



# AVS Northern California Chapter

Joint Users Group Meeting

Wednesday, June 29, 2022

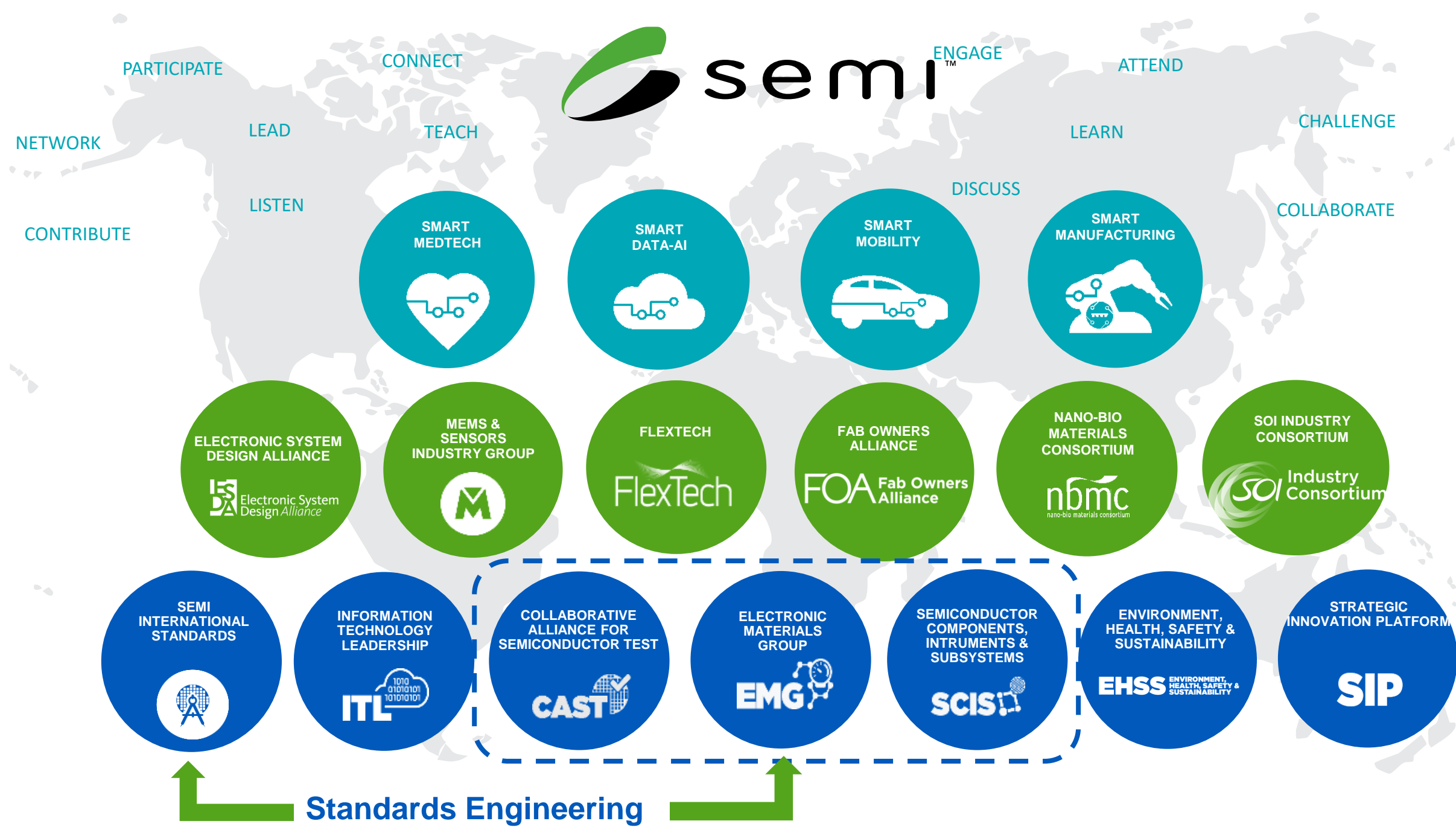
Melissa Grupen-Shemansky / CTO & VP of  
Technology Communities, SEMI

# SEMI

**SEMI PROVIDES PLATFORMS TO CONNECT THE  
GLOBAL ELECTRONICS SUPPLY CHAIN**



# Opening the Door to a World of Technology Communities



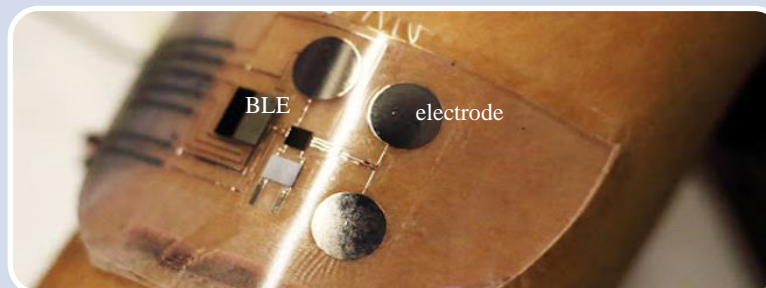
# FHE: The Best of Both Worlds

Conventional Electronics



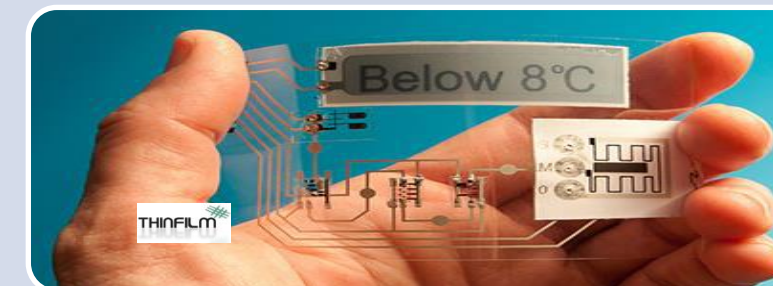
Rigid  
Etched **Cu** interconnect  
Surface mount packaged components  
**High performance packaged ICs**

Flexible/Conformal Hybrid Electronics



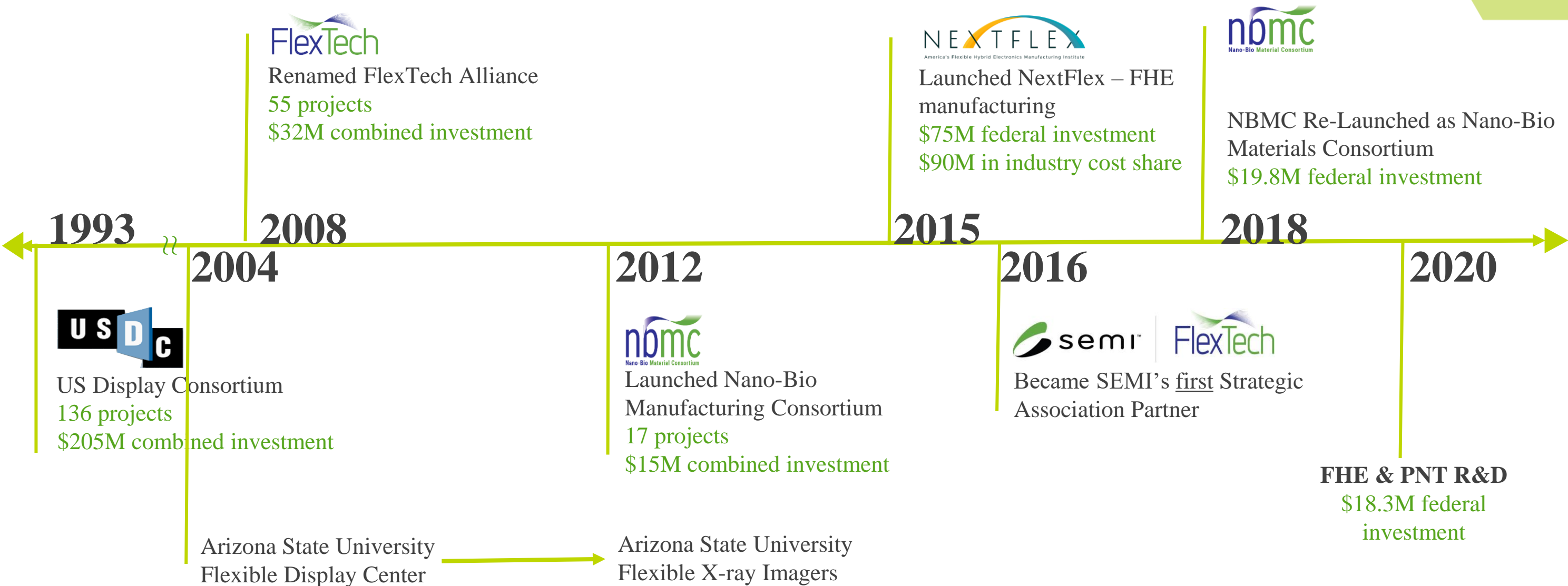
Conformal, unique form factors  
Printable  
Lightweight  
Large area compatible, possible roll-to-roll  
High performance, ultra-thin ICs  
The system is the package

Printed Electronics



**Conformal, unique form factors**  
**Fully printed**  
Low cost, **roll-to-roll**  
**Large area compatible**  
**Lightweight**  
Performance limited

# History of USDC - FlexTech – ARL Partnership





From our Industry Members

# FHE & The Future

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- **Achievements:**

- Flexible Display Center: not in the original plan but events unfolded, resources brought to bear, and 2<sup>nd</sup> and 3<sup>rd</sup> level uses for the technology discovered
- The birth of NextFlex (2015) dedicated to the development of FHE pilot manufacturing platforms and prototype products
- US FHE ecosystem development from fundamental materials, equipment/processes, & power systems to more recently, AI and FHE

- **Critical role of advanced packaging** and heterogeneous system integration in the US Electronic Resurgence Initiative (DARPA)

- Open the aperture: FHE is the flexible, heterogeneous version of 2.5D
- Emphasis is mobile, conformal, sustainable – not limited to “flexible”
- Additive processing and Environmental Sustainability
- PCB and security
- Smart Manufacturing and enabling reshoring

- **Uniqueness** of the FlexTech public-private partnership = development of the distributed ecosystem (adaptive, interdisciplinary, self-organized, thrives on partnerships, scalable, sustainable)

- Supply chain **resiliency**

# An Aging Infrastructure Will Benefit From Monitoring



## Bridges

- 50 years = average modern bridge lifetime as designed
- Stress and strain sensors
- Structural integrity sensors



## Drinking Water

- Increase # of breaks and repairs
- Waterborne diseases detection
- Screening for lead and other contaminants



## Public Transportation

- Vehicle wear detection
- Vibration monitoring for wings and engines



## Roads

- Vibration sensing of roadbed



## Dams and Levees

- Sensing for structural integrity

## Monitoring Requirements

- Large area and redundant sensing
- Cost effective
- Unique reliability
- Low maintenance
- Data storage and communication
- Automated analytics

# The Transportation Experience



## Autonomy

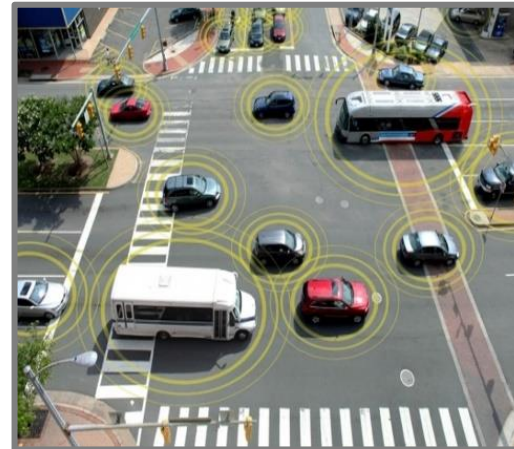
- Sensors
- Advanced driver assist
- Driver monitoring
- Highway pilot to full automation (SAE level 4-5)



Royole

## Cockpit of the Future

- Functionality meets interior design
- Driver and passenger monitoring
- Displays – curved, center stacked, head-up



## Connected

- Infotainment apps
- Local travelers' services
- Telematics for fleets, roadside assist, infotainment



## Safety & Security

- 360° birds eye view
- Information-rich lighting
- Anti-theft



## Fuel & Power

- Electric vehicles – batteries
- Energy harvesting windows / devices

## Monitoring Requirements

- Stringent automotive reliability requirements
- Cost effective
- Volume manufacturing
- Safety-critical standardization
- Anti misuse & abuse



## BMW iX Flow 2022, all electric

- A. Personalization, customization
- B. Information – external display of useful update
- C. Functional – control sunlight reflection and control energy / climate control

### Eink technology

- Does not consume energy in its display state, just in change of state.
- Electrophoretic ink-filled pixels on plastic
- Plastic-based TFTs
- Applied electric field brings neg (white) or pos (black) particles to surface.
- Black to white and all shades of grey



# Medical, Health and Wellness



## Cognitive Function

- Military, consumer, industrial, and athletics
- High value assets, safety, performance



## Telemedicine

- Vital sign and geriatric patient monitoring
- Reduced health care costs
- Continuous measurement capability



## Treatment Response

- Reduce treatment cycle times
- Reduced costs
- Lower mortality rates



## Aeromedicine

- Coordinated triage
- Continuous vital sign monitoring
- Variable / austere environment



## Performance Monitoring

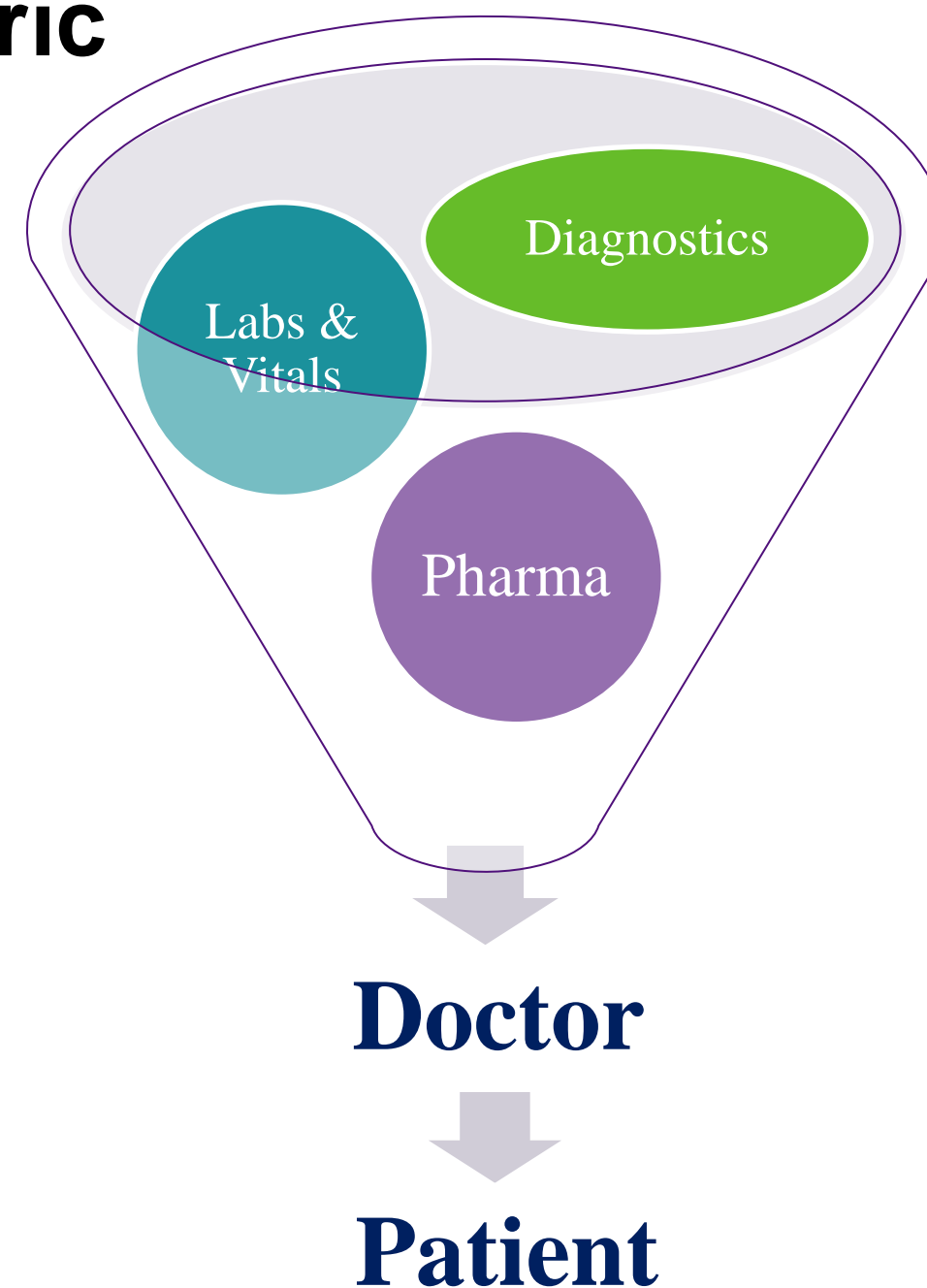
- Improved health and wellness
- Athletic performance enhancement

## Monitoring Requirements

- Cost effective
- Unique accuracy & precision
- Low maintenance
- Automated analytics

# Current Care Model Is Provider-Centric

New technology and systems innovation is dramatically changing this model

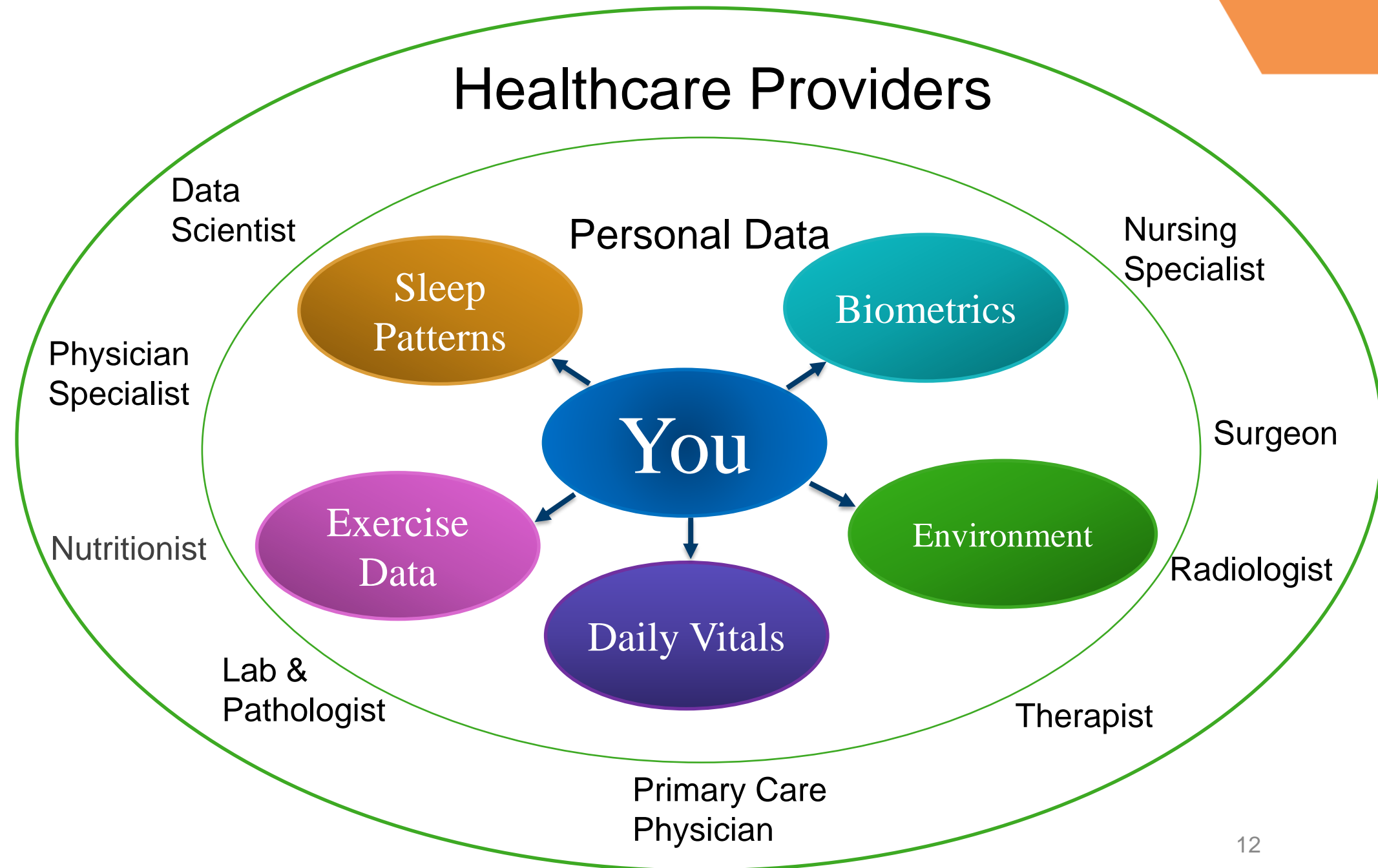




# Care Model Centered Around You

## Personalized Care Model

- Outcome-based
- Decentralized healthcare
- Large population database
- Personalized medicine
- Providers connected like never before





# SEMI Sponsored R&D: Bioling

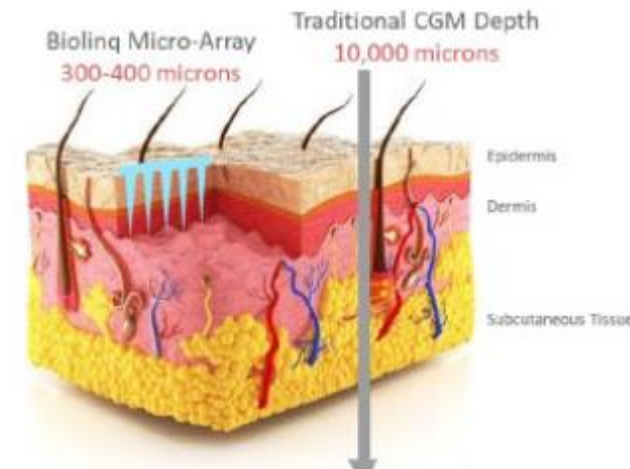
## A Microneedle Sensor Patch for Continuous Interstitial Fluid Cortisol Measurement

**Funds:** NBMC, SEMI & AFRL partnership

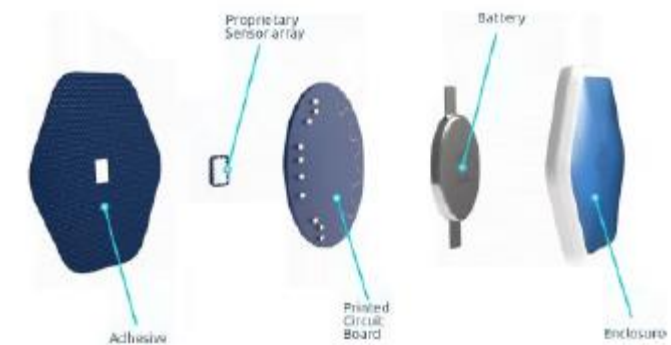
**Objective:** MEMS microneedle platform & benchtop demonstration of an end-to-end wirelessly enabled continuous cortisol monitoring system using clinical samples

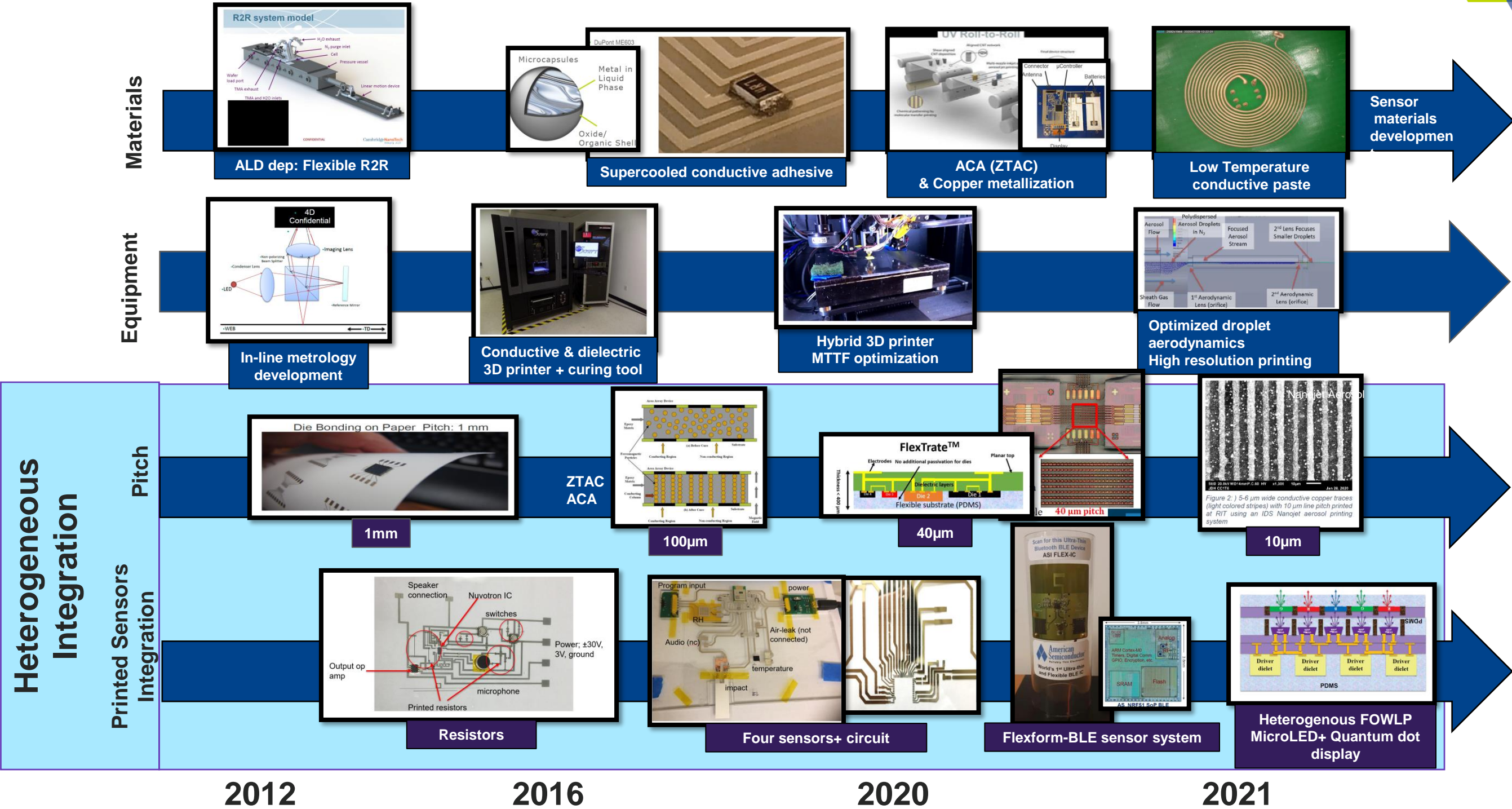
**Why:** Assess cognitive state, in real time to ensure safety for those engaged in high performance work

**How:** Novel analyte sensing system to passively measure circulating metabolites in the dermal interstitial fluid – microneedle array sensor.

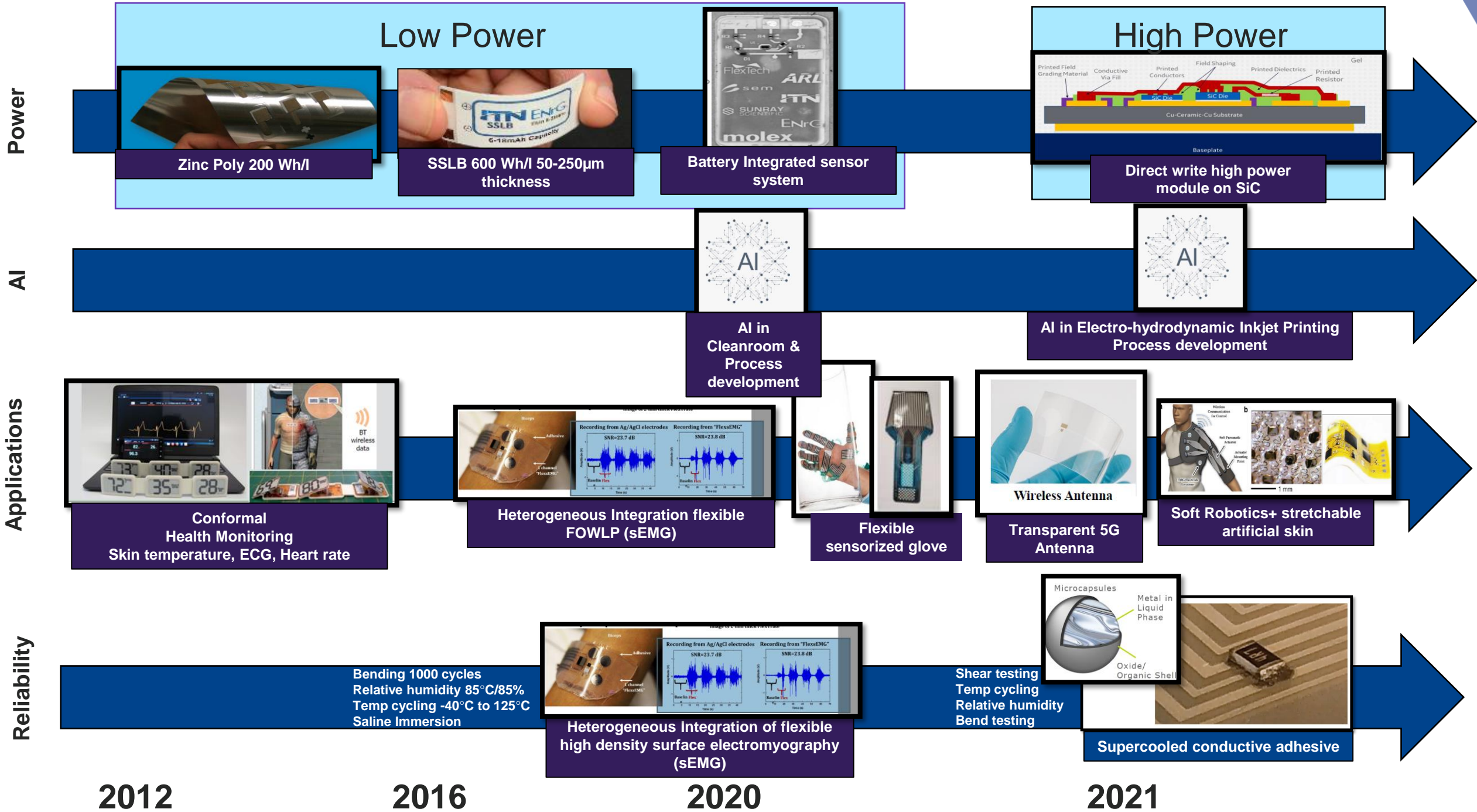


Venous plasma samples collected from the antecubital every 5 – 15 minutes.

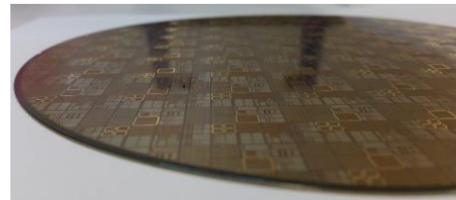




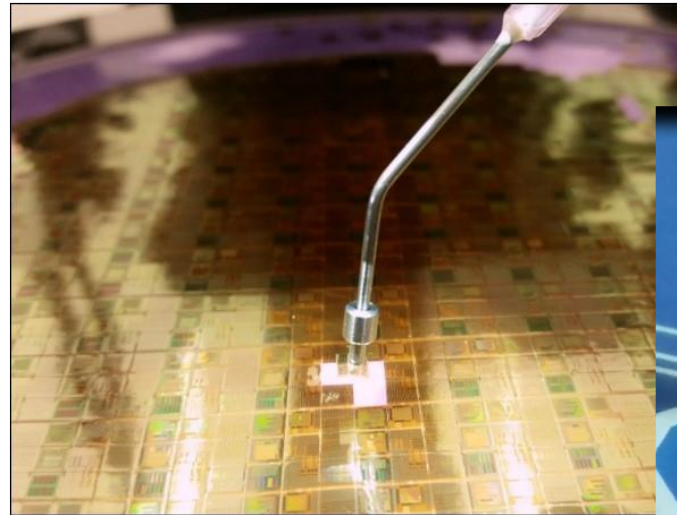




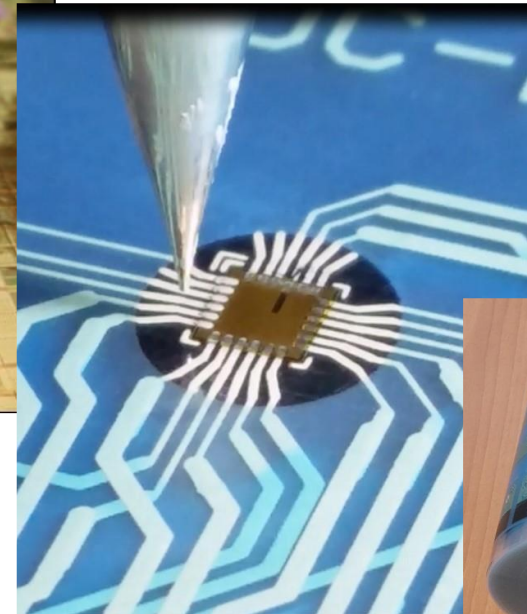
# Flexible High-Performance ICs



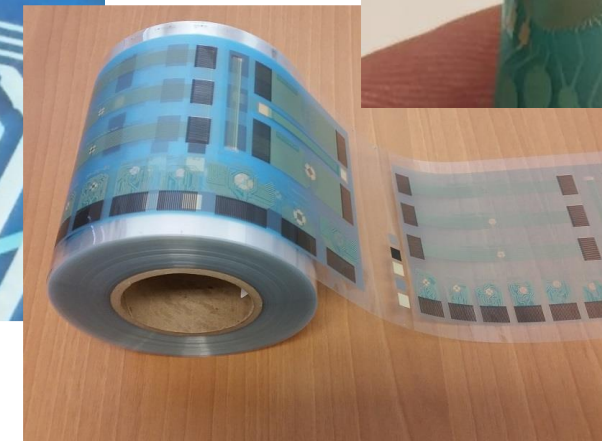
CMOS wafer prep



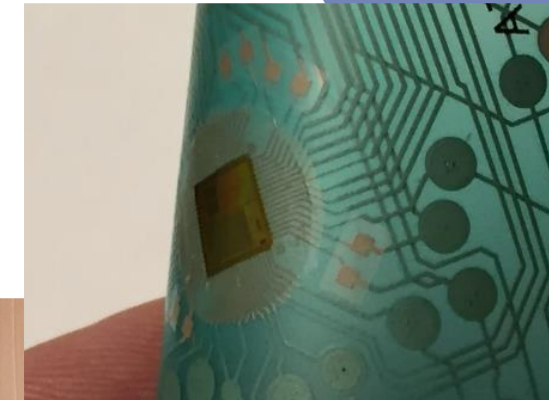
Pick & Place



3D Additive Interconnection



Roll to Roll Manufacturing



**Lead:** American Semiconductor

**Team:** Molex

**Objective:** Demonstrate Flexible Hybrid Electronics (FHE) manufacturing capability with FleX-IC integration assembly through the function of body-worn sensors

**Delivered:** Advancements from the FleX wafers to final assembly of the FHE systems:

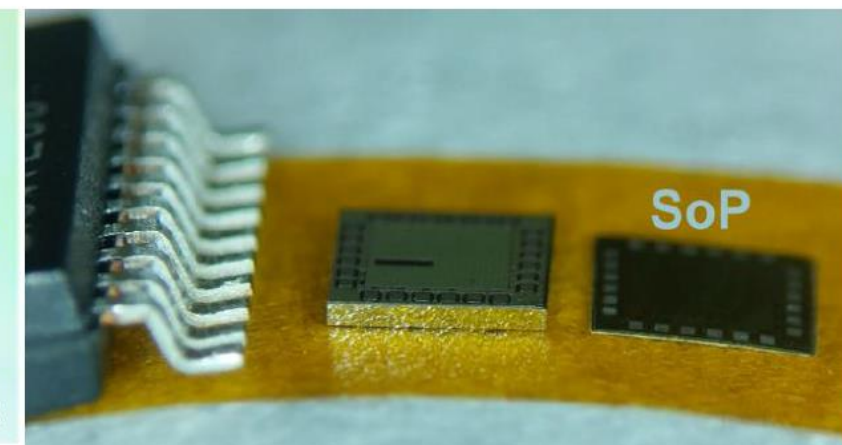
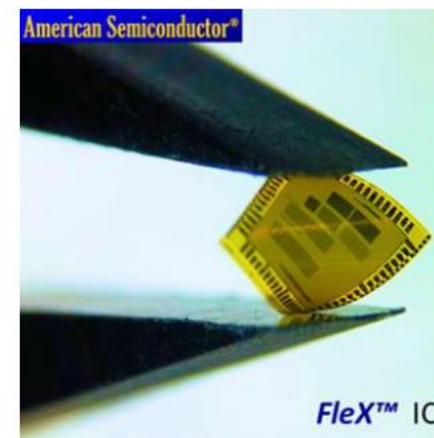
- FleX wafer handling MRL3 -> MRL6
- FleX wafer dicing and FleX-ID pick MRL2 -> MRL6
- FleX-IC place to FHE substrate MRL 3 ->MRL5

**Status:** American Semiconductor advanced packaging technology and services provide ultra-thin capabilities <https://www.americansemi.com>



# FHE Sensor Development Kit

- Lead: American Semiconductor
- **Team:** Boise state University, Dupont, HD MicroSystems, ITN
- Objective:
  - Develop a Flexible Hybrid Electronics sensor system reference design with wireless Bluetooth Low Energy (BLE) data communication for environmental sensing applications.
  - Develop an APP that wirelessly scans, reports status, graphs data, and can be used to configure system.
- Key Technical Achievement
  - Multiple sensors can be integrated and tested within this platform
  - FHE integrated system + APP
  - Ultra-thin, flexible BLE SoC (Nordic nRF51822)
  - Advanced flip chip ACA assembly



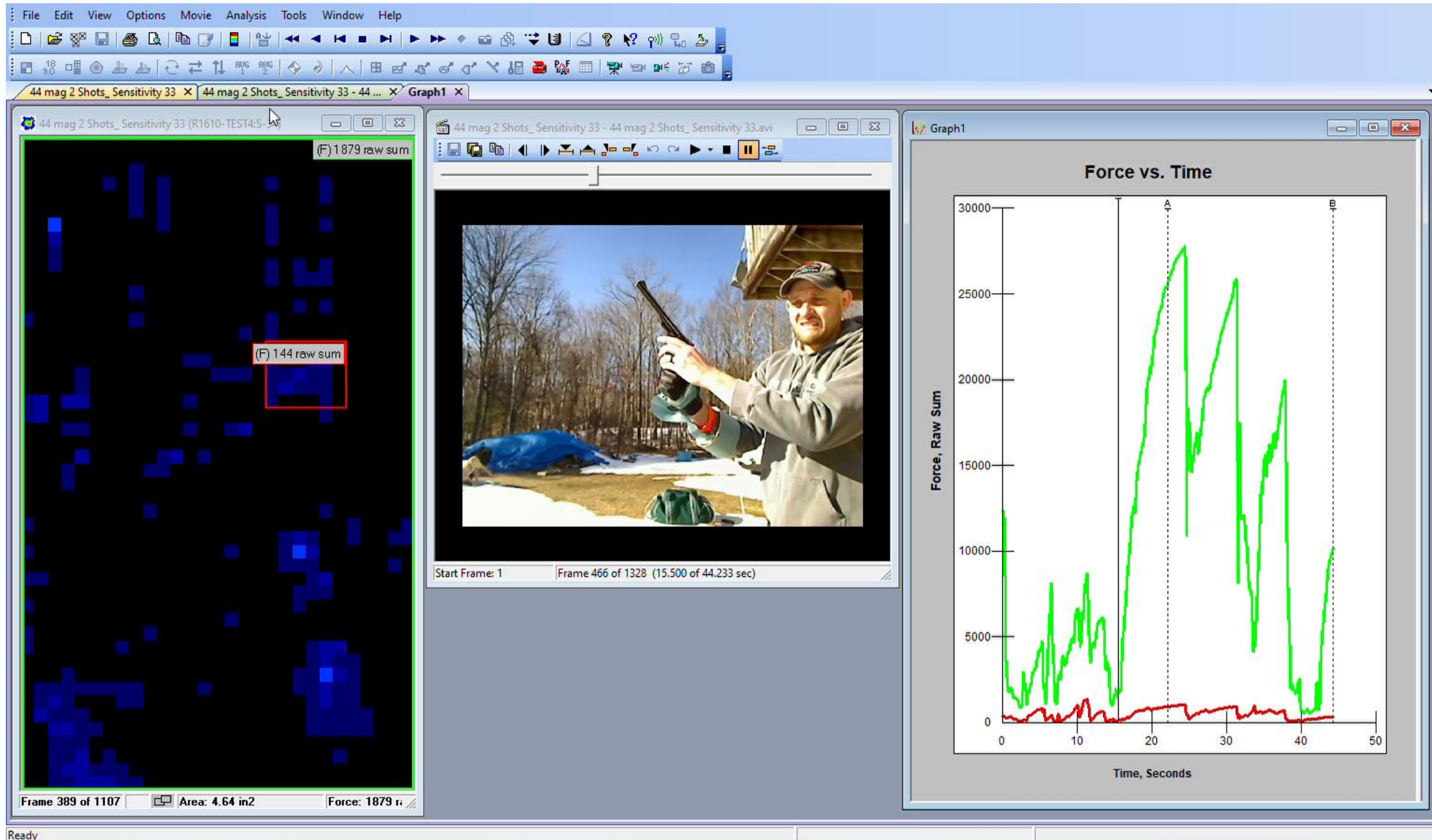
**FleX-SoP IC Compared in Size to Packaged IC and Traditional Bare Silicon Die**

# Flexible Sensorized Glove

- Lead: TekScan
- Objective:
  - Develop a fully integrated pressure-sensitive glove with wireless data output relaying tactile force/pressure used during tool operation.
  - Training, corrective action, robotic translation
- Key Technical Achievements:
  - Printed force sensors (resistive composite element)
    - 1000 sensing cells on the palm and side of hand
  - Flexible substrate (TPU) for the electronic circuit
  - Additive electronic circuit printing process with pressure sensitive and dielectric inks
  - A flexible conductive and pressure sensitive ink system coupled with flexible substrate (Flexible printed electronics force sensing resistor).

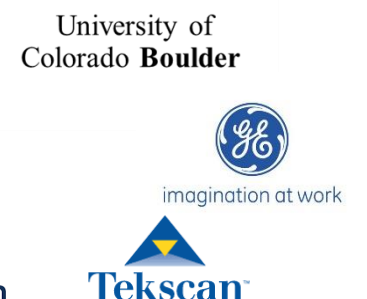
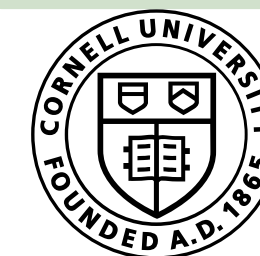
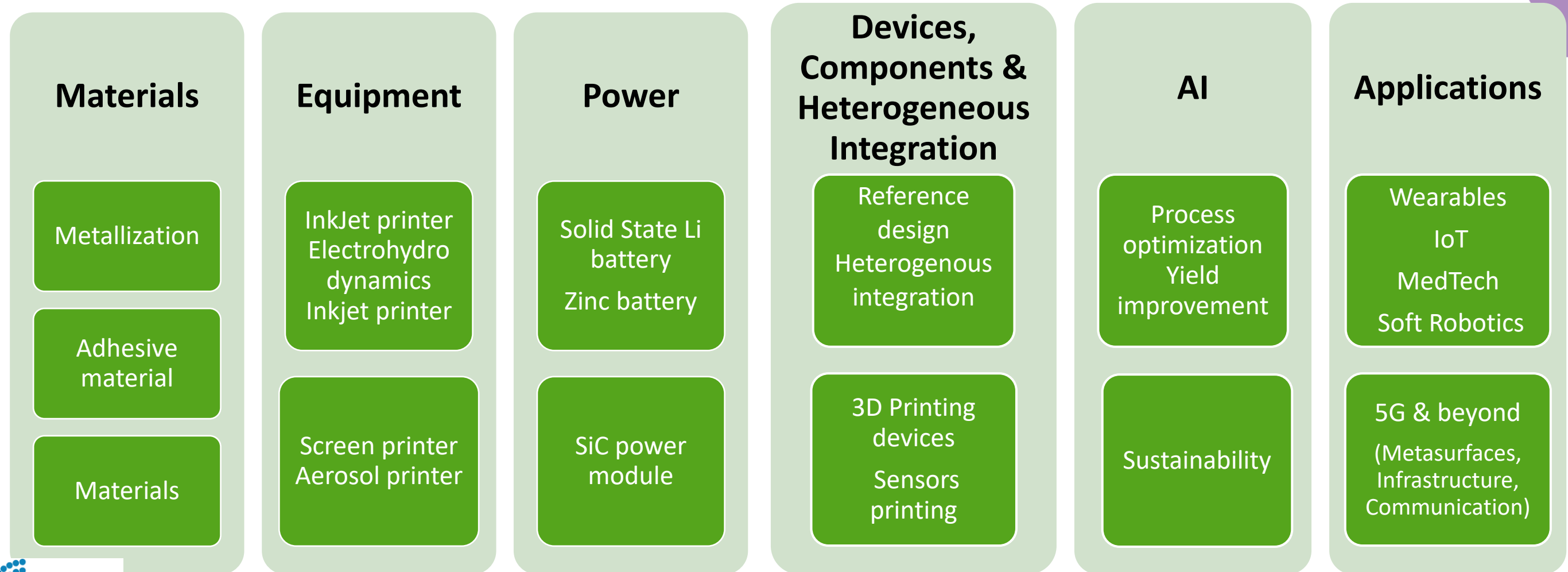


Figure 1b: Final glove form factor in use gripping 9mm pistol





# Supply Chain : Technology Chain





# FLEX CONFERENCE & EXHIBITION

July 11-14, 2022  
Moscone Center  
San Francisco, CA

## ELECTRONICS IN MOTION

FLEX, the Flexible Hybrid Electronics (FHE) go-to event is the center of technical and informative demonstration of flexible hybrid and printed electronics products, equipment, processes & materials, and the applications they enable.

The FLEX Conference features the latest advances in flexible and printed electronics, including applications that deepen interactions between users and their surroundings, including innovations emerging from public-private partnerships formed by—FlexTech, NBMC (Nano-Bio Materials Consortium) and NextFlex.

FLEX is so much more than a conference and tradeshow. It is the annual touchpoint centered around flexible hybrid, printed electronics products, equipment, processes, and materials, emphasizing the latest technical breakthroughs, unique electronics applications, and business strategies.

You'll get SOLID, USEFUL, ACTIONABLE, technical information enabling you to move faster and smarter with real-world solutions.

## CONFERENCE HIGHLIGHTS

3 Keynotes | 2 Panel Discussions | 16 Technical Sessions | FLEXTalks | Student Poster Session | FLEXI and Student Poster Awards | Exhibition | MedTech, Mobility, Sustainability, and Workforce Development Sessions | Networking | Countless Business Opportunities Await You!

## WHO SHOULD ATTEND

- Executive Management
- Business Development
- Market Analysts
- Trends Forecasters
- Sales Teams
- Technical Leadership
- Human Resources and Staffing
- Market Intelligence
- Investors & Financial Analysts
- Materials Engineers
- Quality Control Engineers
- Manufacturing Leadership
- Engineering & Design Staff
- Packaging and Assembly Engineers

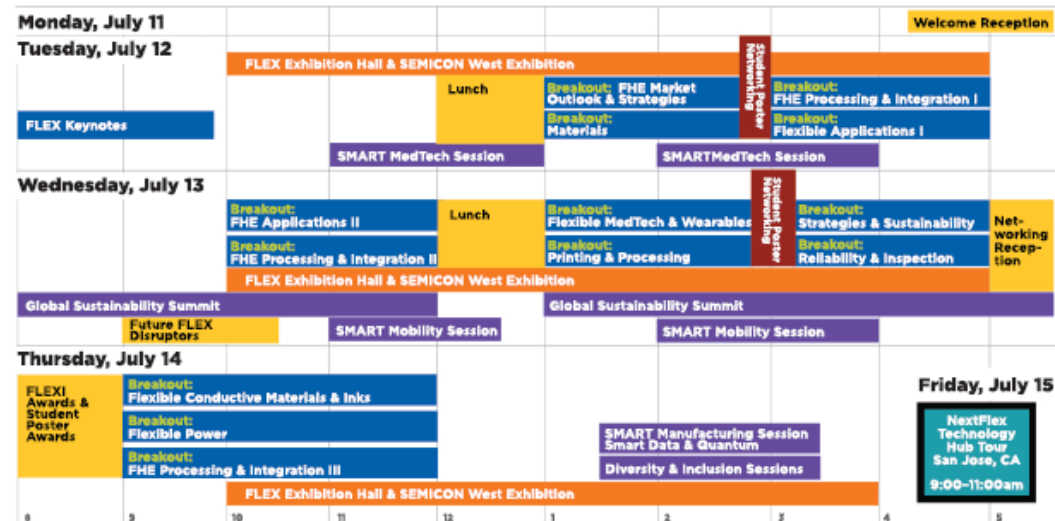
Organized by



Co-located with SEMICON West

[flex.semi.org](http://flex.semi.org)

## FLEX AGENDA-AT-A-GLANCE



## KEYNOTES



John Williams, PhD  
Boeing Research and Technology

Multilayer Flexible Electronic Devices  
for IoT and RF Applications



Michael D. McCreary  
E Ink

Electrophoretic Display Technology Will  
Change the Look of Automobiles,  
Transportation and Beyond



Dawson Cagle, PhD  
IARPA

IARPA's SMART Epants Program—  
Weaving Electronics Into Textiles

## FEATURED EXHIBITORS

- ACI Materials
- Alertgy Inc.
- Ateios Systems
- Bayflex Solutions
- Brilliant Matters
- Chemcut Corporation
- Converting Quarterly/AIMCAL
- E Ink Corporation
- Eastman Kodak
- Honeywell Analytics
- Innovize
- J.A. Woollam
- Komori America Corporation
- Liquid X
- MacDermid Alpha Electronics Solutions
- Metalor
- MicroConnex
- Nagase Chemtex America LLC.
- Neotech AMT GmbH
- nScript
- NSM Norbert Schaffli/NTV
- RN Technologies
- University of WA - Washington Clean Energy Testbeds



[flex.semi.org](http://flex.semi.org)



**THANK YOU**

# R&D Programs

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# SEMI Builds Communities in Growth Segments

