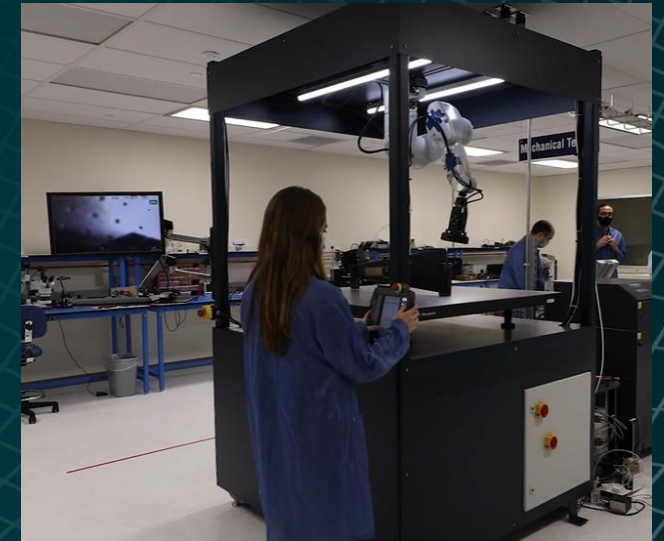
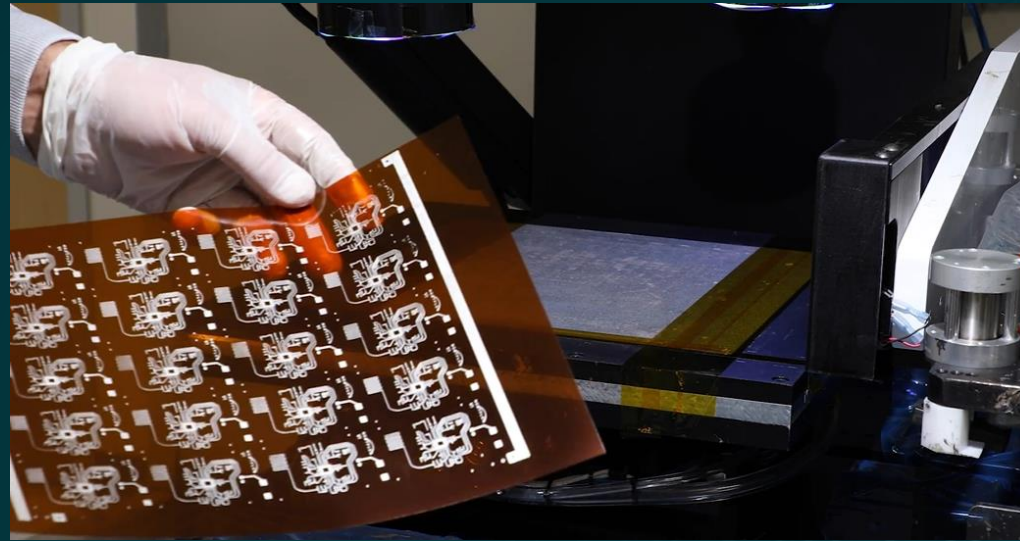
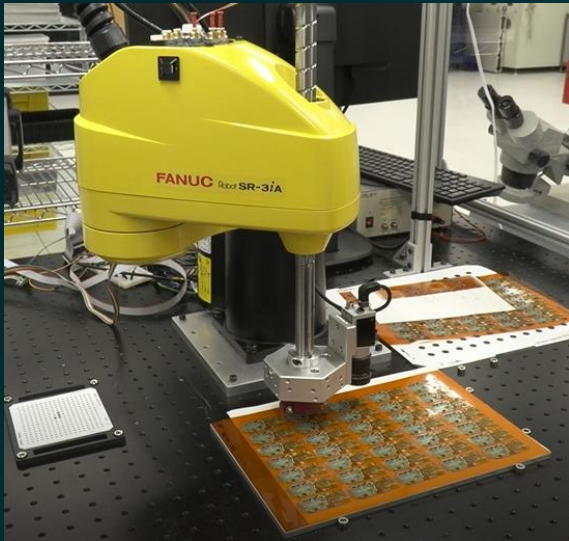


NEXTFLEX[®]



NEXTFLEX

BUILDING THE FHE COMMUNITY



SCOTT M. MILLER, PH.D.
DIRECTOR OF TECHNOLOGY
OCTOBER 27, 2022

ACKNOWLEDGMENT



This material is based on research sponsored by Air Force Research Laboratory under agreement numbers FA8650-15-2-5402 and FA8650-20-2-5506. The U.S. Government is authorized to reproduce and distribute reprints for Governmental purposes notwithstanding any copyright notation thereon. The views and conclusions contained herein are those of the authors and should not be interpreted as necessarily representing the official policies or endorsements, either expressed or implied, of Air Force Research Laboratory or the U.S. Government.

Manufacturing USA connects people, ideas and technology to solve industry-relevant advanced manufacturing challenges. The 16 Manufacturing Innovation Institutes, 9 of which are funded by the Department of Defense, are enhancing industrial competitiveness and economic growth and strengthening our national security. The Institutes have three shared goals:

1. Advance the manufacturing & technology process to full scale production

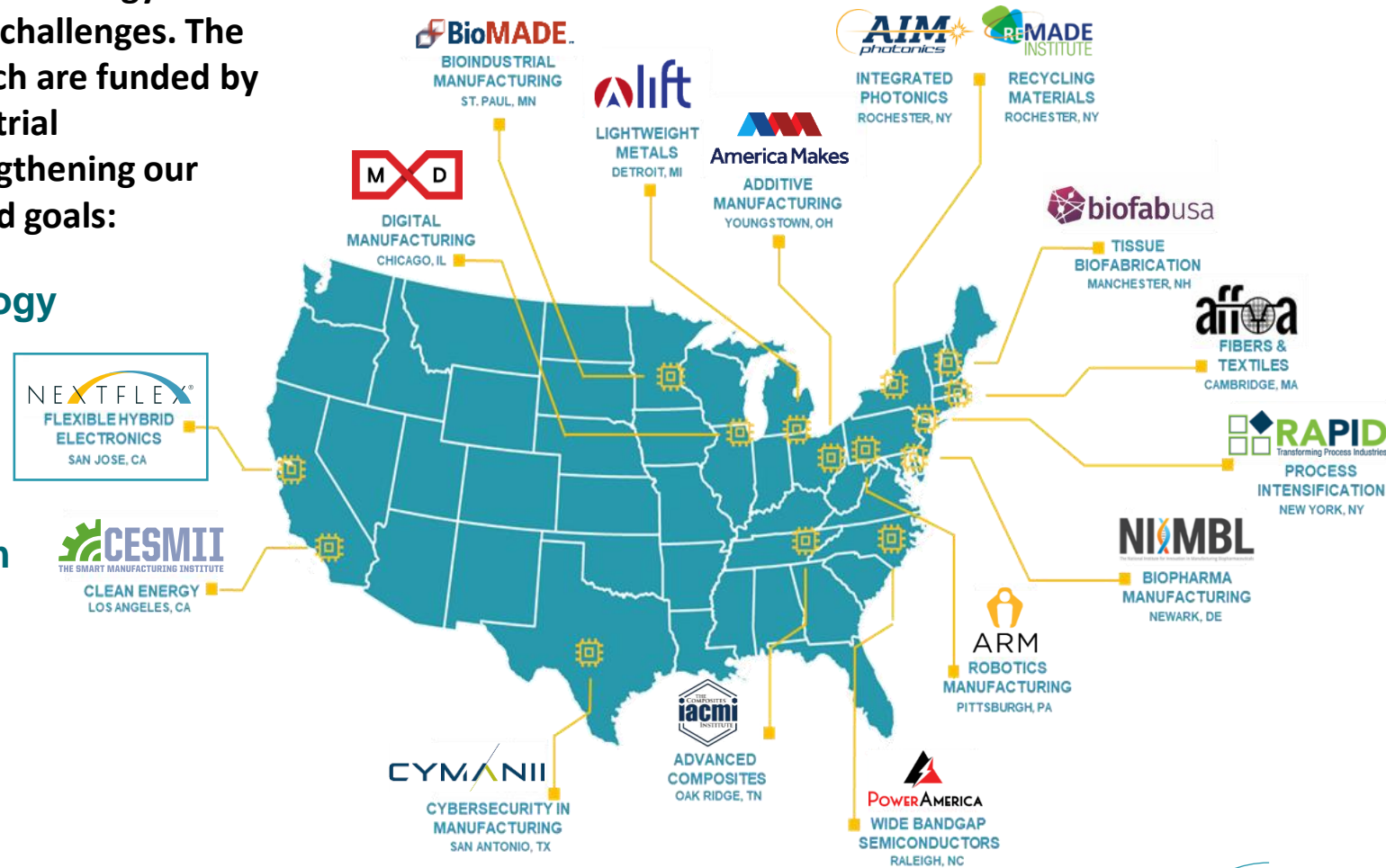
Partner with industry to investment in applied research and industrially-relevant manufacturing technologies

2. Create a robust commercial ecosystem around the technology

Establish regional manufacturing hubs and ecosystems for long-term, national impact

3. Secure human capital

Develop manufacturing-specific education and workforce development resources to ensure innovative technology is manufacturable



NEXTFLEX: A PUBLIC-PRIVATE PARTNERSHIP



Established		28 August 2015
Hub Location		San Jose, California
Agreement Period		2015 – 2027
Industry & Academic Members		100
Government Agencies Engaged		>40 DoD & OGAs
State / Regional Hubs		NY, MA, MO
Workforce Partners		50 companies 34 colleges >100 K-12 districts
Core Federal Funding		\$102 million
Committed Cost Matching		\$146 million
Agency Projects		120; \$185 million
Core Funded Project Calls		81; \$124M total value



MISSION

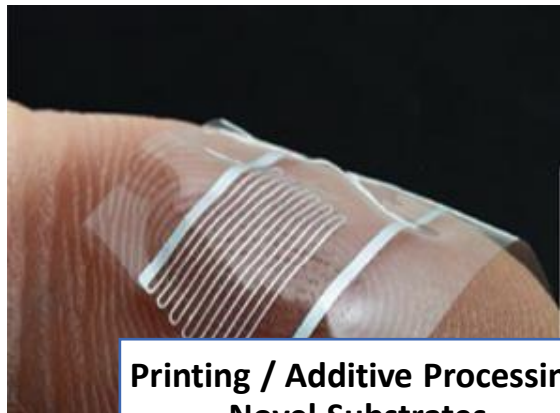
Create a leadership position for the U.S. industrial base for Flexible Hybrid Electronics (FHE) and related additive electronics manufacturing.

- Establish and grow a strong U.S. FHE manufacturing ecosystem and supply chain
- Serve DoD and industry with engineering and manufacturing capability; develop and disseminate technology
- Develop human capital

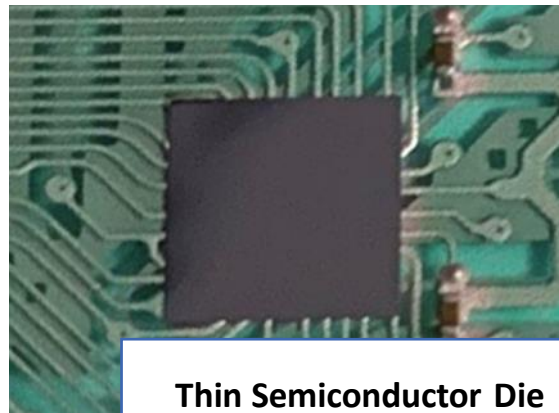
FLEXIBLE HYBRID ELECTRONICS: NEXTFLEX PERSPECTIVE



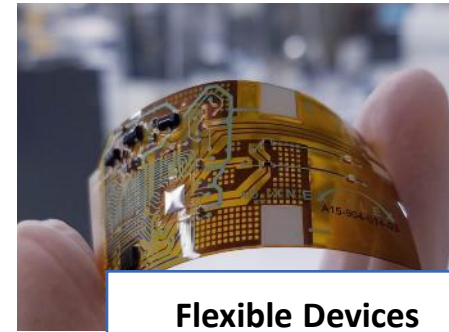
Flexible Hybrid Electronics (FHE) is an electronics technology and manufacturing approach that combines printed / additive manufacturing with the performance of semiconductor devices.



**Printing / Additive Processing
Novel Substrates**



Thin Semiconductor Die



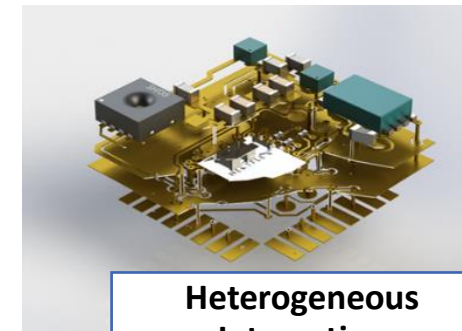
Flexible Devices



**Structural / Conformal
Electronics**



**Advanced Packaging &
Automation**



**Heterogeneous
Integration**



WHAT WE DO



- Nationwide Workforce Development Programs



- FHE Consortium: 100 Members and Growing

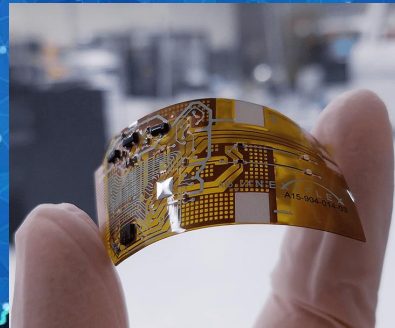


- Regular Communication
- Webinars & Workshops Events



- NextFlex Technology Hub: Design & Prototyping Services

NEXTFLEX®



- Project Calls: \$124M to Develop FHE Manufacturing



- 11 Tech. Working Groups with 5-Year Roadmaps that Validate Market Needs



BRINGING TOGETHER THE FHE ECOSYSTEM



DESIGN/MANUFACTURING



EQUIPMENT



INDUSTRIAL/AEROSPACE



MEDICAL/WEARABLE DEVICES



RESEARCH



DESIGN/COMPONENT MANUFACTURING



MATERIALS



INDUSTRY STANDARDS



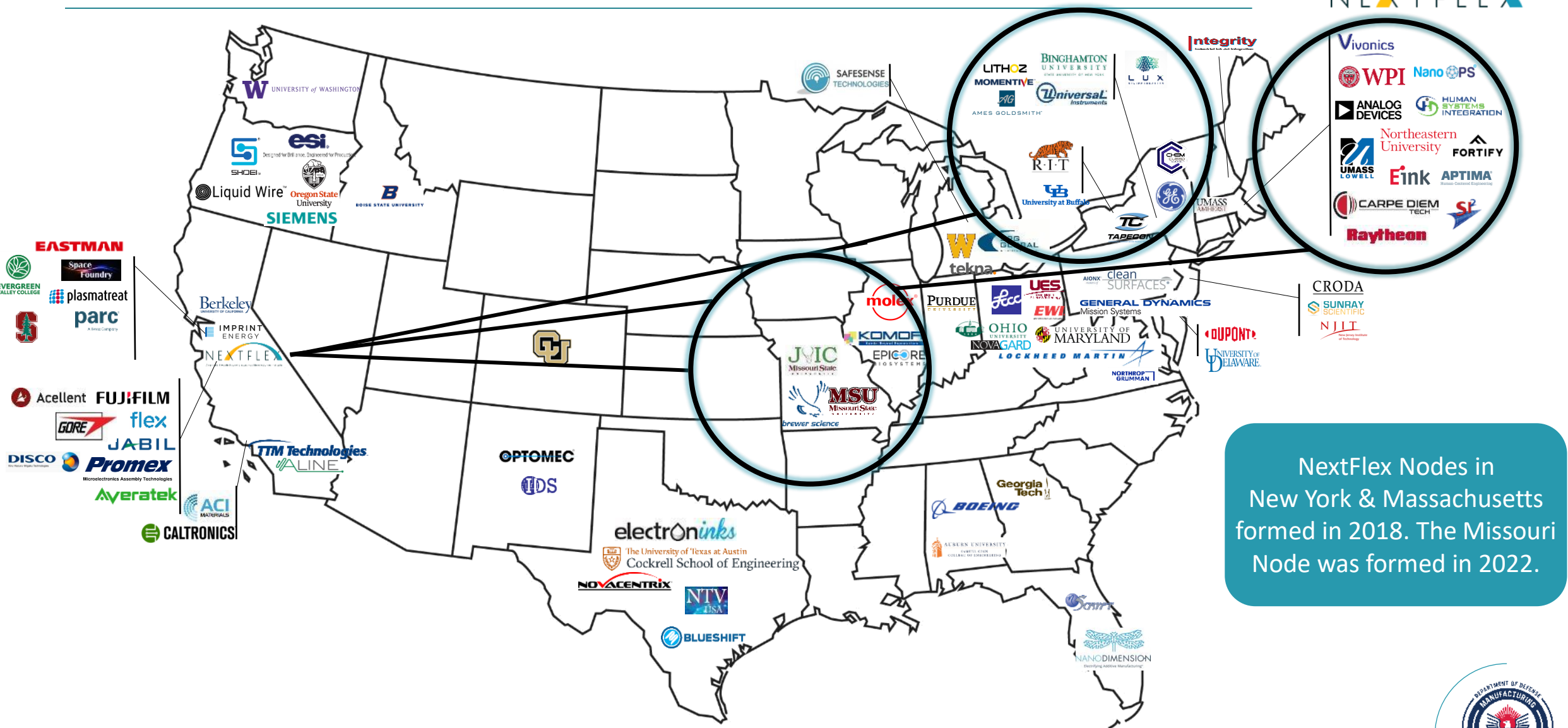
ACADEMIC



SEMICONDUCTOR



BUILDING A NATIONAL NETWORK



NextFlex Nodes in New York & Massachusetts formed in 2018. The Missouri Node was formed in 2022.



STATE GOVERNMENT PARTNERS



NEW YORK NODE



New York supports NextFlex members and partners with matching project cost-share to support Project Calls and Agency Projects, along with research and development at regional partners.

MASSACHUSETTS NODE



Massachusetts supports NextFlex members and non-members working in FHE with capital equipment grants, including for use as project cost-share, to create economic benefit.

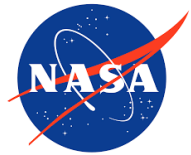
MISSOURI NODE



Missouri supports NextFlex members and partners in hybrid electronics and advanced packaging to grow regional activity and strengthen onshore capability.



GOVERNMENT PARTNERS AND SUPPORTERS




TECHNICAL WORKING GROUPS (TWGs)









Manufacturing Thrust Areas

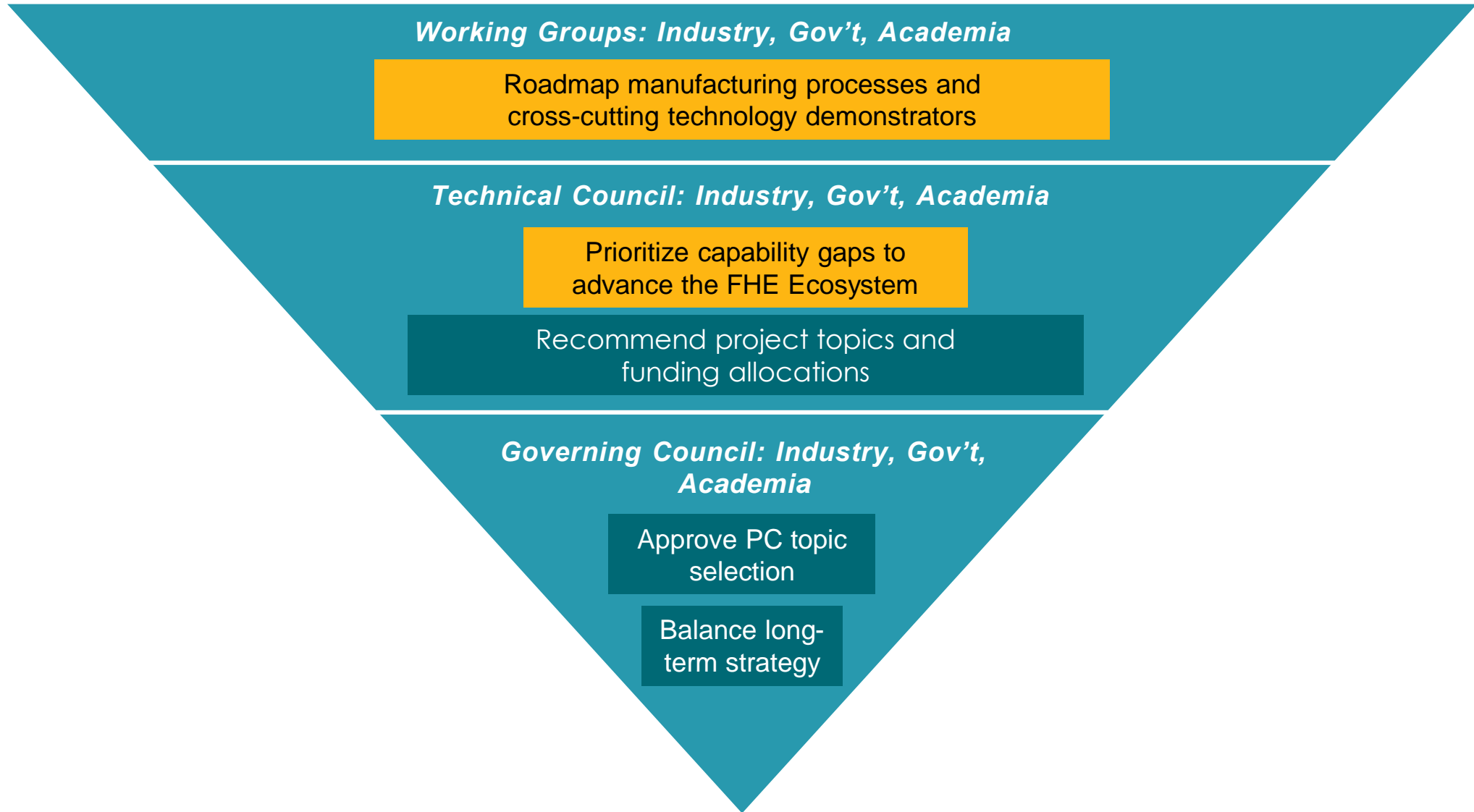
-  **Device Integration & Packaging**
-  **Materials**
-  **Modeling & Design**
-  **Printed Components & Microfluidics**
-  **Standards, Test & Reliability**



Technology Platform Demonstrators

-  **Automotive**
-  **Asset Monitoring Systems**
-  **Flexible Power**
-  **Human Monitoring Systems**
-  **Integrated Antenna Arrays**
-  **Soft & Wearable Robotics**

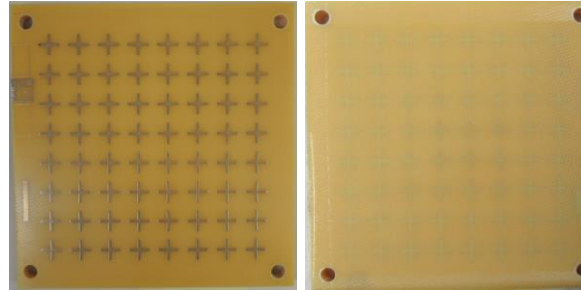
PROJECT CALLS – ECOSYSTEM-DRIVEN PROJECTS



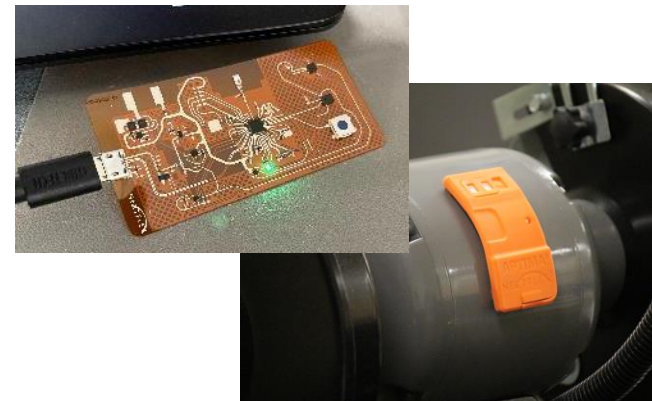
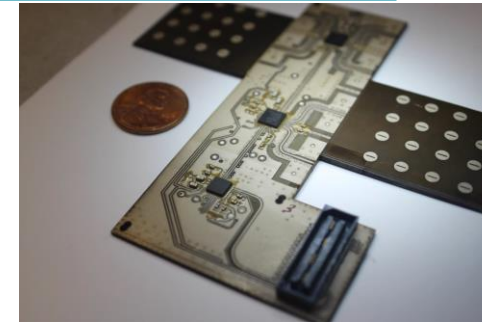
PROJECT HIGHLIGHTS



Universal Instruments “High Speed Wafer Feeder” - Tool Commercialized



General Dynamics Mission Systems / UMass Lowell “Conformal, Multi-Layer FSS Structures for Radomes”



Aptima / NextFlex
“Industrial Asset Monitor”



Lockheed Martin led “Small Unmanned Aircraft Systems Using FHE for expanded multi-mission operation”



Boeing led “FHE Demonstrator for UAV Applications”



GE and Boeing led projects on high-temp FHE for hypersonics.

PROJECT INFORMATION SHARED WITH ALL MEMBERS

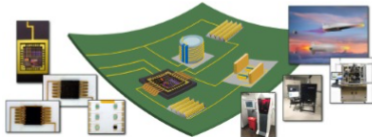


NEXTFLEX Member Portal

Home Calendar TWGs **Project Calls** Events Tech Hub Project Call Reviewers Design Software Members Contact Us Edit Not following Share

PC 6.1: Temperature and Humidity Monitoring Tag

Developer: GE Global Research & Binghamton University
Status: Completed



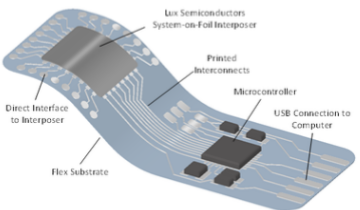
PC 6.1.1: AM High Temperature RF Components for Hypersonics

Developer: GE Research
Status: Active

PC 6.2: Conformal Embedded Sensing Antenna

Developer: The Boeing Company
Status: Completed

Project Call 6.0

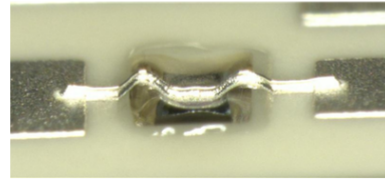


PC 6.1.2: Evaluating System-on-foil™ Interposer for High-Performance FHE

Developer: Lockheed Martin
Status: Active

PC 6.10: RF Over Fiber and Flexible Interconnects for Large Deployable X-Band Phased Arrays

Developer: Lockheed Martin Corporation
Status: Active



PC 6.2.1: Reliability Validation and Sustainment of Direct-write Printed RF Devices

Developer: Lockheed Martin
Status: Active

NEXTFLEX Member Portal

Home Calendar TWGs **Project Calls** Events Tech Hub Project Call Reviewers Design Software Members Contact Us Help Guides NextFlex Leadership Edit Not following Share

PC 5.4

FHE Enabled Embedded Sensor for Composite Structure SHM

FHE ENABLED EMBEDDED SENSOR FOR COMPOSITE STRUCTURE SHM
GE Research, Georgia Tech, Binghamton University, Lockheed Martin Sikorsky Aircraft

Problem Statement: Compared to metals, composite materials offer designers many benefits: enhanced strength, reduced weight, greater customizability, and much greater fatigue resistance. In order to fully realize these benefits, large structure state awareness is required to optimize manufacturing and to make hidden flaws and incipient faults detectable throughout their life.

Objective: Demonstrate scalable processes for fabrication and integration of wireless sensors into carbon fiber and glass fiber composites to enable monitoring from factory to the field. Advantages include structural health monitoring of aircraft which enables new paradigms. On the industrial side: manufacturing optimization and closed loop control of wind turbines.

Approach:

1. Model battery-less RF circuit for multiple sensors.
2. Print sensor patches and integrate into composite, define process windows.
3. Complete DICE experiment on embedded sensors to optimize reliability and robustness for real world conditions.
4. Pioneer integration and interrogation methods and prove technique with scale articles.

Deliverables: Report on sensor printing parameters optimized for reliability. Scalable processes for manufacturing and embedding sensors in a composite strap. THRE demonstration of sensors on large-area composite articles (in 2017).

Duration: 12 months

PC 10044

Lead Developer Organization: GE Global Research
Team Members: Georgia Institute of Technology, Sikorski (Lockheed Martin Corporation)

Project Lead: Nancy Staffell (General Electric Company)

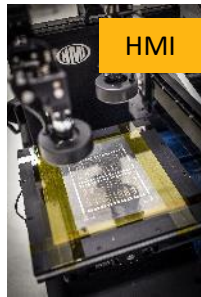
PC 5.4 Files

Name	Obj	Date	Experts/Mod...
PC5.4 - GE - 06 - 06 - 30 - 21 - PRESE...	06	6/30/2021	Presentations
PC5.4 - GE - 06 - 06 - 30 - 21 - REPO...	06	6/30/2021	Reports
PC5.4 - GE - 06 - 06 - 30 - 21 - WEB...	06	6/30/2021	Webinars
PC5.4 - GE - 06 - 06 - 30 - 21 - WEB...	06	6/30/2021	Webinars
PC5.4 - GE - 06 - 06 - 30 - 21 - PRESE...	06	6/30/2021	Presentations
PC5.4 - GE - 06 - 06 - 30 - 21 - REPO...	06	6/30/2021	Reports

All projects deliver quarterly technical reports and webinars. Members can attend live and have access to recordings and reports through the member portal.



THE NEXTFLEX TECHNOLOGY HUB



HMI



ESI Femtosecond Laser



Komori



Besi Datacon



Universal Instruments



Fanuc Robot



Yuasa



Cleanroom features:

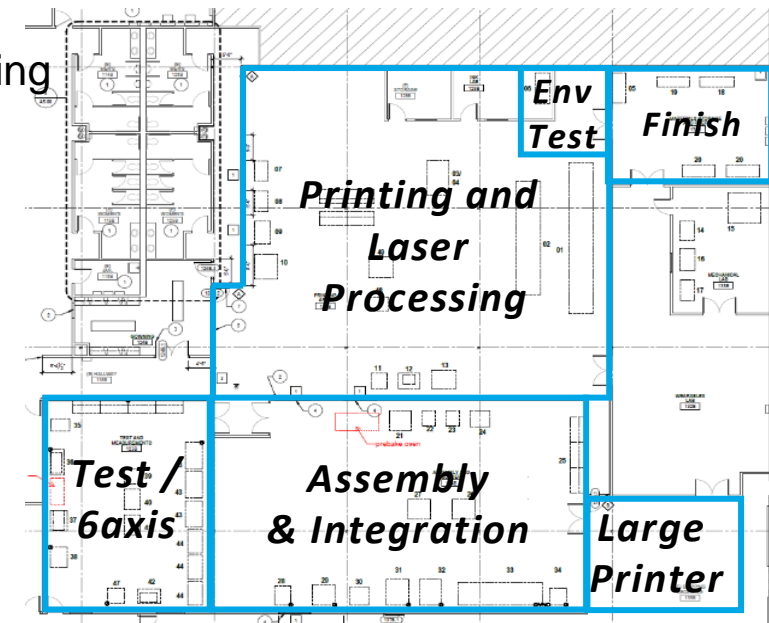
- Sheet to sheet based
- Flexible process flow to accommodate high mix, low volume prototyping
- Manufacturing capable printing and assembly tools
- Unique tools in development for printing, assembly and inspection
- ITAR Compliant*
- FDA GMP Compliant**

Lab space: 10,700 sq. feet

Total facility size: 34,000 sq. feet

(*) ITAR – International Traffic in Arms Regulations

(**) CGMP – Current Good Manufacturing Practices



The Tech Hub equipment list can be found here: <https://www.nextflex.us/commercial-services/tech-hub-equipment/>.



LEARNING PROGRAMS PORTFOLIO 2022



FlexFactor

Target Audience:
K12 & Transitioning Military

Purpose: Awareness Building
Familiarize audience with FHE and broader adv. mfg. sector education & career pathways

Stage:
K12: Commercially Available
Military Version: In development

Flex2Future

Target Audience:
Community College Students

Purpose: Skill Building
Work-based learning experience for students in technician pathways

Stage:
Commercially Available

FlexAhead

Target Audience:
Graduate Students

Purpose: Skill Building
Increase functional knowledge of FHE among graduate students in engineering pathways

Stage:
In Development (Expected Launch Date Spring 2023)

FlexPro

Target Audience:
Incumbent Workforce

Purpose: Awareness & Skill Building
Increase knowledge, skills, and training on FHE

Stage:
In Person Workshop – Commercially Available

Digital/Online version in development (Expected Launch Date Spring 2023)

Consulting: STEM/FHE Workforce consulting for industry, academic, and government stakeholders



THANK YOU



SCOTT MILLER, PH.D.

SMILLER@NEXTFLEX.US

[HTTP://WWW.NEXTFLEX.US](http://www.nextflex.us)