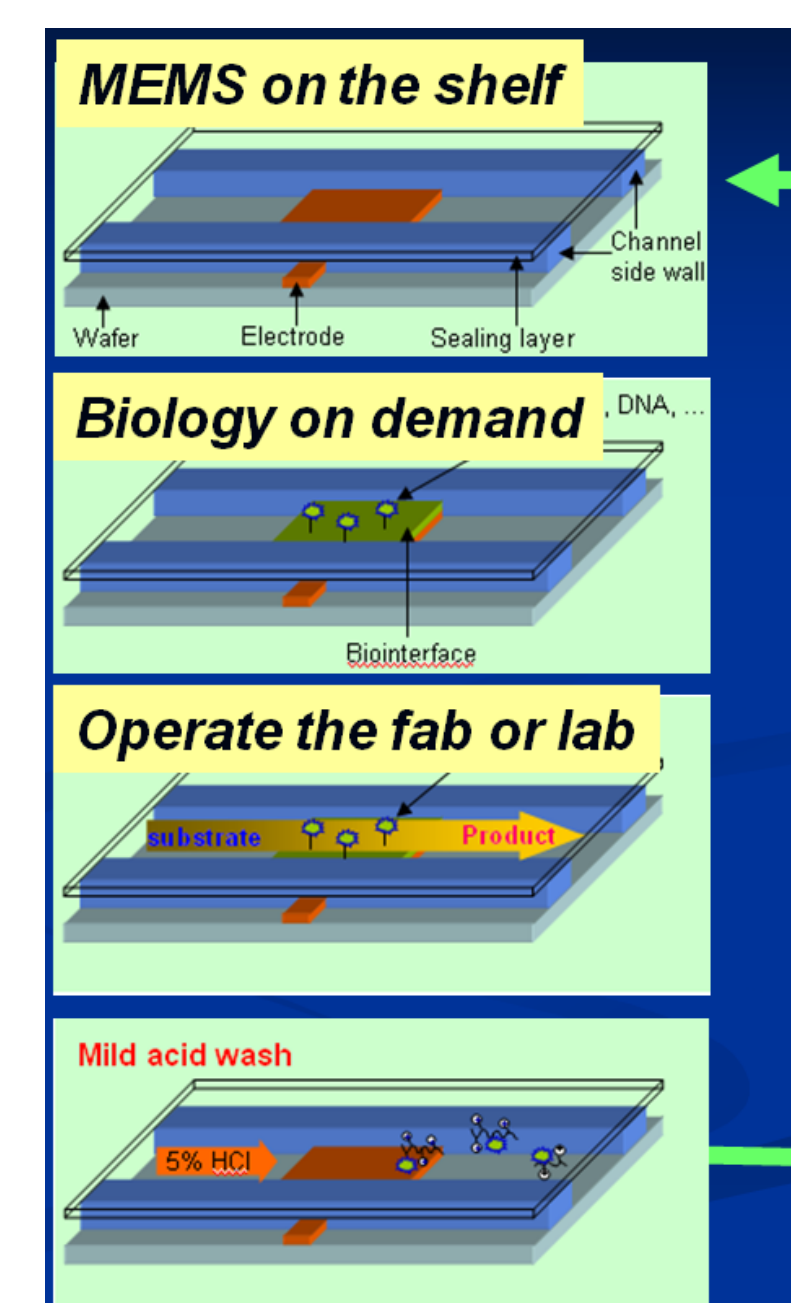
Integrating process models with factory level simulations combines continuous and discrete event simulations to reveal factory-level consequences of changes in processes, equipment architecture, factory capital equipment, and scheduling.



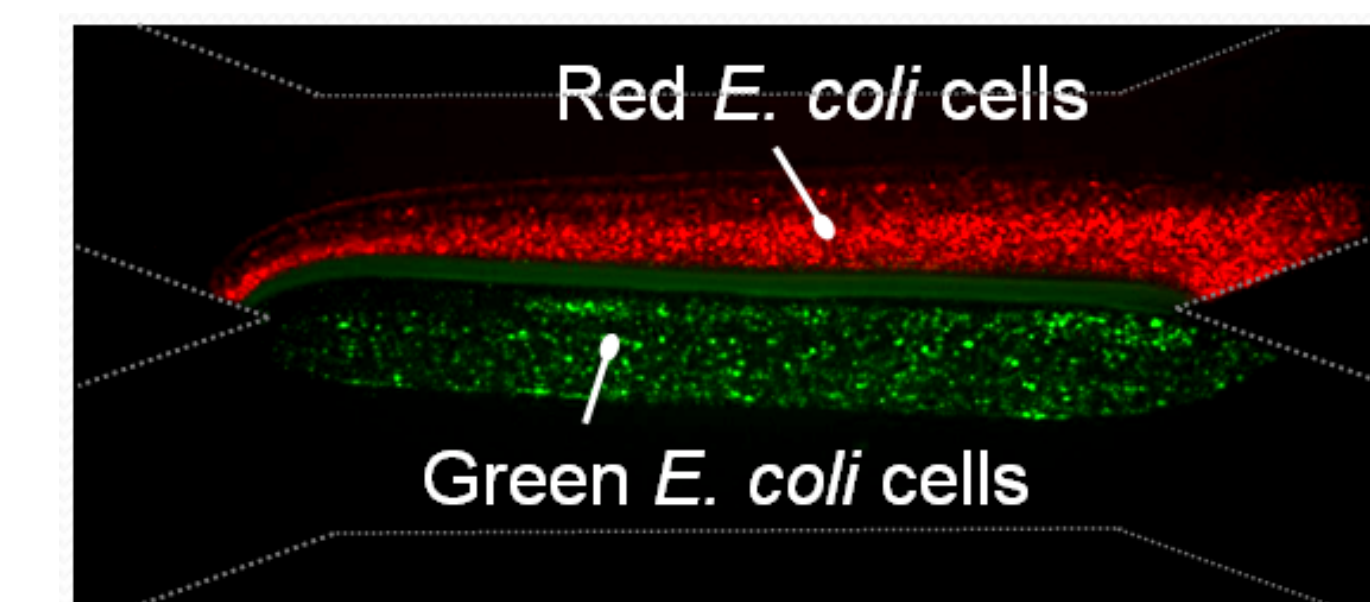
Nano-Bio Microsystems

ISR Opportunity: development of biomicrosystems as laboratories and factories for biotech applications

Nano-Bio Microsystems exploit MEMS microfluidics for biotech applications. Our **BioChip Collaborative** has pioneered the notion of biofabrication for programmable assembly of biomolecules and cells within prefabricated microfluidic chips, with benefit in metabolic engineering and cell signaling research.



Programmable assembly of biomolecules enables re-creation of metabolic (enzyme) pathways involved in bacterial quorum sensing on a chip as a platform for discovery of new antimicrobial drugs.



Spatial assembly of cell populations has been accomplished at both electrodes and interfaces, enabling investigation of biological signaling between populations and ultimately prototyping of personalized therapies.