NEXTFLEX PROPOSER’S DAY:
PROJECT CALL 9.0

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ACKNOWLEDGMENT

DEPARTMENT OF DEFENSE · UNITED STATES OF AMERICA

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AGENDA

- Additional Resources
- NextFlex Background
- PC 9.0 Process, Schedule, and Themes
- PC 9.0 Topics
- Evaluation Criteria
- Q&A
- PC 9.0 Teaming Event

ADDITIONAL RESOURCES

PC 9.0 Events

- PC 9.0 Teaming Event – to follow

PC 9.0 Guidebook

- Definitive reference for PC 9.0

Still have questions?

- proposal@nextflex.us

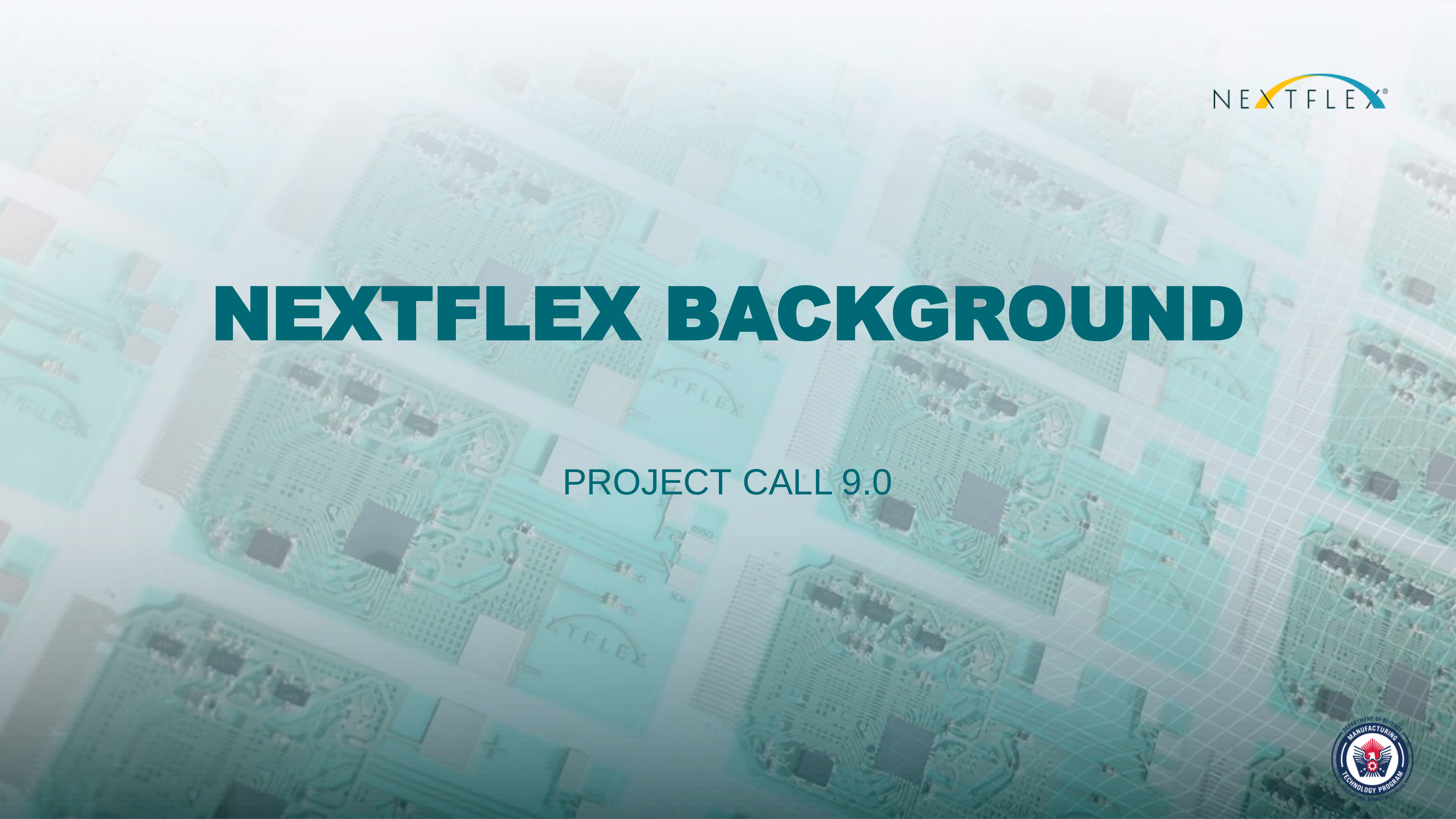
PROJECT CALL 9.0

ABOUT

NextFlex **Project Calls** fulfill one of the Institute's primary goals: **fostering technology innovation and commercialization.**

Project Call (PC) 9.0 is the ninth project call issued by NextFlex. Like the previous project calls, it is intended to advance the state of the art in manufacturing for hybrid electronics and to promote the strength, competitiveness, and interconnectedness of the U.S. manufacturing ecosystem for hybrid electronics. Each

https://www.nextflex.us/project-call/project-call-9-0/



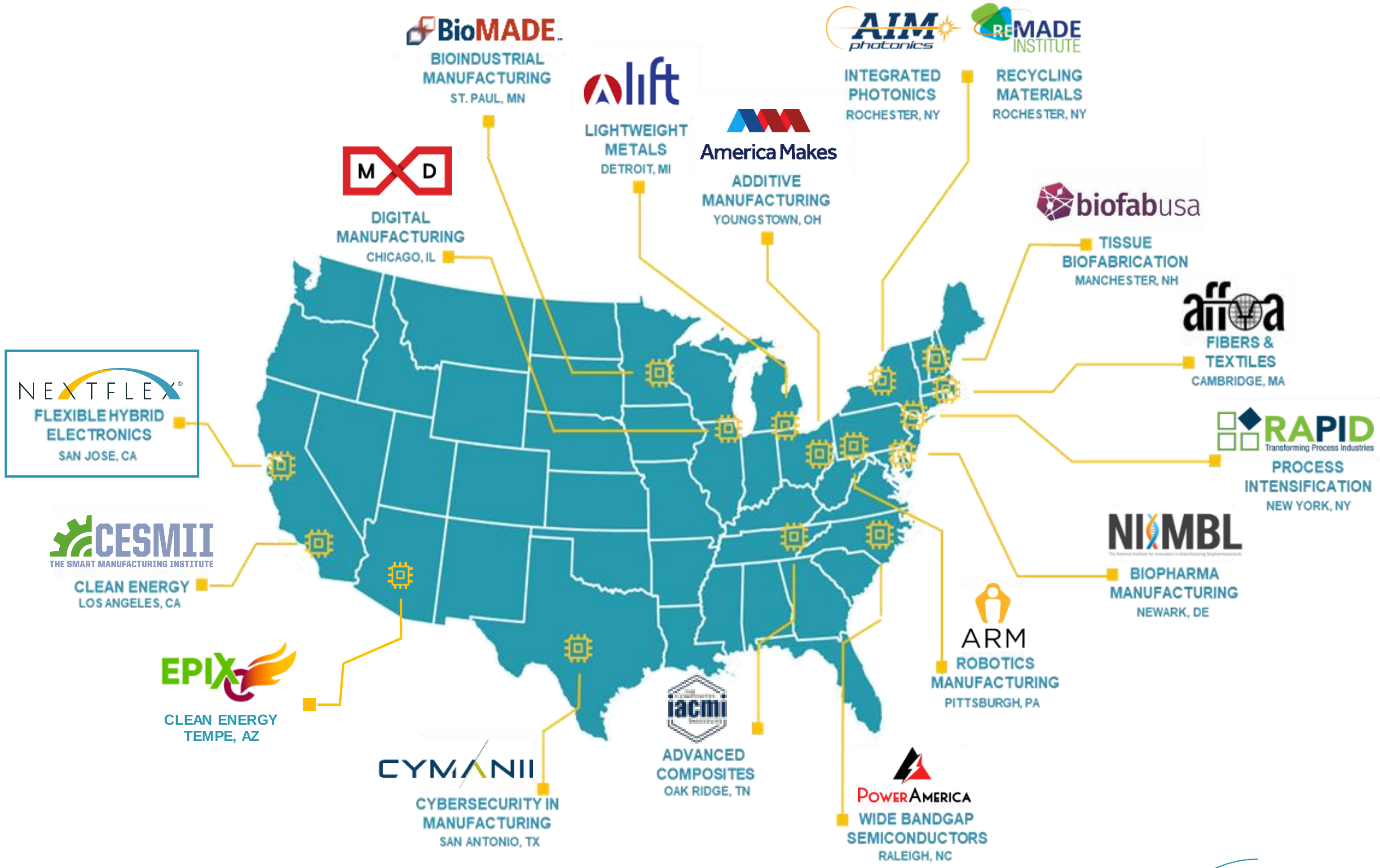
NEXTFLEX BACKGROUND

PROJECT CALL 9.0

INSTITUTES BUILD POWERFUL CONNECTIONS

Manufacturing USA connects people, ideas and technology to solve industry-relevant advanced manufacturing challenges. The 17 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**
2. **Create a robust commercial ecosystem around the technology**
3. **Secure human capital**

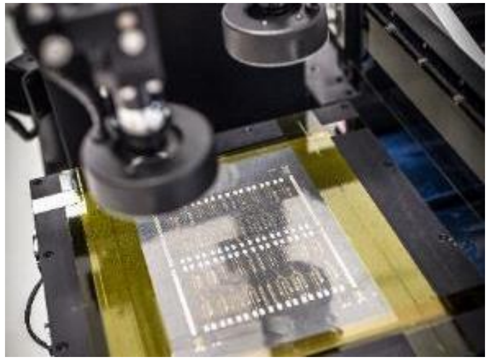


NEXTFLEX: A PUBLIC-PRIVATE PARTNERSHIP

MII Established	28 August 2015
Technology Hub Location	San Jose, California
Facility / Fab Size	34,000 ft^2 total, 10,700 ft^2 fab
Industry & Academic Members	100 members across supply chain
Gov't Organizations Engaged	>70 DoD & Other Government Agencies
State / Regional Hubs	New York, Massachusetts, Missouri
Workforce Partners	50 companies, 34 colleges, >100 K-12 districts
Core-Funded Project Calls	89 projects, $132M total value, $52M funding
Agency Projects	148 projects, $251M
Core Funding / Cost Matching	$102M (through 2027) / $140M (through 2024)
Technology Transitions	>25 DoD Prototypes Delivered; >10 Commercial Demos
Key Outcomes	Mfg Tools, Process, Products, & Prototypes to DoD & Industry; Integrated Knowledge

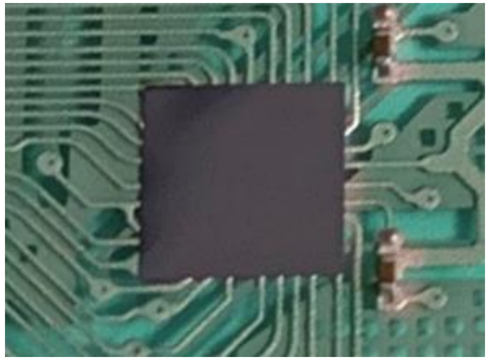
HYBRID ELECTRONICS: NEXTFLEX PERSPECTIVE

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



Printed / Additive Electronics Fabrication

+



Discrete ICs Components

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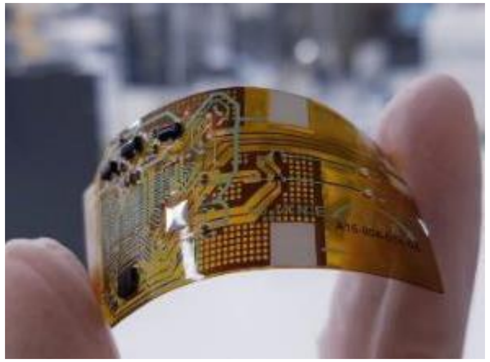


Flexible Devices

Structural / Conformal Electronics

Advanced Packaging & Heterogeneous Integration

https://semiwiki.com/eda/synopsys/306290-heterogeneous-integration-a-cost-analysis/

BRINGING TOGETHER THE FHE ECOSYSTEM

NEXTFLEX®

DESIGN/MANUFACTURING

JABIL
EWI We Manufacture Innovation
CALTRONICS
Averatek
tekna.
SIEMENS
TTM Technologies
molex
TC TAPECON
Promex Microelectronics Assembly Technologies
INFINITE CORRIDOR TECHNOLOGY
SYGHT
FABRIC8LABS

MEDICAL/WEARABLE DEVICES

GE HealthCare
HUMAN SYSTEMS INTEGRATION
APTIMA Human-Centered Engineering
Vivonics
Intricon

INDUSTRY STANDARDS

semi | FlexTech

SEMICONDUCTOR

LUX SEMICONDUCTORS
ANALOG DEVICES

EQUIPMENT

OPTOMEC
Nano OPS
Universal Instruments
Scrypt
Impossible Objects
Space Foundry
LITHOZ
FORTIFY
plasmatreat
CARPE DIEM TECH
FUJIFILM
KOMORI
NANODIMENSION
bayflex solutions
IDS
NTV USA

RESEARCH

UES Excellence in Science & Technology
SRI

DESIGN/COMPONENT MANUFACTURING

Liquid Wire™ MADE TO MOVE™
anthro
E Ink
BIOSENSOR SOLUTIONS
SI2

ACADEMIC

AUBURN UNIVERSITY
BINGHAMTON UNIVERSITY STATE UNIVERSITY OF NEW YORK
Georgia Tech
Northeastern University
UMASS LOWELL
IOWA STATE UNIVERSITY
UNIVERSITY of WASHINGTON
OHIO UNIVERSITY
Lorain County Community College
NJIT New Jersey Institute of Technology
WPI
University of Massachusetts Amherst
BOISE STATE UNIVERSITY
Drexel UNIVERSITY
EVERGREEN VALLEY COLLEGE
WESTERN MICHIGAN UNIVERSITY
Oregon State University
RIT
Stanford University
Berkeley UNIVERSITY OF CALIFORNIA
VIRGINIA TECH
SJSU SAN JOSÉ STATE UNIVERSITY
University at Buffalo The State University of New York
TEXAS The University of Texas at Austin
UTD THE UNIVERSITY OF TEXAS AT DALLAS
UNIVERSITY OF DELAWARE
UNIVERSITY OF MARYLAND
Missouri State UNIVERSITY
University of Dayton

INDUSTRIAL/AEROSPACE

LOCKHEED MARTIN
GE
Raytheon Technologies
BOEING
GENERAL DYNAMICS Mission Systems
NAUTILUS DEFENSE
NORTHROP GRUMMAN
EATON

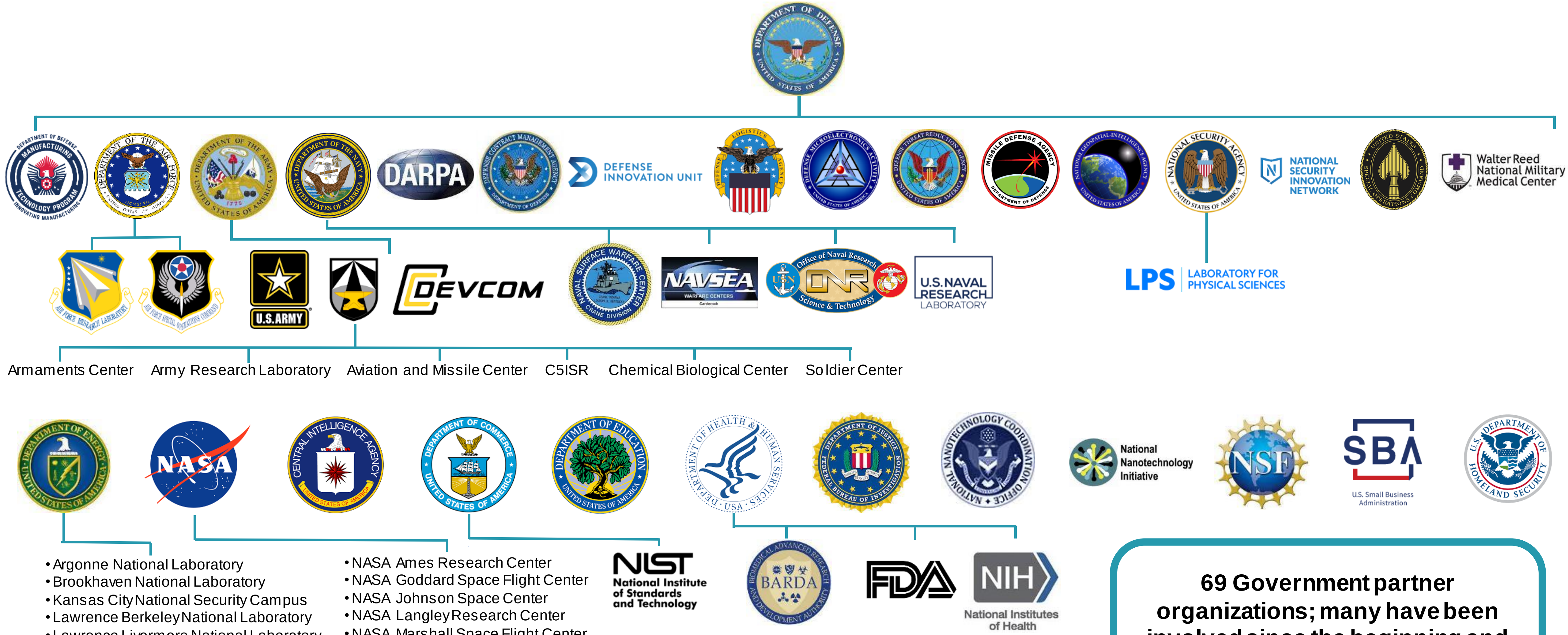
MATERIALS

brewer science
ANI applied NANOTECH INC. A NANO MAGIC COMPANY
SHOEI
NOVAGARD
SUNRAY SCIENTIFIC
EASTMAN
KODAK
AMES GOLDSMITH
iris light technologies
MOMENTIVE
electroninks
Celanese
PRECISION CIRCUIT TECHNOLOGIES EVERY MICRON MATTERS
NeXolve Technology for Today & Tomorrow
Heraeus Precious Metals
DUPONT

DEPARTMENT OF DEFENSE MANUFACTURING TECHNOLOGY PROGRAM INNOVATING MANUFACTURING

GOVERNMENT PARTNERS AND SUPPORTERS

NEXTFLEX®



Armaments Center
Army Research Laboratory
Aviation and Missile Center
C5ISR
Chemical Biological Center
Soldier Center

- Argonne National Laboratory
- Brookhaven National Laboratory
- Kansas City National Security Campus
- Lawrence Berkeley National Laboratory
- Lawrence Livermore National Laboratory
- National Renewable Energy Laboratory
- Oak Ridge National Laboratory
- Pacific Northwest National Laboratory
- Sandia National Laboratories
- Savannah River National Laboratory

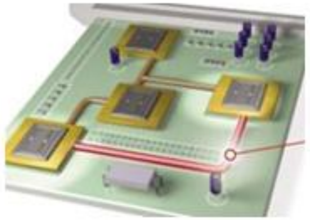
- NASA Ames Research Center
- NASA Goddard Space Flight Center
- NASA Johnson Space Center
- NASA Langley Research Center
- NASA Marshall Space Flight Center

69 Government partner organizations; many have been involved since the beginning and have expanded their relationship with NextFlex over time.

MRL AND TRL RELATIONSHIPS

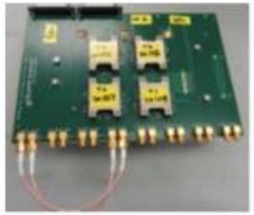
Pre-Material Solution Analysis			Materiel Solution Analysis	Technology Maturation and Risk Reduction		Engineering & Manufacturing Development		Production & Deployment	
MRL 1 Basic Mfg Implications Identified	**MRL 2** Mfg Concepts Identified	**MRL 3** Mfg Proof of Concept Developed	**MRL 4** Manufacturing Processes In Lab Env't	**MRL 5** Components In Production Relevant Env't	**MRL 6** System or Subsystem In Production Relevant Env't	**MRL 7** System or Subsystem In Production Representative Environment	**MRL 8** Pilot Line Demonstrated Ready for LRIP	**MRL 9** LRIP Demonstrated Ready for FRP	**MRL 10** FRP Demo'd Lean Production Practices in Place
TRL 1 Basic Principles Observed	**TRL 2** Concept Formulation	**TRL 3** Proof of Concept	**TRL 4** Breadboard in Lab	**TRL 5** Breadboard in Representative Environment	**TRL 6** Prototype in Representative Environment	**TRL 7** Prototype in Operational Environment		**TRL 8** System Qual	**TRL 9** Mission Proven

Breadboard



Focus Examples:
- Technology and Industrial Base
- Materials
- Cost and Funding

Brassboard



Focus Examples:
- Design
- Process Capability and Control
- Quality Management

Production

Focus Examples:
- Manufacturing Workforce
- Facilities
- Manufacturing Management

Slide adapted from AFRL Materials and Manufacturing Directorate

PROJECT CALL 9.0
PROCESS, SCHEDULE, AND THEMES

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

VERSIONS OF THE ROADMAP

Member-Benefit Version

~20 pages each (>200 pages)

America's Flexible Hybrid Electronics Manufacturing Institute

Device Integration & Packaging
Technology Roadmap

December 2021
NextFlex Confidential

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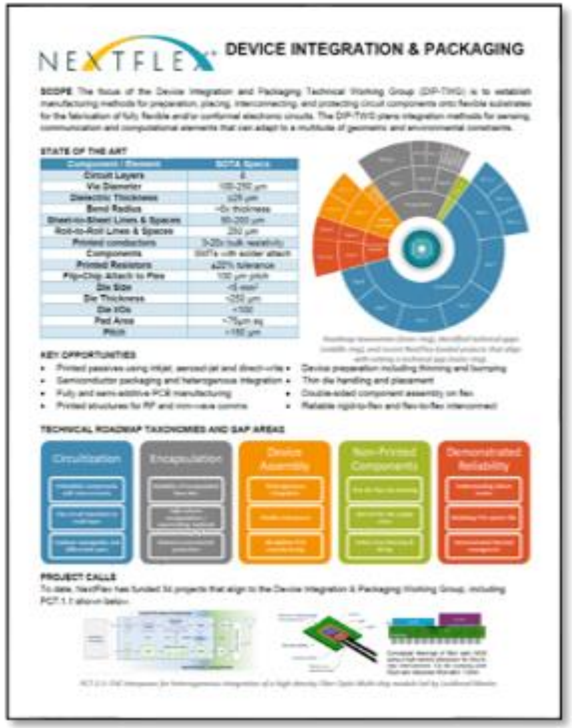
Available on the Member Portal TWG Pages

Public Summary

1 page each (15 pages)



DEVICE INTEGRATION & PACKAGING

SCOPE

STATE OF THE ART

KEY OPPORTUNITIES

TECHNICAL ROADMAP TAXONOMIES AND GAP AREAS

Circuitization

Encapsulation

Device Assembly

Non-Printed Components

Demonstrated Reliability

PROJECT CALLS

Available on PC 9.0 website

PROJECT CALL TOPIC DEVELOPMENT

Working Groups: Industry, Gov't, Academia

Roadmap manufacturing processes cross-cutting with TPDs

Develop TPDs to demonstrate manufacturing processes

Technical Council: Industry, Gov't, Academia

Cross-reference common manufacturing requirements

Identify specific technology capability gaps

Prioritize project topics and funding allocations

Governing Council: Industry, Gov't, Academia

Approve topic selection

Balance long-term strategy

PROJECT CALL 9.0 PROCESS

Roadmap-Based Topic Development
- Technical Working Groups
- Government Partners
- NextFlex Staff

Project Call Guidebook (RFP)
- NextFlex Staff
- Government Partners
- Technical Council & Governing Council

Pre-Submission Consultation
- Proposers
- NextFlex Staff

Proposal Development & Submission
- Proposers

Peer Review
- Tech council members, member volunteers
- NextFlex Staff
- Government SMEs

Project Selection
- Tech Council (Voting Members)
- Governing Council

PROJECT CALL 9.0 KEY DATES

Event	Date
Project Call Announcement and Posting	06/03/2024
PC 9.0 Virtual Proposers Day & Teaming Event	06/10/2024
First date for pre-submission consultation	06/17/2024
Proposal Online Cover Sheet Due	07/17/2024
Proposal Submission Deadline	**07/24/2024**
Anticipated Technical Council Review	Mid-Sept
Anticipated Governing Council Review	Late-Sept

PROJECT CALL 9.0 OVERVIEW

Focus of PC 9.0

- Address critical hybrid electronics manufacturing challenges
- Enable the transition of hybrid electronic devices into applications that require superior performance, assured reliability, and improved environmental sustainability
- Emphasize projects with strong opportunity for technology transition into commercial products, DoD Programs of Record, or manufacturing operations.

Important Considerations

- Proposal process will be 1-stage (straight to full proposal) – there is no pre-proposal round
- Discussion with NextFlex during proposal development is strongly encouraged to ensure that proposals align to the goals of the topics
- NextFlex anticipates funding one or more project in each topic area; however, other outcomes are possible depending on the cost and quality of the projects proposed
- Given the clear focus on projects that have a near-term commercial impact, teams that are industry-led or have a strong industry partner as part of the commercialization plan will be favorably considered in the evaluation process
- Proposals that fall within the topics area definitions that address DoD Critical Technology Areas will be viewed favorably
- Prior to final granting of awards, recipients and their partners who are not already NextFlex members will be required to become members of the Institute and execute a development agreement
- NextFlex always welcomes suggestions for future project call topics; recommendations should be brought to the attention of the NextFlex TWGs

PROJECT CALL 9.0: ITEMS TO CONSIDER

- Proposals should build on and take advantage of developments from prior project calls, where appropriate, as well as the best available technology.
- Total NextFlex Funds: $5.3M
- Estimated total project value (with cost share): $11M
- NextFlex Funding: ≤ $400k – $500k per project by topic
- Duration: 12 – 18 months (maximum varies by topic)

PROJECT FUNDING & NEXTFLEX MEMBERSHIP

- Minimum of 50% of each project’s total cost must be cost-share provided by recipients
- 50% minimum cost-share requirement is based on entire team – not individual contributors
- Cost share can include labor, materials, use of equipment, travel
- Any recipient of NextFlex funding must be a Tier 1-3 member
  - This applies to all sub-recipients / project partners performing development work
  - Companies supplying standard COTS components or services (e.g. build-to-print) to team members are not required to be members of NextFlex.
- Federal Government partners cannot receive NextFlex funding, although their self-funded participation is encouraged.

MANUFACTURING USA INSTITUTE PROJECTS

Submitters with experience in government funding should take special note that the ways in which NextFlex and Manufacturing USA Institutes operate may be quite different than those to which proposers may be accustomed.

NextFlex development projects should not be compared to SBIR, STTR, NIH, or other similar programs, nor should they be compared to commercial customer activities. Unlike acquisitions programs, these efforts are aimed at co-funded development; thus, a cost share element is required.

NextFlex projects are designed around time-bound and measurable deliverables with clear performance metrics. If these cannot be established at the outset of the project, the subject matter under consideration may be of too low an MRL and thus more suitable for another funding mechanism.

The objective is not to develop a specific product, but rather to solve a common gap that many companies in the hybrid electronics manufacturing ecosystem are facing. Developments are reported to and benefit all members, so the approach taken is as important as the promised outcomes. The proposal evaluation criteria reflect this.

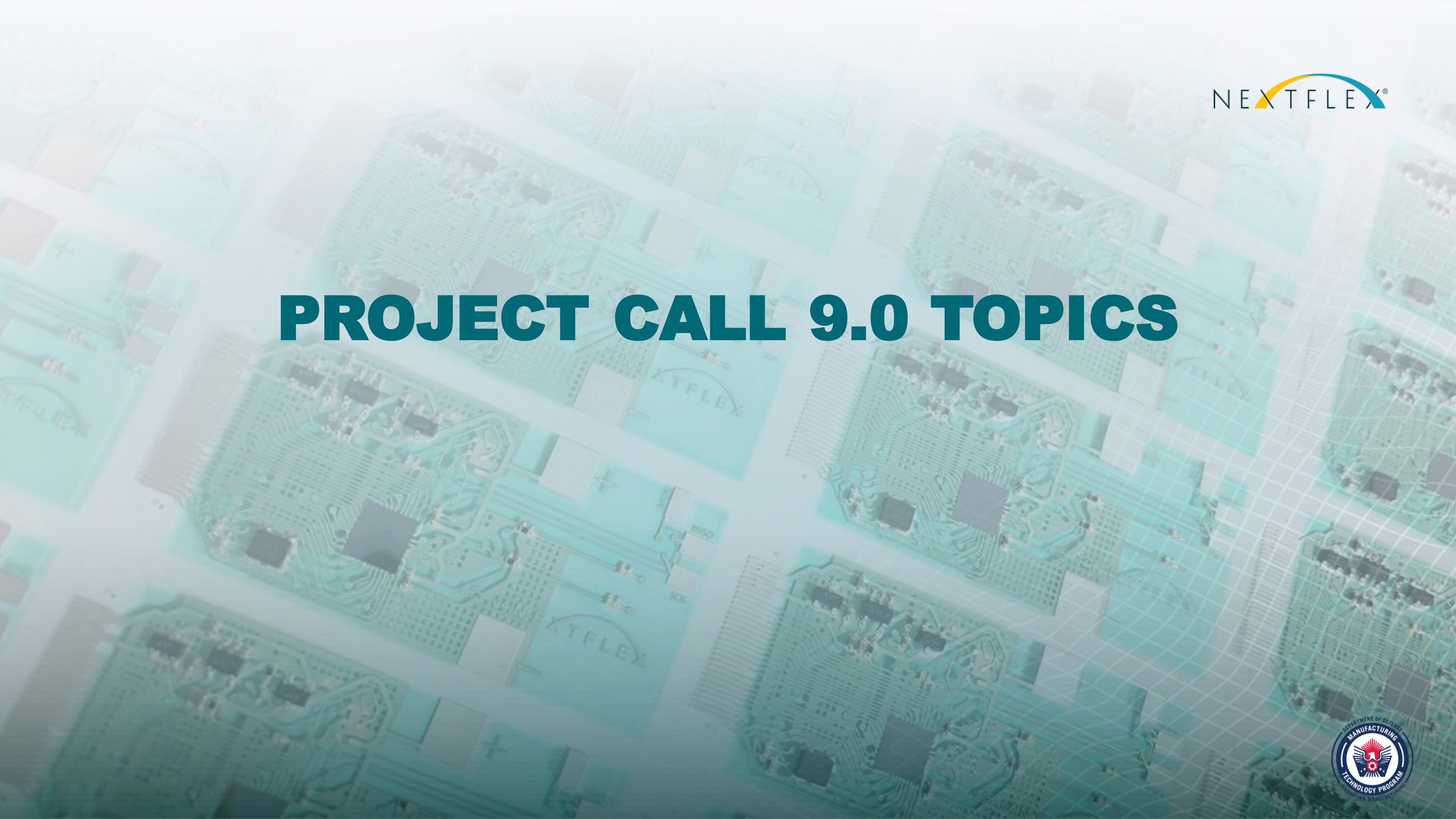
Project funding will follow a cost reimbursement mechanism. If the lead or any team partners have audited indirect rates, please use those. Commercial rates or profit (fee) may not be included in project submissions.

PROJECT OBJECTIVES AND DELIVERABLES

- These projects focus on developing and qualifying manufacturing processes, methods, or tools identified as hybrid electronics needs via the roadmapping process and discussions with TWG leads and members.
- Development of software tools should include licenses or provisions to allow NextFlex member and personnel use.
- Projects focused on process development must document processes with enough detail that they are reliably replicable.
- These projects shall include, but are not limited to, the following deliverables:
  - Data on materials, processes, performance, and reliability for sharing at quarterly reporting
  - A flow chart of the process steps and design information for device fabrication or process repetition.
  - Relevant process information including material properties obtained, tolerance and yield with comparison to current industry processes, consistency of process specifications and device performance, and optimized equipment parameters.
  - Details of the method of test and measurement performed during development to establish TRL and MRL advancements.
  - Identification of the specific task and outcome that results in TRL and/or MRL advancements.
  - Cost model framework and associated assumptions for the proposed manufacturing technique.
- Reliability and standards cut across all topics; although not called out in every topic, all PC 9.0 proposals are encouraged to address these needs within their project plans.

BROADLY DEFINED TOPICS WITH EXAMPLE AREAS OF INTEREST

- Topics aim to advance hybrid electronics technology and fill gaps identified by the TWGs in the Roadmaps. The outcomes of the projects that are selected are expected to have broad impact on both commercial and defense applications and to advance U.S. hybrid electronics manufacturing capability.
- Each topic has a maximum funding and duration; proposals that seek lower levels of funding and shorter duration are welcome.
- Topics are structured with a description that include all requirements followed by examples of proposal areas that would meet the topic area requirements and align to prioritized roadmap gaps.
  - These examples are not sub-topics into which proposals must fit, and any proposal that meets the overall topic area requirements will be equally considered whether it addresses one of the examples or not.
  - A proposal may address only part of an example area and still be responsive to the Topic so long as it meets all requirements of the Topic.



PROJECT CALL 9.0 TOPICS

PROJECT CALL 9.0 TOPICS

Topic #	Topic Description	Max Duration (months)	Max Funding *	Technical Working Group Alignment										
				Printed Components & Microfluidics	Materials	Device Integration & Packaging	Modeling & Design	Standard, Test & Reliability	Human Monitoring Systems	Asset Monitoring Systems	Integrated Array Antennas	Soft & Wearable Robotics	Flexible Power	Automotive
9.1	Manufacturing of High Resolution, Multilayer Electronic Packages and Devices	18	$ 500k	X	X	X		O	O	O	O			O
9.2	Thermal Management for Power Electronics	18	$ 500k	X	X	X	O	X			O		O	X
9.3	Reliable Hybrid Electronics for Extreme Conditions	18	$ 500k	X	X	X	O	X	X	X	X	X	O	X
9.4	Conformal & Structurally Integrated Hybrid Electronics	18	$ 500k	O	O	X	X	X			X	O		X
9.5	Additive Processes for Improved Environmental Sustainability of Electronics Manufacturing	18	$ 500k	X	X	O		X						
9.6	Open Topic for "New Project Leads"	12	$ 400k	X	X	X	X	X	X	X	X	X	X	X
				X	Direct TWG Alignment									
				O	Indirect TWG Alignment									

*Max Funding reflects the maximum funding from NextFlex for an individual project on each topic. Total program value must include the required minimum 1:1 cost share.

TOPIC 9.1: MANUFACTURING OF HIGH RESOLUTION, MULTILAYER PACKAGES AND DEVICES

$500,000 maximum Institute funds / Up to an 18-month duration

This topic seeks development and evaluation of manufacturing approaches for multilayer advanced packages and hybrid electronic devices that could transition to volume-manufacturing scale. Proposers are encouraged to produce enough test articles to estimate yield and include modeling and simulation of RF performance, if appropriate. Proposers must identify why the manufacturing approach is preferred over the state-of-the-art. Examples of possible approaches of interest include, but are not limited to:

a. High Resolution Direct Write Interconnects for Heterogenous Integration
b. Additive Manufacturing of 3D Hybrid Electronic Devices
c. Higher Throughput Manufacturing Processes for Multilayer Hybrid Electronics
d. High Frequency RF / Millimeter Wave Devices

TOPIC 9.2: THERMAL MANAGEMENT FOR POWER ELECTRONICS

$500,000 maximum Institute funds / Up to an 18-month duration

Dissipation of heat from electronic packages and devices is an increasingly important challenge as performance advances and components are moved closer together, and even stacked in three-dimensions. This topic seeks evaluation of additive and hybrid electronics manufacturing approaches for thermal management in advanced semiconductor packaging and electronic components / devices. Active and passive cooling technologies are within scope, if they demonstrate a route to manufacturability and reliability. Thermal management performance should be fully characterized using test methods and standards consistent with those appropriate for the given application(s) described by the proposer. Multiphysics modeling and experimental validation of performance is desired, but should not be the focus of a proposed project. Topics of interest include, but are not limited to:

a. High-Power Modules with Additive Active Cooling Schemes
b. Hybrid Electronics with High Efficiency Passive Cooling Structures
c. Materials Solutions for Thermal Management

TOPIC 9.3: RELIABLE HYBRID ELECTRONICS FOR EXTREME CONDITIONS

$500,000 maximum Institute funds / Up to an 18-month duration

Hybrid electronics have demonstrated high reliability and survivability in numerous applications and use-cases, including harsh environments. This topic seeks to further advance demonstration and evaluation of hybrid electronic interconnects and / or components into additional extreme environments and CONOPS not sufficiently explored. Extreme conditions of interest include, but are not limited to: high or low temperature and humidity, thermal shock, high vibrations, high G-force / shock, vacuum, ionizing radiation, high strain rate deformation, corrosive chemical exposure, and high particulate matter environments. Projects should include full reliability testing appropriate for the target use-case. Alignment to specific standards (i.e. MIL-STD-810G, or similar) is required. Examples of projects of interest include, but are not limited to:

a. Evaluation of Hybrid Electronics for Space Applications
b. Electronics for High Shock and Strain
c. High Temperature Inks from Domestic Sources

TOPIC 9.4: CONFORMAL & STRUCTURALLY INTEGRATED HYBRID ELECTRONICS

$500,000 maximum Institute funds / Up to an 18-month duration

Transitioning from planar electronics to complex 3D conformal and structurally integrated electronics enables exciting new device architectures, however, considerable challenges remain throughout the ideation-to-manufacturing pipeline that must be addressed before these devices can be successfully manufactured at scale. This topic seeks solutions for common challenges / gaps associated with printing and assembly of additive electronics integrated onto and into complex 3D surfaces, including mechanical / electronic design, multilayer toolpath generation, high fidelity print and post processing, multiphysics validation and simulation, and reliability and performance testing. Examples of projects of interest include, but are not limited to:

a. Printed Module-to-Module Interconnections Wire Harness Replacement

b. Improved Software Tools for Printing on Complex 3D Geometries

c. Printable Dielectric Materials for 3D RF Devices

TOPIC 9.5: ADDITIVE PROCESSES FOR IMPROVED ENVIRONMENTAL SUSTAINABILITY OF ELECTRONICS MANUFACTURING

$500,000 maximum Institute funds / Up to an 18-month duration

For this topic, NextFlex has received dedicated funding, and based on the number and quality of proposals received, anticipates awarding four projects.

Additive manufacturing materials and process technologies have demonstrated improved environmental sustainability versus traditional electronics manufacturing by greatly reducing the materials waste and utilizing novel materials systems that reduce or eliminate harsh solvents and require reduced energy input to anneal / cure. Near-term opportunities exist to adopt additive processes into workflows for existing electronic products (including PCBs and PCBAs) to greatly reduce the number of processing steps, and therefore the time, materials, and energy input for manufacturing. This topic seeks to further address the environmental sustainability of hybrid electronics manufacturing and explore their adoption and potential impact.

a. Evaluation of Additive Processes for PCB Manufacturing
   i. Embedded Printed Passives (resistors, capacitors, and/or inductors)
   ii. Printed Solder Masks and Conformal Coatings
   iii. Additive Vias, Interconnects, and Component Attach

b. Automated Rework and Repair of Electronics for Reduced E-Waste Generation

c. Environmentally Sustainable Electronics Encapsulants and Overmold Materials

TOPIC 9.5 ONLY – PROPOSING ADDITIONAL OPTIONAL TASKS

- Proposals for Topic 9.5 may include optional tasks outside of the scope, funding, and period of performance of the core project proposal.
- The objective of the optional tasks is to further mature the technologies for transition and / or commercialization or support actual transition activities.
- Details of the proposed optional tasks should be included in a Section 10 of the proposal submission, and is excluded from the proposal's page count limit; <u>this optional task description must not exceed two pages</u>.
- Additional information can be found in Section 5.4 of the PC 9.0 Guidebook. The budget for optional tasks must not exceed $250,000 and will require additional cost-share of at least 1:1.
- Whether or not proposed, these <u>optional tasks will not be evaluated by reviewers at this time and will not factor into selection of projects.</u>
- For any projects that are selected for award, these optional tasks will be evaluated for possible subsequent award during the project execution phase based on factors including but not limited to project performance, task objectives, anticipated impact, and availability of funds.

TOPIC 9.6: OPEN TOPIC FOR “NEW PROJECT LEADS”

$400,000 maximum government funds / Up to a 12-month duration

Delivering the NextFlex mission requires participation from across the U.S. hybrid electronics ecosystem. The purpose of this topic is to encourage participation from organizations that have not led a NextFlex PC project in the recent past. Projects must align to the NextFlex Roadmaps and may address either manufacturing thrust or technology demonstrator topics. In the case of technology demonstrator development, the project should, at least in part, address the challenge of manufacturing such a demonstrator.

For this open topic, proposals must clearly identify the technical working group(s) to which the project aligns, and the manufacturing capability gaps to be addressed.

Eligibility requirements: The lead proposer organization for this project must not have led a NextFlex project call project under either of the four most recent project calls (PC 5.0 – PC 8.0). As with all proposals, teaming is strongly encouraged; organizations that have led projects under PC 5.0 through PC 8.0 may be project partners, however at least 60% of the NextFlex funding for projects in this category must be allocated to organizations that meet the eligibility requirement (there is no restriction on allocation of cost share).

For clarity, organizations that have participated as partners/subcontractors on prior project calls do qualify as “new project leads” provided they have not led a PC 5.0 - PC 8.0 project.

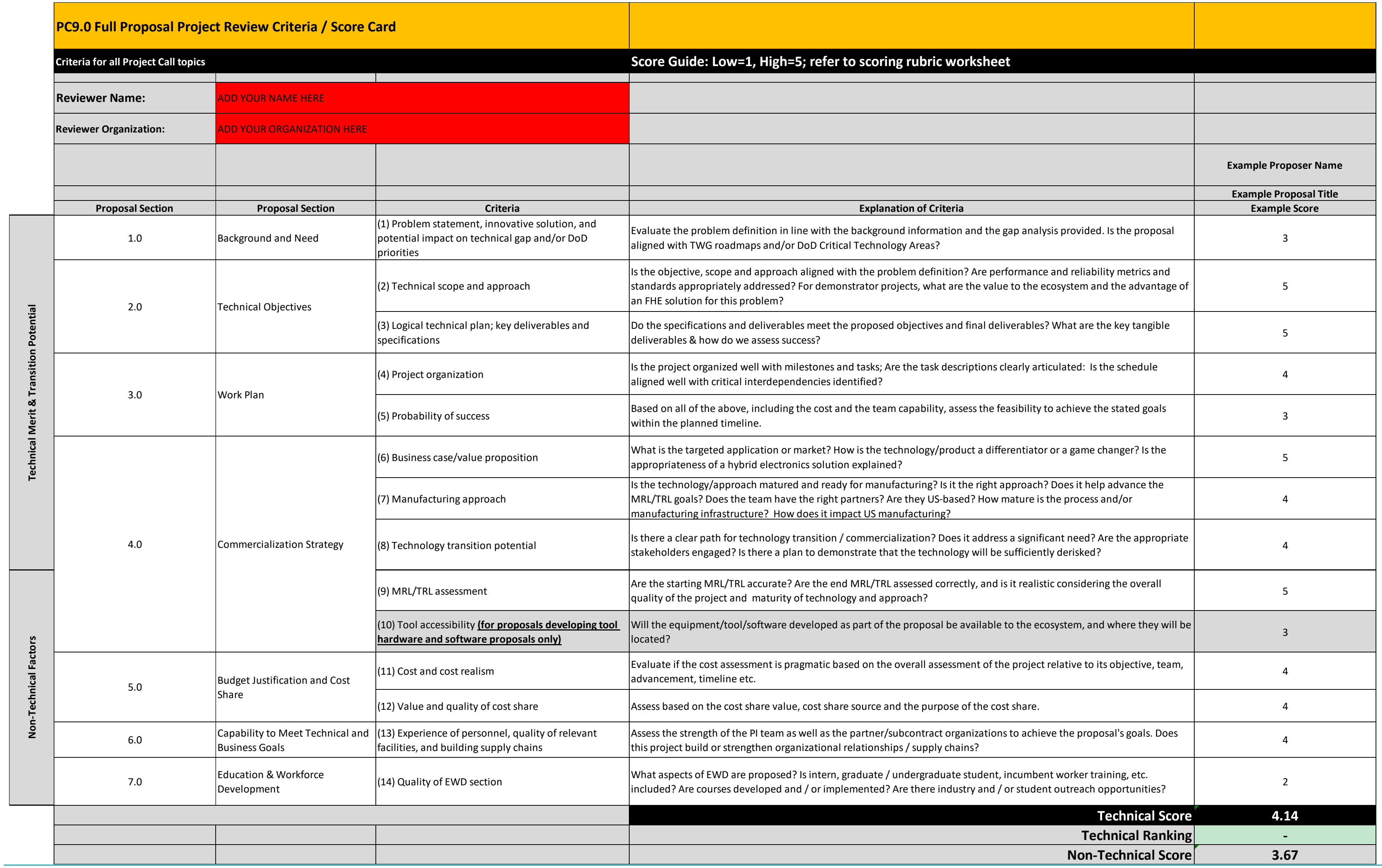
EVALUATION CRITERIA

PROJECT CALL 9.0

PROPOSAL EVALUATION PROCESS

- Proposals are distributed to a slate of reviewers which include:
  - NextFlex members
  - Government subject-matter experts
  - NextFlex staff
  - NextFlex may occasionally engage other persons as part of the proposal review process (e.g., third-party SMEs)
- Reviewers evaluate the proposals, score each proposal in several categories, and provide comments.
- NextFlex compiles and analyzes the reviews and summarizes comments for the NextFlex Technical Council.
- Technical Council votes a set of recommendations to the NextFlex Governing Council.
- Governing Council votes to select projects for award negotiation.

PROPOSAL EVALUATION CRITERIA



	PC9.0 Full Proposal Project Review Criteria / Score Card				
	Criteria for all Project Call topics			**Score Guide: Low=1, High=5; refer to scoring rubric worksheet**	
	Reviewer Name:	ADD YOUR NAME HERE			
	Reviewer Organization:	ADD YOUR ORGANIZATION HERE			
					Example Proposer Name
					Example Proposal Title
	Proposal Section	**Proposal Section**	**Criteria**	**Explanation of Criteria**	**Example Score**
Technical Merit & Transition Potential	1.0	Background and Need	(1) Problem statement, innovative solution, and potential impact on technical gap and/or DoD priorities	Evaluate the problem definition in line with the background information and the gap analysis provided. Is the proposal aligned with TWG roadmaps and/or DoD Critical Technology Areas?	3
	2.0	Technical Objectives	(2) Technical scope and approach	Is the objective, scope and approach aligned with the problem definition? Are performance and reliability metrics and standards appropriately addressed? For demonstrator projects, what are the value to the ecosystem and the advantage of an FHE solution for this problem?	5
			(3) Logical technical plan; key deliverables and specifications	Do the specifications and deliverables meet the proposed objectives and final deliverables? What are the key tangible deliverables & how do we assess success?	5
	3.0	Work Plan	(4) Project organization	Is the project organized well with milestones and tasks; Are the task descriptions clearly articulated: Is the schedule aligned well with critical interdependencies identified?	4
			(5) Probability of success	Based on all of the above, including the cost and the team capability, assess the feasibility to achieve the stated goals within the planned timeline.	3
	4.0	Commercialization Strategy	(6) Business case/value proposition	What is the targeted application or market? How is the technology/product a differentiator or a game changer? Is the appropriateness of a hybrid electronics solution explained?	5
			(7) Manufacturing approach	Is the technology/approach matured and ready for manufacturing? Is it the right approach? Does it help advance the MRL/TRL goals? Does the team have the right partners? Are they US-based? How mature is the process and/or manufacturing infrastructure? How does it impact US manufacturing?	4
			(8) Technology transition potential	Is there a clear path for technology transition / commercialization? Does it address a significant need? Are the appropriate stakeholders engaged? Is there a plan to demonstrate that the technology will be sufficiently derisked?	4
Non-Technical Factors			(9) MRL/TRL assessment	Are the starting MRL/TRL accurate? Are the end MRL/TRL assessed correctly, and is it realistic considering the overall quality of the project and maturity of technology and approach?	5
			(10) Tool accessibility **(for proposals developing tool hardware and software proposals only)**	Will the equipment/tool/software developed as part of the proposal be available to the ecosystem, and where they will be located?	3
	5.0	Budget Justification and Cost Share	(11) Cost and cost realism	Evaluate if the cost assessment is pragmatic based on the overall assessment of the project relative to its objective, team, advancement, timeline etc.	4
			(12) Value and quality of cost share	Assess based on the cost share value, cost share source and the purpose of the cost share.	4
	6.0	Capability to Meet Technical and Business Goals	(13) Experience of personnel, quality of relevant facilities, and building supply chains	Assess the strength of the PI team as well as the partner/subcontract organizations to achieve the proposal's goals. Does this project build or strengthen organizational relationships / supply chains?	4
	7.0	Education & Workforce Development	(14) Quality of EWD section	What aspects of EWD are proposed? Is intern, graduate / undergraduate student, incumbent worker training, etc. included? Are courses developed and / or implemented? Are there industry and / or student outreach opportunities?	2
				Technical Score	**4.14**
				Technical Ranking	**-**
				Non-Technical Score	**3.67**

Technical Merit & Transition Potential Criteria

New Criterion for PC 9.0

Non-technical Criteria

PROPOSAL EVALUATION AND SELECTION

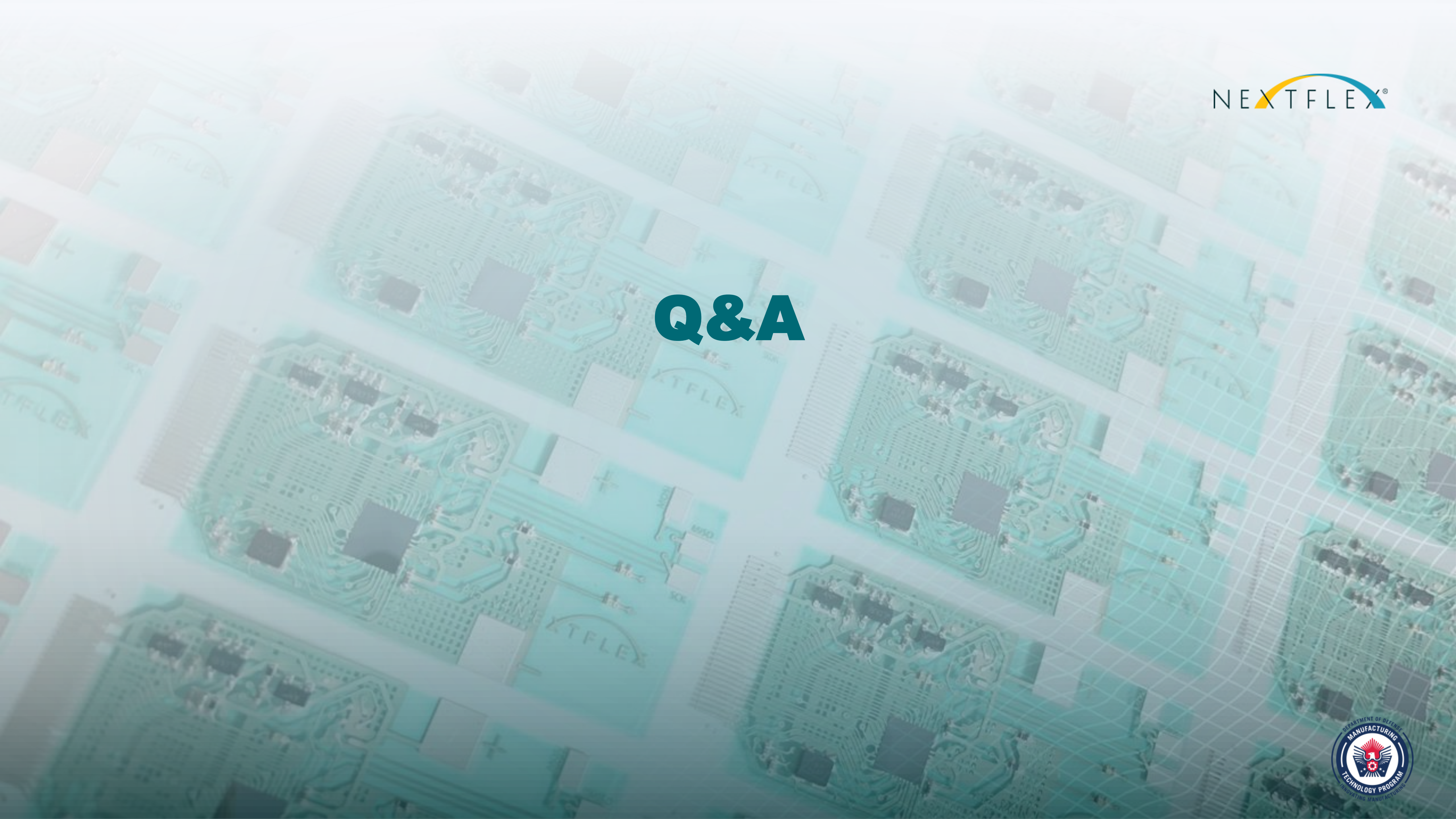
- A new evaluation criterion specifically focused on technology transition potential was added for PC 9.0.
- Technical Score and a Non-Technical Score are determined by averaging the scores in from each category. Scores from all reviewers produce average scores and a Technical Ranking.
- Project selection will rely heavily on the Technical Score and Ranking; Non-Technical Score and reviewer feedback are particularly useful to distinguish proposals that are rated closely to each other, as well as to identify potential outliers (high or low).
- Scores and comments from reviewers will be compiled, ranked, and prioritized for consideration by the Technical Council in voting.
- The Governing Council will consider input from reviewers, Technical Council recommendations, and factors such as alignment with the NextFlex dual mission to promote development and U.S. manufacturing of FHE and support DoD technology transitions, and balance of the project portfolio in selecting proposals.

CALL FOR PC 9.0 REVIEWERS

- Vitally important to the process that there be strong member involvement in reviewing
- Benefit of NextFlex membership because it allows your organization to influence what projects go forward
  - Members cannot serve as a reviewer for a topic in which their organization is proposing
- Please help recruit others from your organization to serve as reviewers
  - Each industry, academic, and non-profit member can provide one reviewer per topic
  - Government organizations may have multiple reviewers in a single topic (within reason)
- All reviewers should be familiar with NextFlex and hybrid electronics or the particular topic

Volunteer to Review Today!

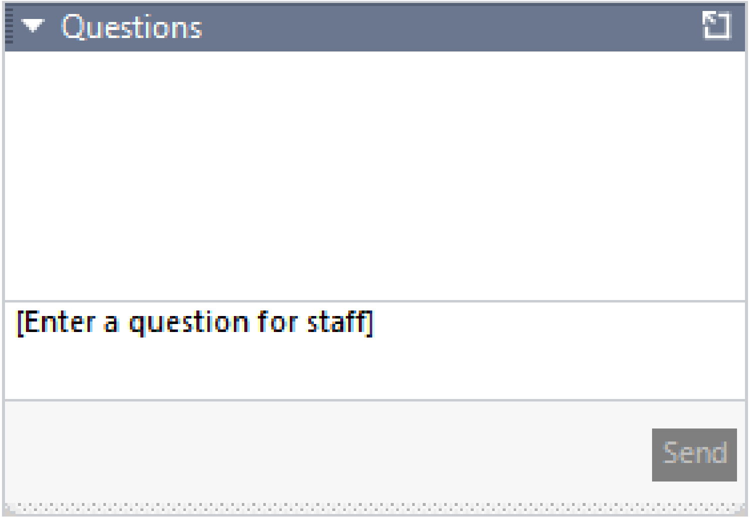
https://nextflex.formstack.com/forms/pc9reviewers



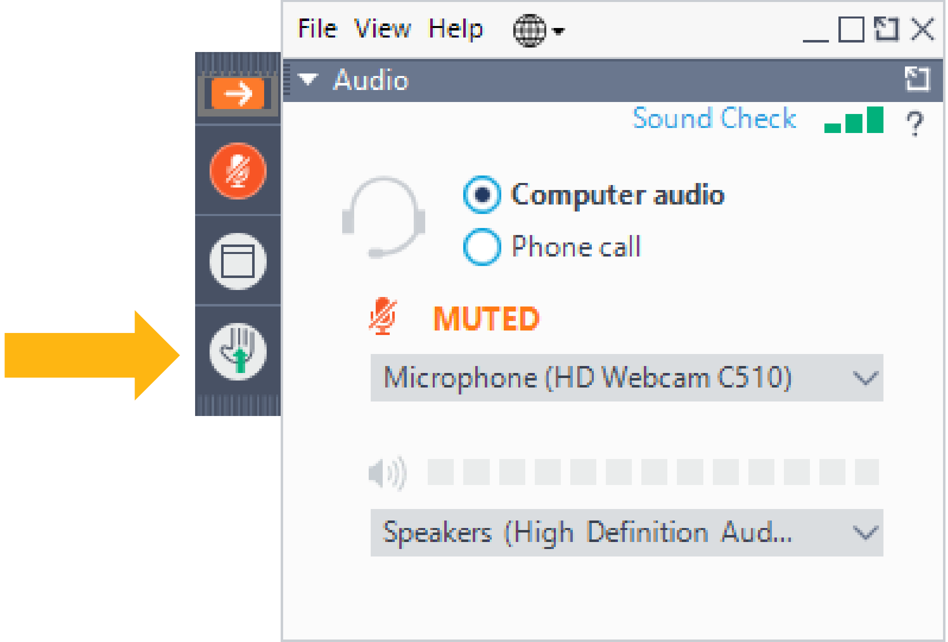
Q&A

QUESTIONS?

- **Method 1: Enter your question into the Questions Pane.**



- **Method 2: Raise Your Hand.**



Computer audio ● Phone call ○

- **Method 3: Unable to access GoToWebinar? Email your questions to marcom@nextflex.us**

proposal@nextflex.us

Volunteer to Review Today!

https://nextflex.formstack.com/forms/pc9reviewers

PROJECT CALL 9.0

TEAMING EVENT

TEAMING EVENT STRUCTURE

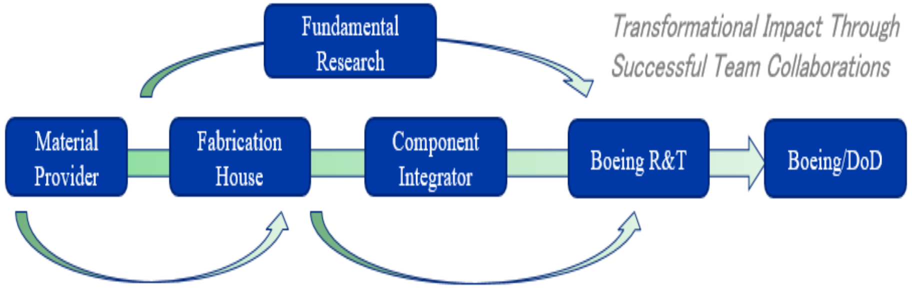
- We will progress though each of the topics sequentially
- Each proposer will be allowed a single slide to pitch their proposal idea, capabilities, and / or type of partnership sought
- Please reach out to the presenters directly after the event for questions or to discuss collaboration opportunities

PC 9.0: INTEREST ACROSS PROJECT CALL TOPICS

NextFlex Project Call 9.X Project Interests

- **Boeing Team:** John D. Williams, Michael Mitchell, Ted Dabrowski, Kalsi Kwan, Adriana Jara, Tim Messer, & John Flynn (Mgmt.)
- **NextFlex Experience:** PC 2.3 - Multilayer print optimization with nScrypt, PC 2.4 - Array Antennas PC 4.5 - Multilayer electronics, PC 3.5 – IoT Health Monitoring Device, 6.3 - Commercial pilot MRL test of inkjet electronics, PC 6.7/6.10 - Phased array electronics, PC 8.2- Sustainable multilayer electronics, PC 8.5 - Die package interfaces for cryo and 500^{o}C
- **In House Capabilities:** 3D printed electronics with nScrypt, ink jet printed circuit boards, low temp solder and adhesive attach, laser patterning, Aerosol jet dispense at 40 um, screen printing, plating, DC - 60 GHz electronics and RF test, PCB board fabrication (for rapid circuit proof of concept), MRL alignment, cost models, product development.
- **PC 9 topics of interest:** PC 9.1 – 9.5. We are primarily interested in advanced packaging, 3D printed and structurally integrated electronics, electronics for wiring, reliability for DoD based applications
- **Seeking:** Academic team members and small businesses to pair with. Always open to new collaborations.
- **Contact:** john.d.williams14@boeing.com, 256-631-3814, or michael.f.mitchell2@boeing.com, 256-937-5254

Vision for implementing FHE into the ecosystem



Fundamental Research

Transformational Impact Through Successful Team Collaborations

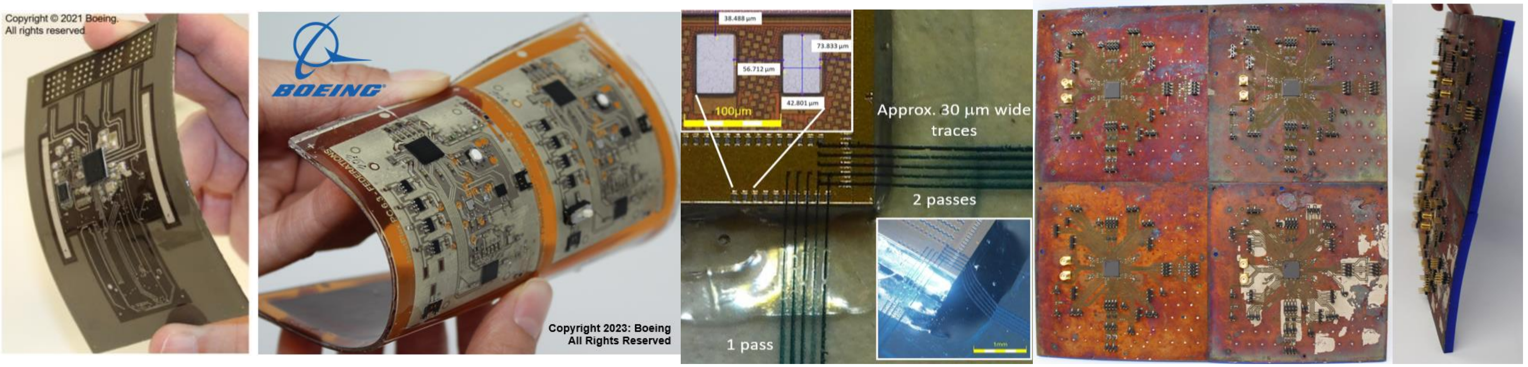
Material Provider

Fabrication House

Component Integrator

Boeing R&T

Boeing/DoD



FABRIC8LABS

Fabric8Labs, headquartered in San Diego, CA, is a metal additive manufacturing company, using its proprietary Electrochemical Additive Manufacturing (ECAM) process

ECAM component features:

- High resolution printing (33 µm resolution)
- Pure-copper composition
- Application optimized component design

Commercial Lead:
Anasuya Adibhatla: anasuya.adibhatla@fabric8labs.com

Technical Lead:
Ian Winfield: ian.winfield@fabric8labs.com

www.fabric8labs.com

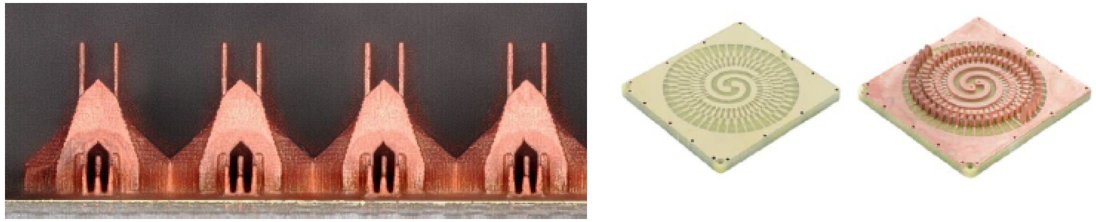
Fabric8Labs is serving customers in the thermal management and wireless communications FHE components markets

Capabilities

- High-resolution, 3D metal printing at room temp without need for post-processing or metal powders
- Direct printing onto PCBs, ceramic, etc.
- Rapidly scalable, foundry-business model

Key Applications & Markets

- Thermal management, wireless communications, and power electronics applications
- Semiconductor, defense, aerospace, telecommunications and automotive markets

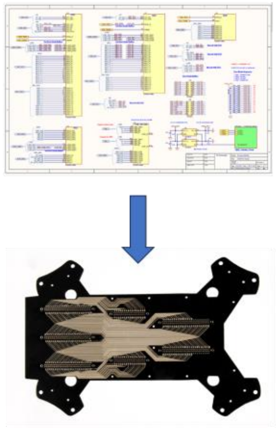


Advanced Printed Electronic Solutions

Contact Info: Richard Neill
rich@advpes.com

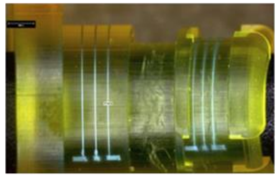
Company/Teaming Capabilities

AME Engineering Services



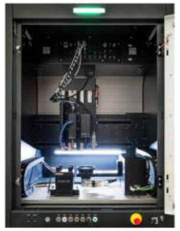
- Architecture and Systems Engineering
- AME Application Electrical/Mechanical and Software Engineering
- Multiphysics Simulation
- Material/Process Engineering
- Customer R&D

Manufacturing Services



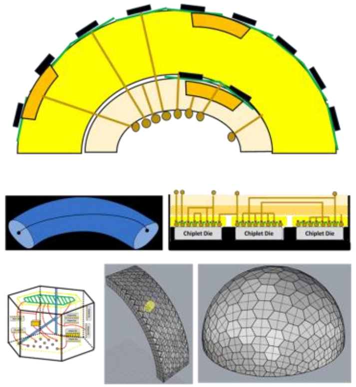
- Prototype-to-Pilot Manufacturing

System Solutions



R&D Areas

- 3D Non-Planar Applications
- AME-Based Chiplet/HI Packaging
- Manufacturing Platform Technologies
  - Tooling, Fine-line, AM Software



PC 9.0 Project Concepts

Topic 9.1a

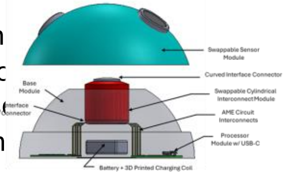
Project concept

Develop/Integrate fine-line (<5um) pitch tooling into existing OEM AME system and manufacturing process. Implement/fabricate reference microsystem based on Chiplet/HI paradigm. Target device can entail refactoring existing member application design into HI device package as evolution of prior PC efforts

Topic 9.1b

Project concept

Design and implement intelligent MEMS sensor application microsystem within a non-planar, complex 3D geometry. Sc can utilize elements of non-planar connector technology (se for modular sensor plug-and-play architecture for non-plan multi-module integration



Topic 9.4a

Project concept

Utilize liquid metal jetting and/or wire filament process in conjunction with additive manufacturing electronic system for fabrication of interconnection of complex 3D wiring and substrates, evaluating performance, power, and environmental robustness

Topic 9.6

Project concept

Implement AM-based 3D curved module connectors (male/female) for non-planar module-to-module interconnection. Addresses problem whereby PCB connectors are no longer viable within non-planar module-to-module scenarios

ZTACH® ACE

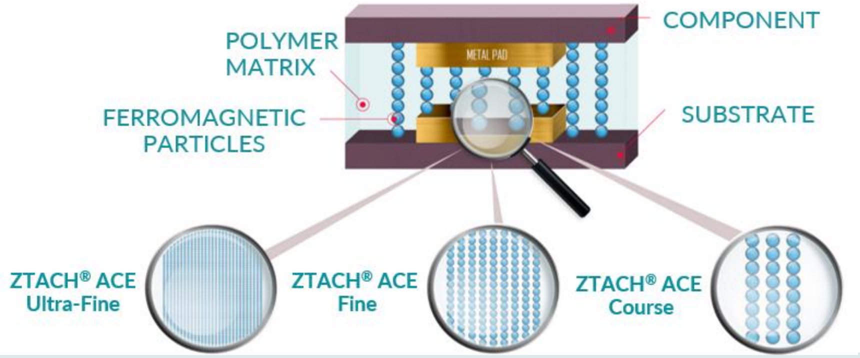
(Anisotropic Conductive Epoxy)

Value Proposition

- Superior adhesion
- Low temperature (80-160°C) cure, no pressure
- Connect to non-planar surfaces
- Fine-pitch, high density interconnects
- Eliminates process steps – reducing cost
- Scalable production via standard SMT processing
- Green Technology, no solvents

Bringing Electronics Manufacturing

Back to the U.S.



Magnetic Alignment of Particles

Before Cure

At 4 Sec.

At 10 Sec.

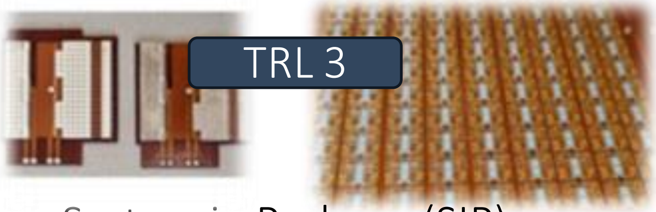
Topics we are interested in partnering on include:

- **9.1 Manufacturing of High Resolution, Multilayer Packages and Devices**
- **9.2.C Materials Solutions for Thermal Management**
- **9.3.A Evaluation of Hybrid Electronics for Space Systems**
- **9.4.A Printed Module-to-Module Interconnections Wire Harness Replacement**
- **9.5 Additive Processes for Improved Environmental Sustainability of Electronics Manufacturing**

PC 9.1: MANUFACTURING OF HIGH RESOLUTION, MULTILAYER PACKAGES AND DEVICES

DragonFly IV Typical Use Cases

Part Shortages & Obsolescence


TRL 3

System in Package (SIP)

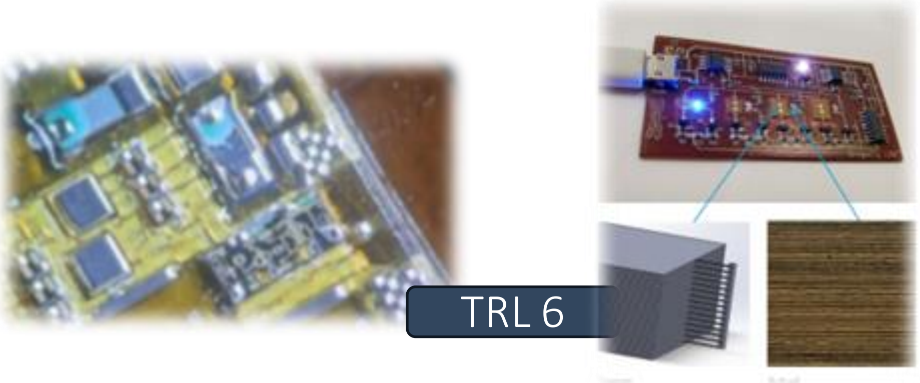
Flex & Rigid-Flex

TRL 4/5

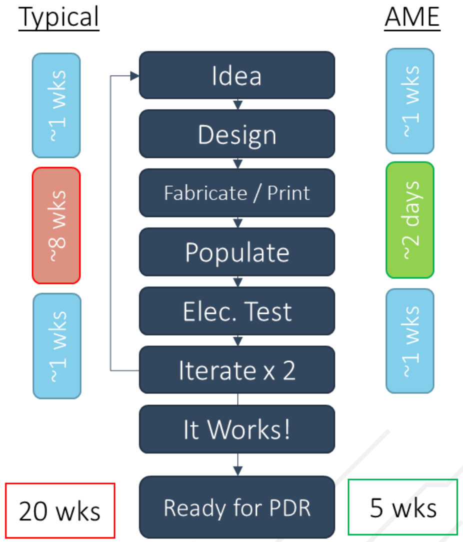
Contact Info:
Matthew.wuensch@nano-di.com
Justin.mattern@nano-di.com


TRL 4/5

Electronics in the Z direction


TRL 6

Multi-Layer PCBs



Typical

~1 wks

~8 wks

~1 wks

20 wks

Idea

Design

Fabricate / Print

Populate

Elec. Test

Iterate x 2

It Works!

Ready for PDR

AME

~1 wks

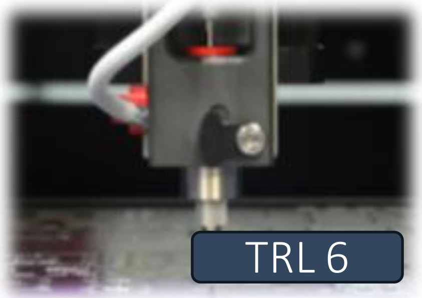
~2 days

~1 wks

5 wks

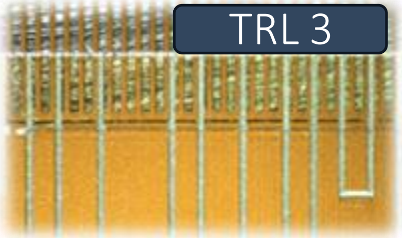

TRL 8

Antenna Fabrication
RF Structures


TRL 6

Prototyping in-house

Conformal Printing / Rework


TRL 3

Program Durations
Doing more with less
On Shoring
IP Security

MRL 6/7

https://www.nano-di.com/dragonfly-iv

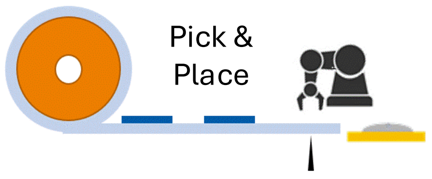
Terecircuits Corporation: Materials Enabling Semiconductor Advanced Packaging

Topic 9.1: Manufacturing of High Resolution, Multilayer Electronic Packages and Devices

Technology: Cleanly decomposable polymers for mass transfer of small, thin, and fragile components

From this:

Existing process:
Slow, Poor Yield



Ejector Needle

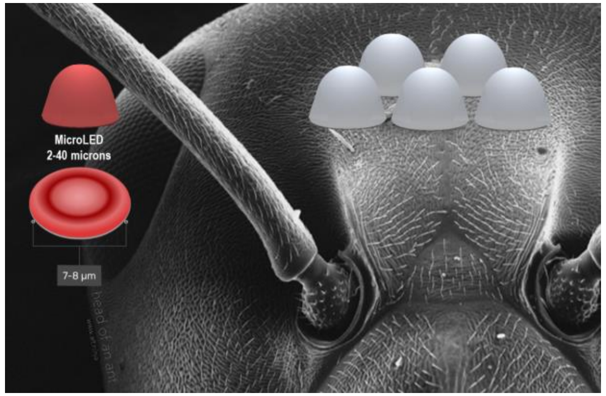
To this:

TERECIRCUITS
Fast, Excellent Yield

Concept: Decomposable polymers that can secure components to a temporary carrier and fully vaporize with application of light and/or heat sources to assemble components with high placement accuracy and without residue. This method overcomes the limitations of pick & place in handling small and fragile components and can be parallelized for increased throughput.

Seeking partners with UV or IR laser transfer tools, experience powering functional LED displays, or challenges integrating thin silicon components into flexible hybrid electronics

Use Case 1: High resolution microLED displays on flexible substrates



MicroLEDs offer significant potential for production of transparent and flexible displays with high brightness and low power requirements. They also allow for in-display senor integration for imaging of surroundings, health monitoring, and more.

For commercially viable displays, the target size of **5 microns** is smaller than a red blood cell.

There is currently no widely accepted or scalable solution for assembly of these tiny, fragile components.

Use Case 2: Mass transfer of thin and fragile silicon-based components for flexible hybrid electronics

Source: © Fraunhofer EMFT

The integration of small and thin silicon-based components into hybrid electronics presents similar challenges to microLED assembly. Components such as ICs, sensors, and MEMS devices, which cannot be directly printed, require a high throughput, cost-effective mass transfer solution.

Mass transfer of silicon-based components small and thin enough for flexible hybrid electronics remains a major challenge using conventional techniques.

Topic 9.3: Reliable Hybrid Electronics for Extreme Conditions

Technology: Nanoparticle-filled epoxies as tunable CTE underfill materials

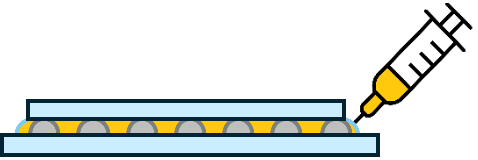
Underfill is required to provide structural stability to stacked electronics, especially components joined by solder balls, which require oven reflow to melt.

The lowest CTE of commercially available underfill is ~26 ppm/K, and often sacrifices thermal conductivity.

Terecircuits is developing a method of producing negative CTE ZrW_2O_8 nanoparticles with favorable morphological and surface properties for making infused epoxy composites.

Material	CTE (ppm/K)
Proposed material	**Tunable**
Epoxy	60 - 80
PCB (FR4)	14 - 17
Solder balls (Sn-Pb)	24-27
Si	2.6 – 3.3
SiO_2	0.55 - 0.75

Seeking partners with thermomechanical testing capabilities and/or applications requiring extreme temperature swings



Contact: Michele Fromel, Director of Technical Operations: mfromel@terecircuits.com / 570-406-8930

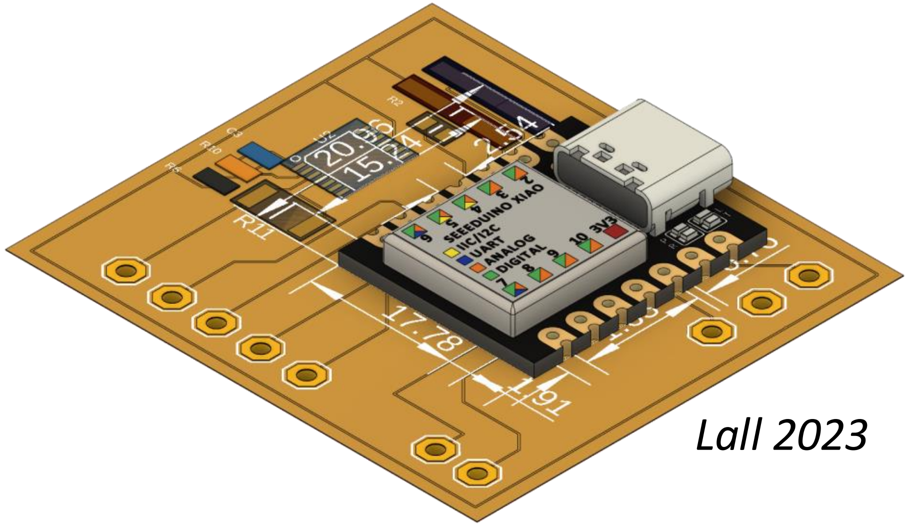
Additively Manufactured 3D Hybrid Electronics Devices

Topic:

9.1 Manufacturing of High Resolution, Multilayer Packages and Devices

Description:

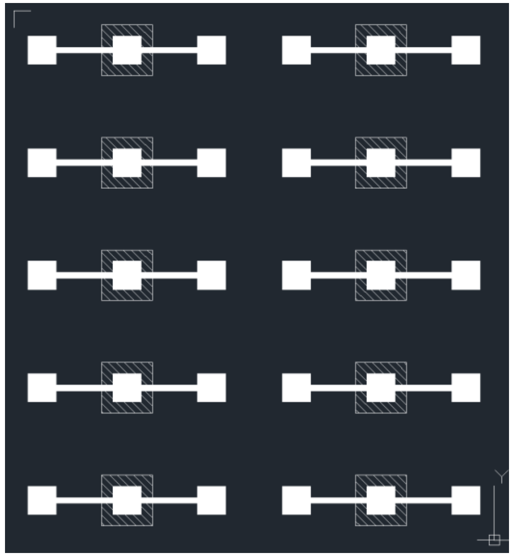
The program will focus on the fabrication of multifunctional prototype devices in a 3D-printed structure. High I/O components and passives will be integrated into the final structure and optimized for electrical performance and reliability.



Lall 2023

Background and Related Work Performed:

- Significant body of prior work development of additive interconnects and additive passives high-temperature planar and 3D architectures with additively-printed circuits in PC6.4, PC6.5 and PC8.2.
- Worked on process control for printed passives on inkjet platform for PC6.5 and attachment of components on additive circuits in PC6.4.
- Prior work on the development of packaging solutions for sustained high-temperature operation in automotive and defense applications.



Capabilities Sought in Potential Project Partners:

- Additive Encapsulation Companies with desirable CTE
- Interconnect Companies – Solders, ICAs, ACAs
- Dielectric Companies with additive materials.

Contact: Pradeep Lall, lall@auburn.edu; (334)740-3424

Manufacturing and Modeling of Multilayer Packages and Devices

- **Topics 9.1 and 9.6:**
  - Manufacturing and Modeling of Multilayer Packages and Devices
  - Utilize newly developed Radial Stretch Tester (RST) to mechanically test in monotonic, cyclic, uniaxial, and biaxial loading scenarios
  - Design guidelines on designing multilayer FHE’s from mechanical testing and simulations.

Capabilities and Background:

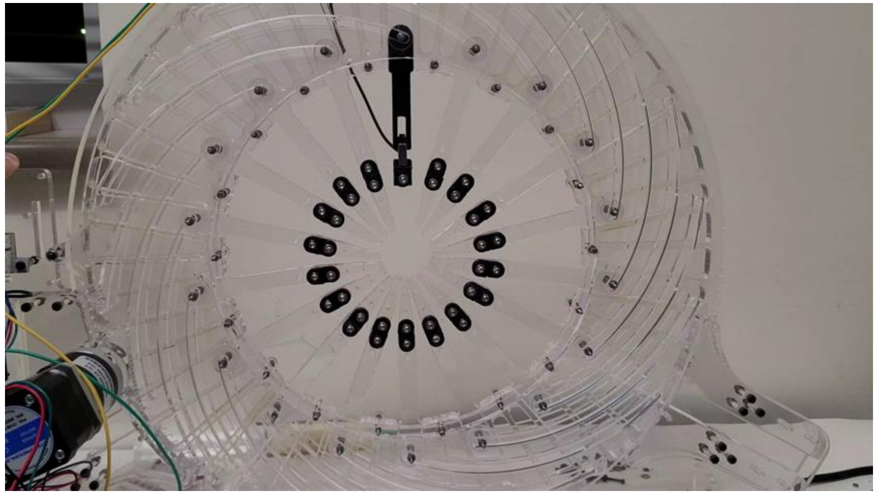
  - Mechanical Characterization :
    - Radial Stretch Tester (RST)
      - Monotonic and Fatigue
      - Biaxial and Uniaxial
    - Load Frame:
      - Monotonic and Fatigue
      - Simultaneous Temperature / Humidity testing
    - 3D Digital Image Correlation (DIC)
  - Finite element simulations (FEA)

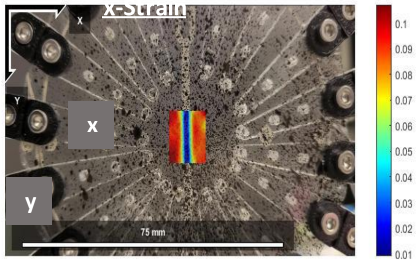
- **Seeking Partners**
  - Industry, materials, manufacturing partners
  - Stretchable electronics
  - Multilayer FHE devices
- **Contact:**
  - Dr. Nick Ginga
  - University of Alabama in Huntsville (UAH)
  - nick.ginga@uah.edu (Lab Group Website)

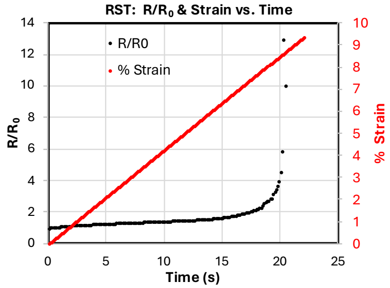
Environmental Chamber

Tensile Monotonic/Fatigue Load Frame

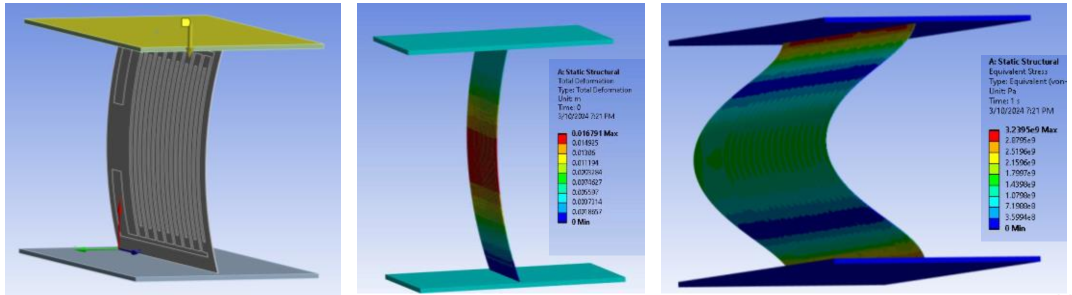
Radial Stretch Tester (RST)







FEA of Additively Manufactured Flexible Capacitor

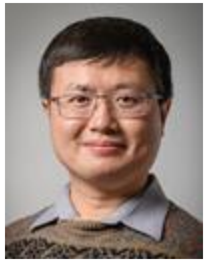


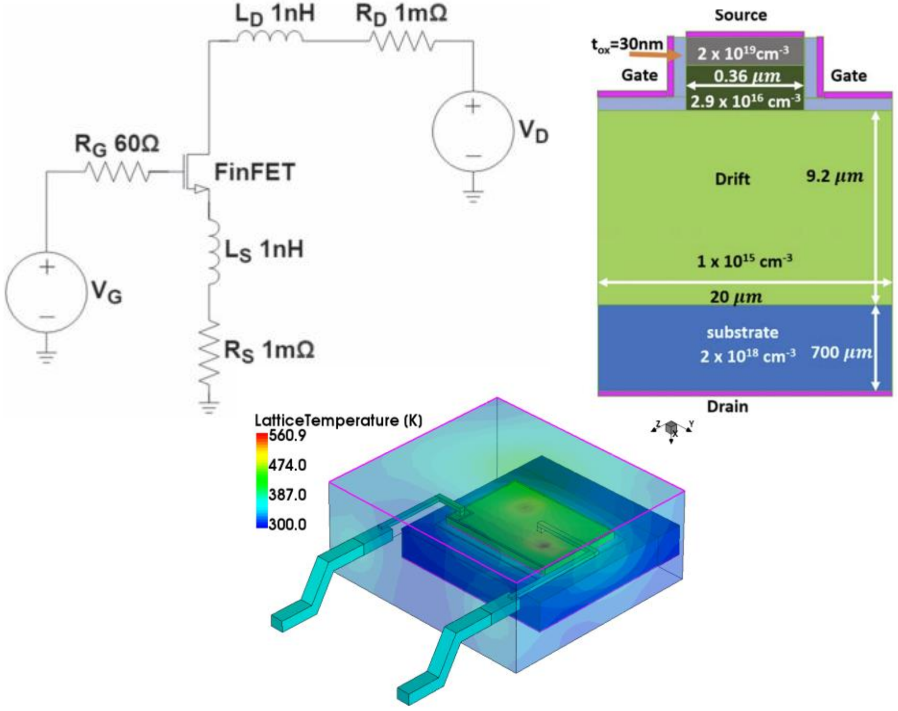
THE UNIVERSITY OF
ALABAMA IN HUNTSVILLE

PC 9.2: THERMAL MANAGEMENT FOR POWER ELECTRONICS

9.2: Package-Device Co-Simulation
9.3: Cryogenic Measurement and Radiation Simulation

PI: Hiu-Yung Wong, SJSU, hiuyung.wong@sjsu.edu (https://www.sjsu.edu/people/hiuyung.wong/)

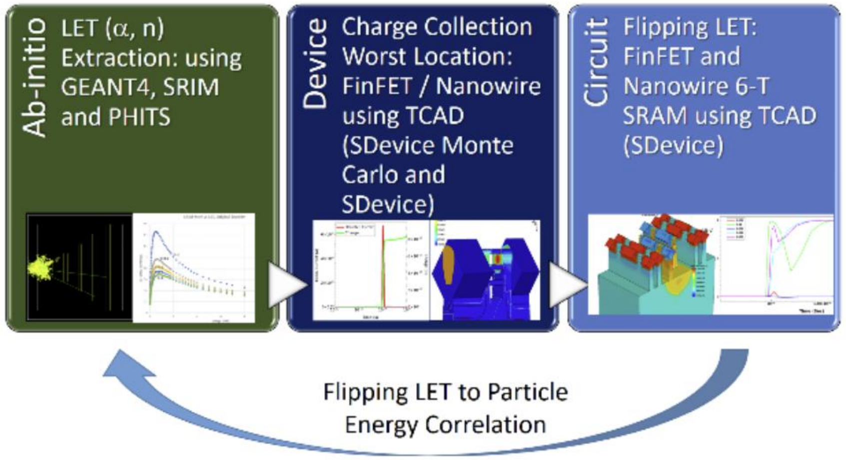




Chip-Package Interaction for Thermal Management (Si, SiC, GaN, Diamond, Ga_2O_3)

TCAD, SPICE

JSSST '22, '23
MR' 20



Ab-initio: LET (α, n) Extraction: using GEANT4, SRIM and PHITS

Device: Charge Collection Worst Location: FinFET / Nanowire using TCAD (SDevice Monte Carlo and SDevice)

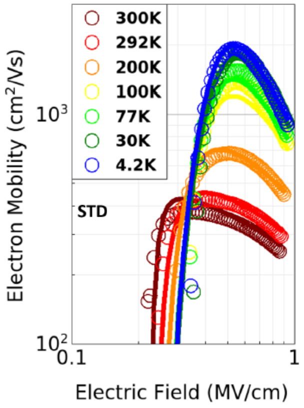
Circuit: Flipping LET: FinFET and Nanowire 6-T SRAM using TCAD (SDevice)

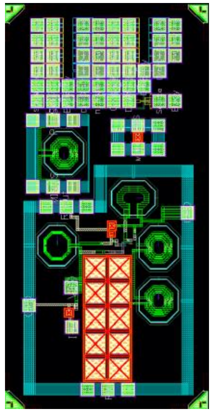
Flipping LET to Particle Energy Correlation

Radiation Hardness

Ab initio to TCAD

TED '21
GOMAC '21





4.2K RF Measurement and Modeling

HCI, NBTI, Gate Oxide Reliability

EDL '23, TED '20

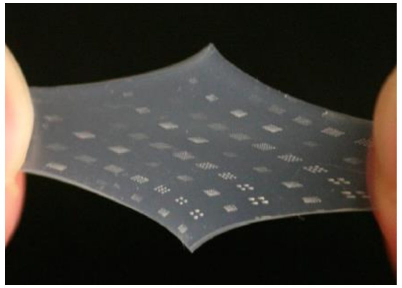
PRINTING A POWER SYSTEM-IN-PACKAGE

POC: NATHAN LAZARUS (NLAZARUS@UDEL.EDU)

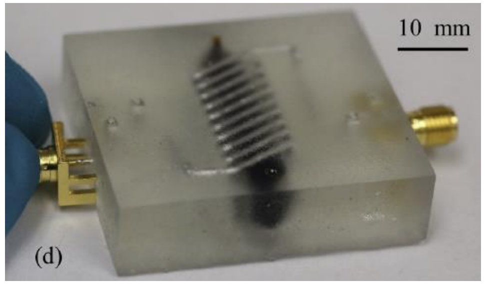
- **Topic 9.2: Thermal Management for Power Electronics**

- **Project Concept:**
  - Printed channels with high performance coolant (room temperature liquid metals)
  - Metallization of printed conductors used to create heat exchangers
  - Used to create a power module with integrated cooling and power passives
- **Background:**
  - Extensive experience in liquid metals, 3D printing metallization and power packaging
  - Longtime researcher with US Army Research Laboratory before joining U. Delaware last year
- **Capabilities Sought:**
  - Corporate partners for scaling up manufacturing concepts
  - Thermal modelling

Liquid Metals for Active Cooling

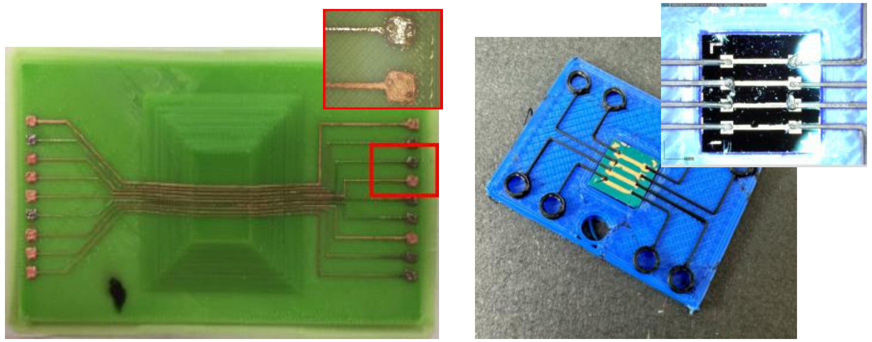


N. Lazarus et al., ACS Appl. Mater. Interfaces 2017



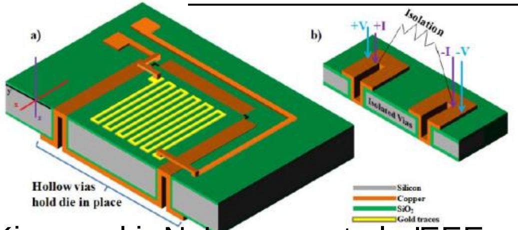
N. Lazarus et al., Addit. Manuf. 2019

3D Printing Metallization

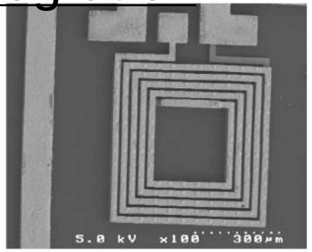


S. Hawasli, N. Lazarus et al., Proc. IMWS-AMP 2018

PowerMEMS Integration



I. Kierzewski, N. Lazarus et al., IEEE Trans. Comp. Packag. Technol. 2015



N. Lazarus et al., JMM 2013

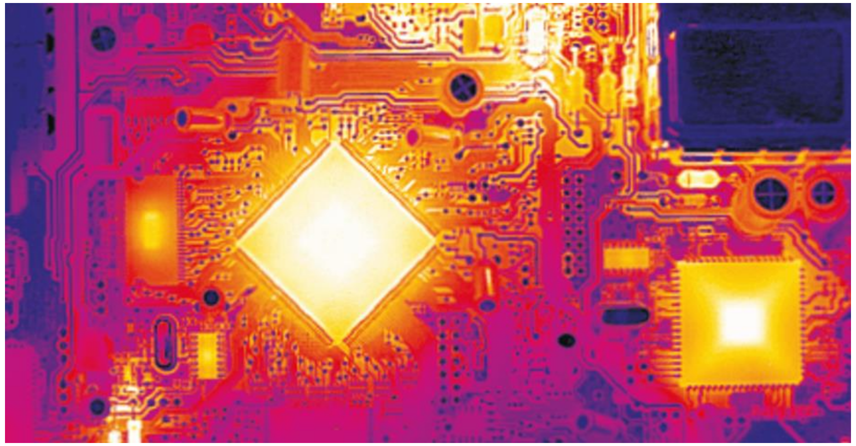
Hybrid Electronics with High Efficiency Cooling Structures

Topic:

9.2 Thermal Management for Power Electronics

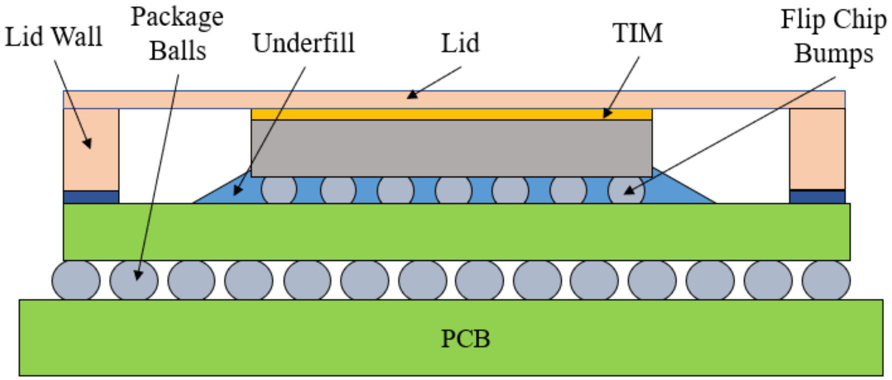
Description:

Additive manufacturing of circuits with passive and active cooling solutions for high heat output applications to enable 3D heat exchangers for thermal management in advanced semiconductor packaging and electronics components.



Background and Related Work Performed:

- Significant body of prior work on the development and characterization of active and passive heat transfer solutions for automotive electronics.
- Worked on the development of new high thermal conductivity materials for high I/O packaging.
- Prior work on the development of packaging solutions for sustained high-temperature operation in automotive and defense applications.



Capabilities Sought in Potential Project Partners:

- Additively printable thermally conductive dielectrics
- High conductivity laminates
- Passive solutions for integration with FHE

Contact: Pradeep Lall, lall@auburn.edu; (334)740-3424

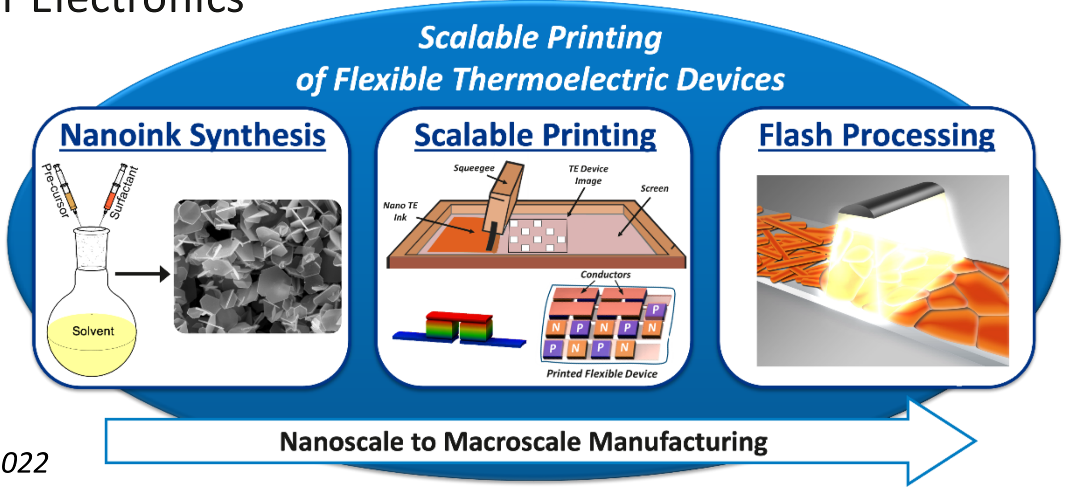
Scalable Printing of Efficient and Low-Cost Thermoelectric Devices for Thermal Management

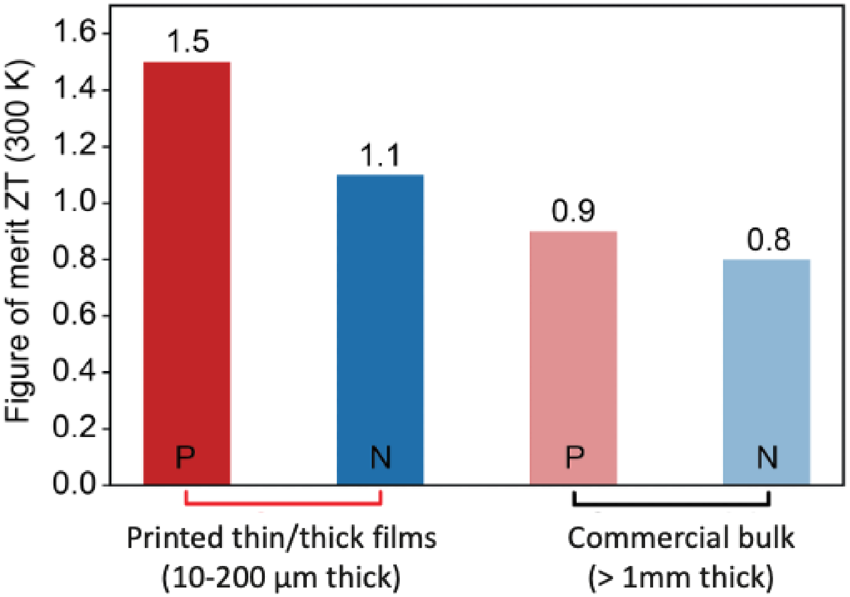
Topic 9.2: Thermal Management for Power Electronics

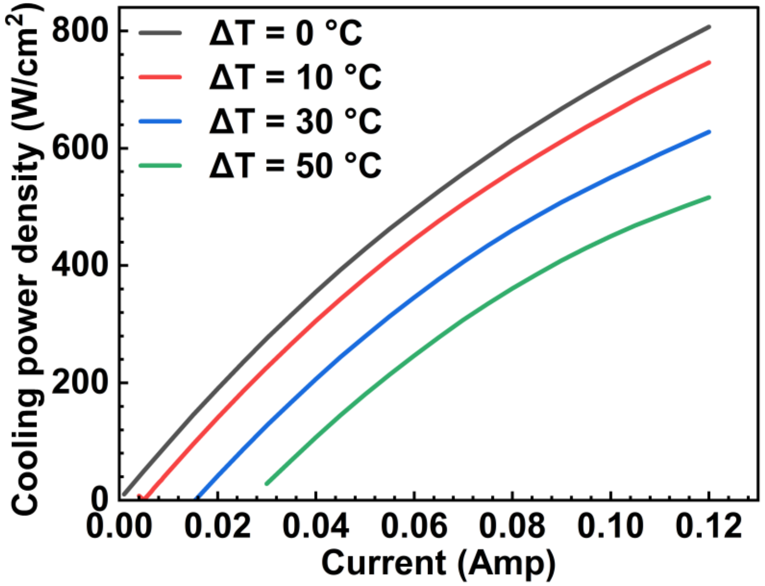
Yanliang Zhang PH.D.
Associate Professor
University of Notre Dame
Email: yzhang45@nd.edu

Our recent publications in printed thermoelectrics:

- ***Energy & Environmental Science,*** *2024*
- ***Nature,*** *617 (7960), 292-298, 2023*
- ***Advanced Materials,*** *35 (47), 2212230, 2023*
- ***Energy & Environmental Science,*** *15 (12), 5093-5104, 2022*
- ***Advanced Functional Materials***, 1905796, 2020.
- ***Advanced Functional Materials***, 1901930, 2019.







PC 9.3: RELIABLE HYBRID ELECTRONICS FOR EXTREME CONDITIONS

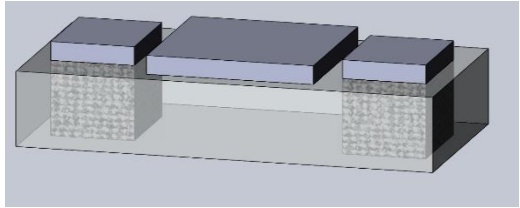
Extreme Temperature Power Module On Flexible Metallized Substrate

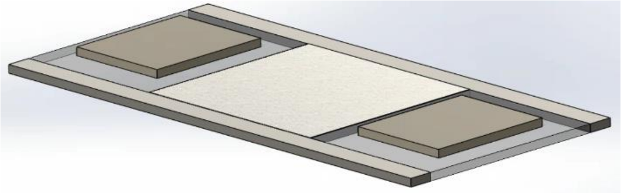
Topic 9.3: Reliable Hybrid Electronics for Extreme Conditions

Patrick McCluskey, University of Maryland, mcclupa@umd.edu

Description of proposal concept

To build a power module on a metallized, high temperature, flexible substrate that can withstand significant voltage. The substrate will be made of flexible glass or ceramic onto which high temperature metallic interconnections will be deposited and sintered using additive manufacturing. Thermal vias will be created through the thickness of the glass for vertical cooling, while also providing planar thermal isolation. Thermal and stress simulation will be conducted to design in reliability. Reliability will be confirmed with temperature cycling, power cycling, drop shock, and humidity testing.





Background on related work performed

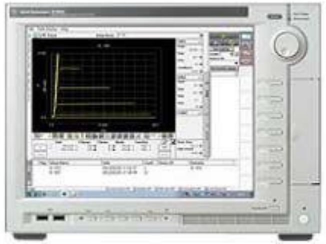
The CALCE Center at the University of Maryland is world renown for its reliability assessment and testing capabilities. Furthermore, extensive work has been conducted on the development of high temperature transient liquid phase sinter materials for interconnection; 3D printing on flexible surfaces; and the use of thermal vias to provide one dimensional heat flow in non-flexible glass substrates.

Capabilities at University of Maryland

Temperature cycling/ humidity

Drop shock

Failure analysis (e.g. SEM)



High power curve tracer

3D printing

Capabilities Sought In Team Members

- Development of flexible glass and ceramic materials
- Circuit Design Expertise

EngeniusMicro Additive Manufacturing

Contact:
Brian A. English, PhD | CTO
brian.english@engeniusmicro.com

Engeniusmicro is developing

1. Affordable hybrid AM tool.
2. Unified software to accelerate manufacturing rate.
3. Ceramic chip carriers with integrated environmental protection.
4. Multi-layer conductor processes

Capabilities/Past Performance

1. Ceramic, Conductor inks and pastes, ULTEM, PTFE, and engineering polymers.
2. Multimaterial parts and electronics
3. Shock survivability beyond 20,000G
4. X-band antennas and interconnects
5. Conformal surface printing.
6. Printed wirebonds from chip to carrier.

Potential Project Partners

1. EGM is looking to support teams and end-users with multi-material prototypes and workflow optimization.


Multi-tool Carriage

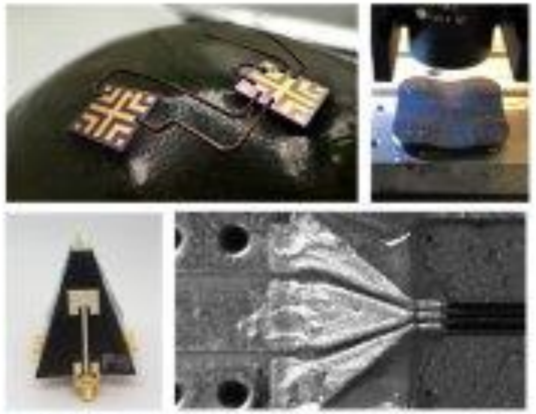
Unified machine code seamlessly combines slicing and toolpath

Ceramic Extrusion

Via Filling


Printed Wirebonds


Printed Packages


Conformal printing copper and silver for interconnects, 3D antennas, and wirebonds

ENGENIUSMICRO

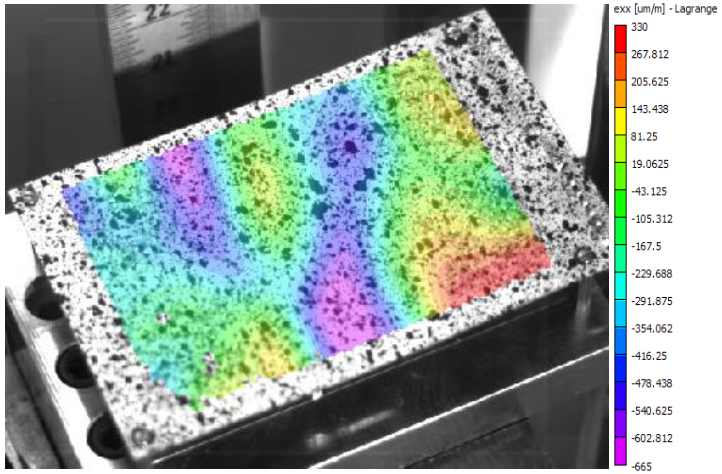
Extreme High-Temperature Wide Temperature Extreme High-G Reliability of FHE

Topic:

9.3 Reliable Hybrid Electronics for Extreme Conditions

Description:

Hybrid electronics with demonstrated high reliability and survivability in high-G, high vibration at high and low temperatures. Development of meaningful accelerated tests and test levels in comparison with conventional designs for standardization of fully additively manufactured circuits.



Background and Related Work Performed:

- Prior body of work in the failure modes-mechanisms, accelerated testing, development of acceleration factors, failure analysis and material reliability interactions.
- Prior Project lead on PC2.5: Development of Accelerated Test Methods for FHE; and PC7.6: In-Mold Electronics for Automotive Applications. Significant prior work on high temperature, wide temperature extremes and high-G reliability for conventional electronics.

Capabilities Sought in Potential Project Partners:

- Companies interested in migrating existing design to FHE technology solutions for harsh environments.
- Accelerated testing companies with solutions for accelerated testing for operation in extreme environments
- OEMs, 1st tier and 2nd tier companies with interest in risk mitigation in use of FHE technology

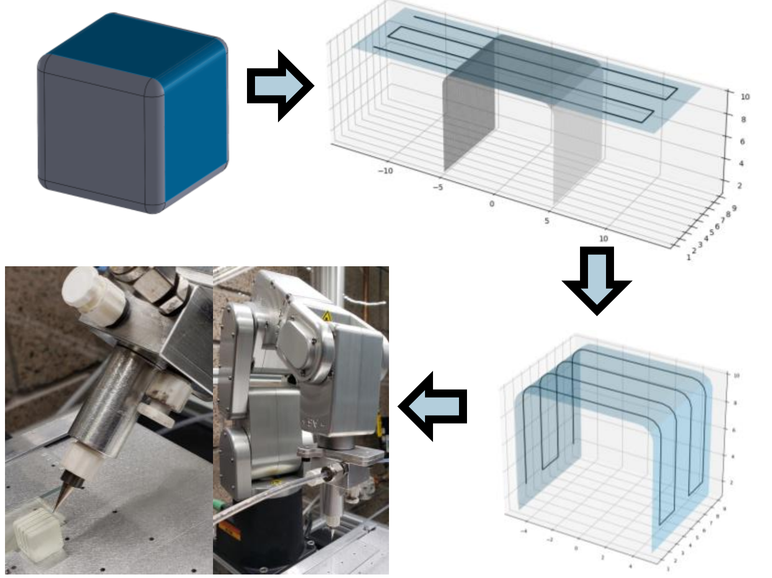
Contact: Pradeep Lall, lall@auburn.edu; (334)740-3424

PC 9.4: CONFORMAL & STRUCTURALLY INTEGRATED HYBRID ELECTRONICS

PROJECT CALL 9.4: CONFORMAL & STRUCTURALLY INTEGRATED HYBRID ELECTRONICS

Design-to-manufacturing workflow for digitally-printed conformal circuits

Computational tools for conformal design and motion planning



1. Extract surface geometry

2. Flatten 3D surface, draw 2D toolpath

3. Invert mapping back to 3D surface

4. Print

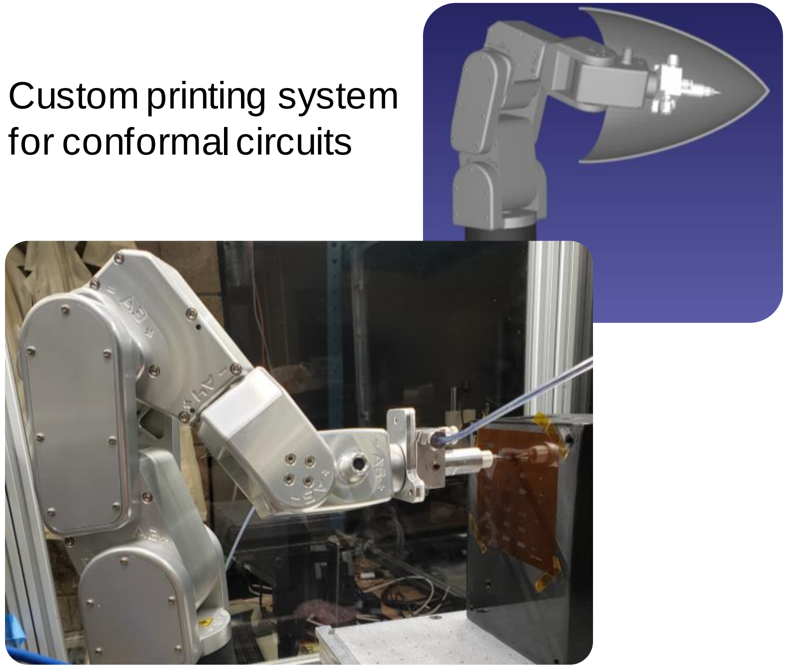
Unique computational method to wrap a 2D design onto a 3D surface

Transparency and tunability of distortion for wrapping to doubly curved surfaces

Generalizable to different patterning methods

Conformal aerosol jet printing (AJP) with robotic arm printhead

Custom printing system for conformal circuits



Potential advantages for printing on large (immobile) surfaces or accessing hard-to-reach regions

Broad experience in AJP material and process development

Primary interests:

- Integrating electronics onto doubly curved composites
- Multilayer conformal circuits with discrete components
- Challenging and relevant demonstrators to push motion planning software and print process development

What we can’t do well (teaming opportunities):

- Circuit and antenna design
- Circuit and antenna simulation
- Circuit and antenna testing (RF)
- Advanced mechanical testing
- Environmental reliability testing
- Conformal printing beyond AJP
- Support much cost share

Ethan Secor, Iowa State University (esecor@iastate.edu)

PC 9.5: ADDITIVE PROCESSES FOR IMPROVED ENVIRONMENTAL SUSTAINABILITY OF ELECTRONICS MANUFACTURING

Topic 9.5: Additive Processes for Improved Environmental Sustainability of Electronics Manufacturing

Proposed Scopes for Sustainability and AM:

1) **9.5aii**—testing/development of inks for printable solder masks using LCA and materials down selection as a framework
2) **9.5c**– interested in the testing/development of water-based conductive inks or printable encapsulants using LCA and materials down selection as a framework

- sustainability models (LCA, hierarchical cluster analysis, technoeconomic assessment (TEA), circular assessment
- materials testing and development at PERC/RURI (UML)

Seeking industry partner to lead projects and provide i) ideas for technology demonstrator and ii) facility to transition process

Background and related work:

- LCA for PCBs; LCA and data management for high volume PEM fuel cell stacking; Circularity assessment
- Materials characterization and development for flexible electronics with an emphasis on conductive inks
- PERC/RURI Printed Electronics Research Collaborative / Raytheon—UMass Lowell Research Institute facility is well equipped and has a history of successful Nextflex projects
- PERC has a network of industry partners in the PE/AM ecosystem

For more information: https://www.uml.edu/research/perc/

Contact: Dr. Guinevere Strack guinevere_strack@uml.edu; https://bit.ly/3KvLr3R
Dr. Jasmina Burek jasmina_burek@uml.edu; https://jasminaburek.com/

PC 9.6: OPEN TOPIC FOR “NEW PROJECT LEADS”

BAYFLEX SOLUTIONS Add-on Projects

REPEAT / MEASURE / OBSERVE

Mechanical Testers / Lab Auto+Analytics / Environments

etsuyuzaki@bayflextechnologies.com
bayflextechnologies.com

bayflex solutions

Flexdata.bobbi

for mostly Academia, Govt Institute Collaboration

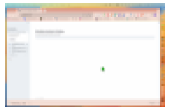
WHAT
Reliability Test Methods AI tool for designated persons (NextFlex tuned ChatGPT-like large language model)

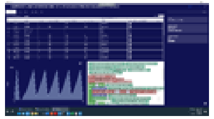
WHY
Workforce development tool to enable all lab technicians to quickly seek the most appropriate testing methodology
(e.g. Nextflex Materials Database, SEMI standards)
but also prompts to show step-by-step test process

HOW
Expand Flexdata platform; Library of 200+ Test processes

NEED
Source NextFlex White Papers documents

RETURN
Seek **$75K** for firmware development
Will match over $75K in Training Equipment or Qualification Hardware, Systems & Firmware





flexdata

Flexdata.leonardo

for mostly Corporate backed Collaboration

WHAT
Automatically detect progression of testing anomalies for Scientists & Engineers with ML/AI techniques (FHE tuned Meta Llama-like data/visual detection)

WHY
Shorten test times with smart, predictive failure detection
to accelerate more material permutations, enabling ideal cost & speed-to-market

HOW
Harvest data from mechanical tools + sensors
Develop PreR2R tester (if for manufacturing)
Expand Flexdata platform;
Machine Learning from one* > multi* > visual sources
- fm resistance, voltage, temp, humidity etc. Sensors

NEED
Dedicated application

RETURN
Seek **$100-150K**/Yr. (multi-year project)
Will match over $250K/Year excluding additional Plug-ins (Robotics, X-Ray/CT Scan, RFID/BLE/Wi-Fi, More optics/Infra-Red etc.)

flexdata

PICO.MIL evolution

for mostly Wearables, Medical, Industrial applications

WHAT
Interchangeable Multi-climate environment (+ dust / rain / shock / vibration) integrated with mechanicals for passive & continuous-use product assessments

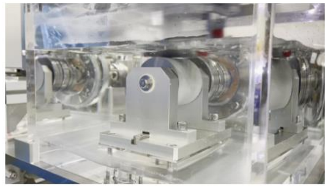
WHY
No versatile low-cost unit exists – difficult to coordinate test conditions across multiple sites & suppliers

HOW
Extend NEXTFLEX PC 8.5 PICO-BLUE mobile test mule for moderate temp/humidity box for further enhancement

NEED
Dedicated application

RETURN
Seek **$75K** for system development
Will match over $75K in system and additional firmware development

PICO



BIOSENSOR SOLUTIONS

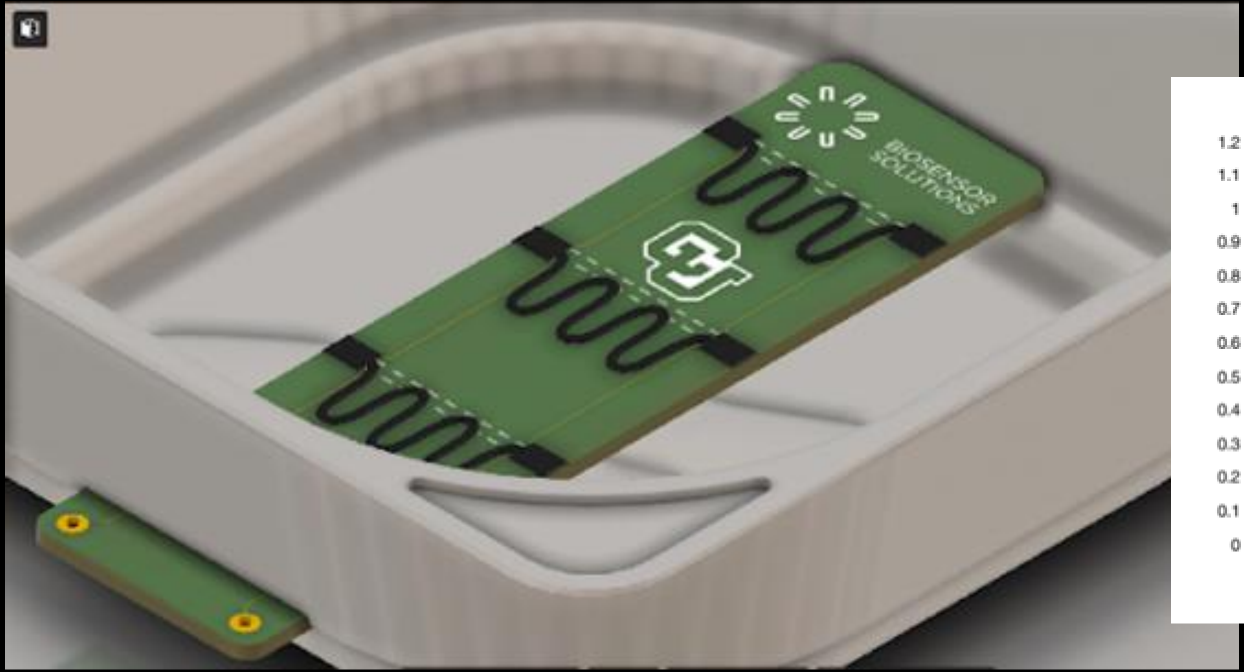
Product Intellectual Property

Patent WO2022031558A1

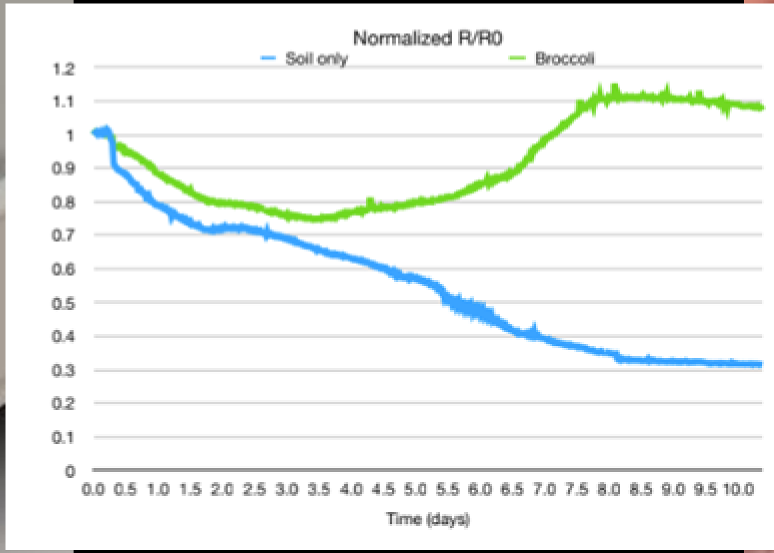
Enzyme electrodes

University of Colorado **Boulder**

LAB



Soil only VS plant



FIELD

ORGANIC INK

University of Dayton/University of Dayton Research Institute

Topic 9.6: Open Topic for “New Project Leads”

BLUEHALO

Concept

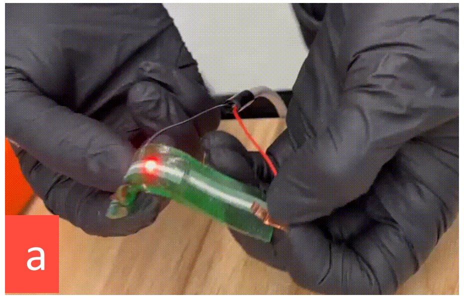
Develop assemblies with combination of novel technologies:

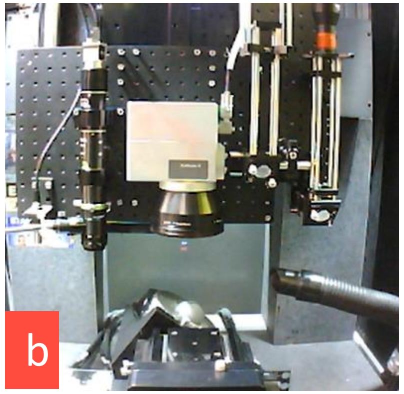
1. Additive flexible substrates
2. ELMNT, liquid metal ink
3. Ultra short pulse laser activation with 5+ axis control

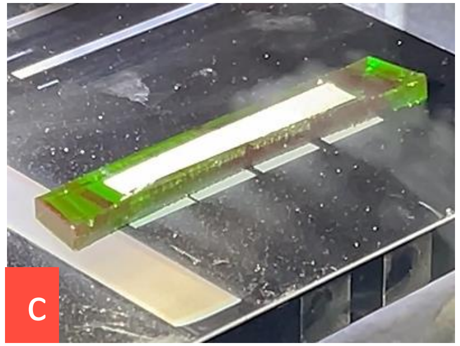
Unlocking:

- Unique manufacturing and assembly options
- Control and manipulation of conductive traces

Feasibility







Resources

- Material testing and characterization
- Sensing and software expertise
- Partnerships with DoD customers

Partnership Objectives

- Seeking partnerships to define end use applications
  - Inspection device in blind bays
  - Inflatable antenna
  - Soft sensing devices

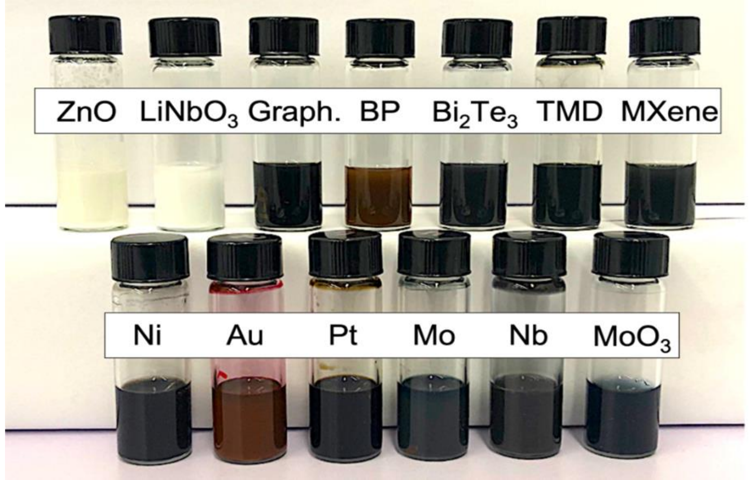
Contact:
Allyson Cox: Allyson.Cox@udri.udayton.edu
Chris Taylor: Christopher.Taylor@udri.udayton.edu
Dr. Alex Watson: watsona1@udayton.edu
Dr. Robert Lowe: rlowe1@udayton.edu

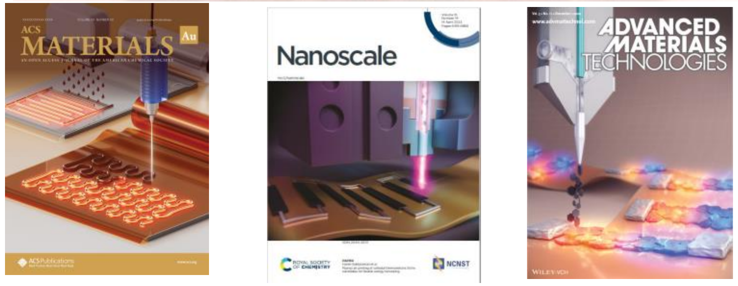
University of Dayton
Research Institute

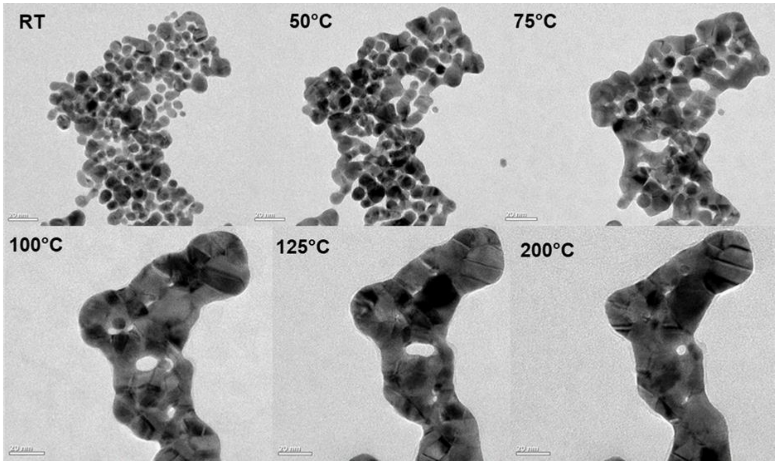
Project Topic – 9.6 Open Topic

Multi jet nanoparticle ink library for advanced manufacturing

We develop a library of novel nanomaterial inks that are compatible with multiple jetting platforms including Aerosol Jet Printing, Ink Jet Printing, Plasma Jet Printing and Electrohydrodynamic printer.







Gold nanoparticles sintering under 200°C

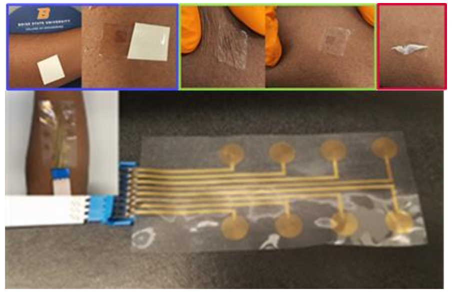
Our area of expertise

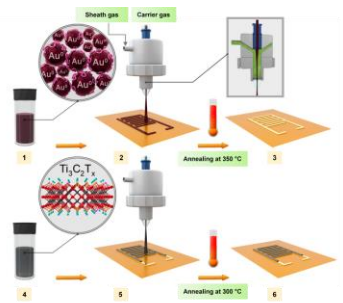
- Scalable and sustainable synthesis
- Rheology optimization
- Printer optimizations
- Low temperature sintering
- Printed sensors, energy harvesters , supercapacitors, photodetectors etc.
- Flexible hybrid electronic printing and integration

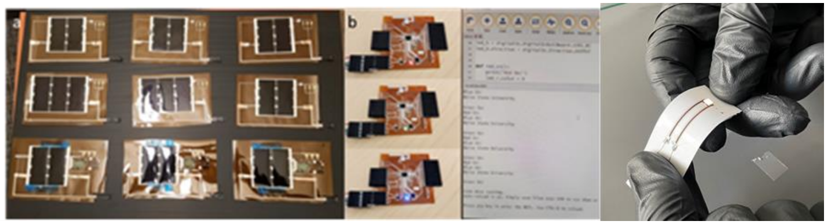
Potential project partners

Boise state university - member
Oregon state university -member
Inflex labs – non member

Device fabrications







Printed semiconductor actives for sensors

Optical: chembio medical wearable non-invasive. Electronic: resistivity change-based

Topic 9.6 Open Topic for "New Project Leads"

TWG: Materials

Technical gap #3: Active materials for printed sensors applications
Technical gap #6 Long term stability of commercial inks in solution

TWG: Components/Microfluidics

Technical gap #1:Need to establish ink/substrate compatibility and standard performance metric with tolerances and repeatability.

Concept:

Advance from existing Iris Light semiconductor active ink + devices with demonstrated repeatability to make functional sensor device

Desired Partner Capabilities

- Sensor use-case owners
- Printing partners to develop beyond current lab environment
- Encapsulation and packaging experts

Additional partner information

- We are open to you leading this topic, or to help on other topics
- We can likely secure at partial cash cost share from the IL govt.
- What other open questions do you have about our capabilities?

Goals (preliminary):

TRL

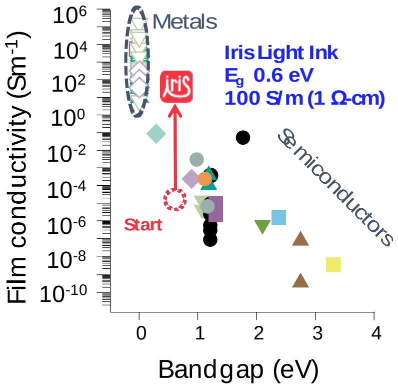
Current: (ink 5). Components (3 or 4 depending on the component)
Goal: TRL 5 (components used to make circuit system/sub-system)

MRL

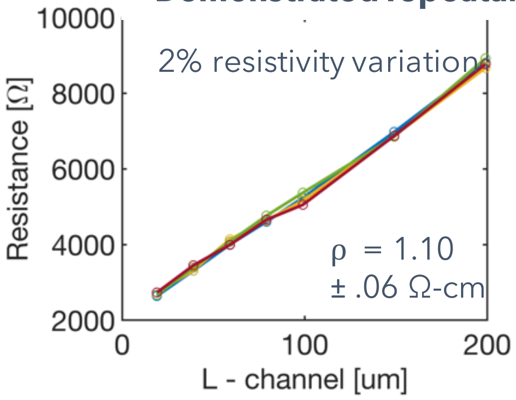
Current: (4 lab): process repeats (ink and deposition), device longevity study ongoing
Goal: 5 components in relevant or 6 (circuit system/sub-system)

Background

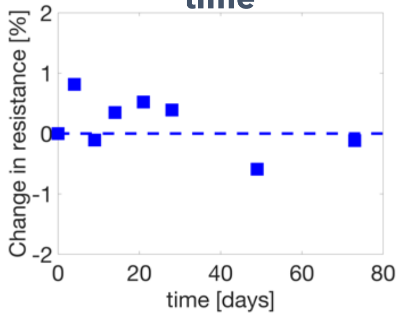
Highest-quality semiconductor ink



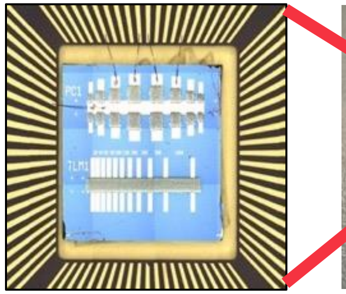
Demonstrated repeatability



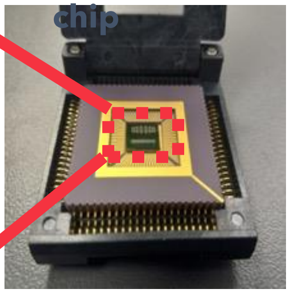
Stability over time



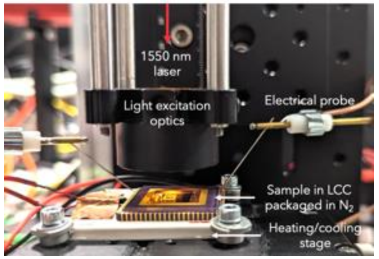
Wire-bonded



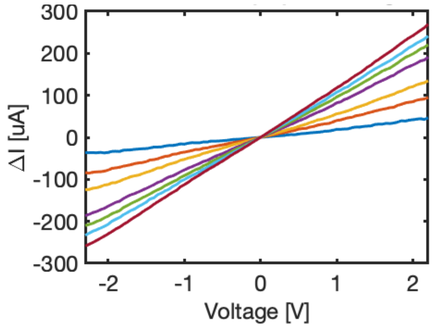
Packaged chip



O-E characterization



1550 nm photoconductor



****Devices: PN diode and photoconductor data available****

Funding: DoD SBIR P1+2, DoE P1, NSF P1, private investment

NEXT: Accelerated lifetime + Advance O-E components (detector/LED) + Circuits

Contact: Chad Husko, Ph.D. | chusko@irisLightTech.com

Thank you!

To schedule pre-submission consultations or ask any questions, email proposal@nextflex.us

Volunteer to Review Today!

https://nextflex.formstack.com/forms/pc9reviewers