Flexible Hybrid Electronics MII

America’s Flexible Hybrid Electronics Manufacturing Institute

Brian W. Anthony, PhD
NextFlex MII, MIT PI
NEXTFLEX, AMERICA'S FLEXIBLE HYBRID ELECTRONICS MANUFACTURING INSTITUTE
FlexTech Alliance Receives $75 Million Department of Defense Award To Create and Manage a Flexible Hybrid Electronics Manufacturing Facility

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First West Coast organization to successfully propose a nationwide effort to organize and manage a new Manufacturing Innovation Institute

August 28, 2015 – San Jose, Calif. – The U.S. Department of Defense (DoD) today awarded FlexTech Alliance a Cooperative Agreement to establish and manage a Manufacturing Innovation Institute (MII) project. The DoD’s award of a $75 million cooperative agreement will fund the creation of a new Manufacturing Innovation Institute that will focus on developing flexible hybrid electronics manufacturing and technologies.
FlexTech Alliance

• 20+ years experience creating and managing electronics industry consortia
• Only US-based organization focused on flexible electronics
  • Multiple technical and business services
  • Wide range of industry, university and government contacts
• Experience managing government R&D programs for military services in flexible electronics
  • DARPA, Army, Air Force
• Flex hybrid electronics is aligned to FlexTech’s skill set and especially well-suited for a California/Silicon Valley institute
Catalyze the development of an ecosystem for manufacturing new forms of electronics that integrate bulk ICs and printed devices with functions such as power, communications, fluidics, and bio-sensing in flexible systems that can bend, fold, stretch, and conform.
NextFlex Mission

• **Create a partnership of the best teams in FHE** based on our extensive existing network; incorporate and leverage the remarkable capabilities already established in industry, universities, and not-for-profits from around the country.

• **Provide DOD and commercial end-users access to low-volume production facilities**, enabling development of a domestic FHE manufacturing base, including manufacturing technologies, equipment, materials, and a highly educated and trained workforce.

• **Catalyze the development of an ecosystem for manufacturing new forms of electronics** that integrate bulk ICs and printed devices with functions such as power, communications, fluidics, and bio-sensing in flexible systems that can bend, fold, stretch, and conform.

• **Form and lead a network of nodes focused on manufacturing technologies related to FHE** and carry out associated education and workforce development, with a hub to coordinate all activities provide electronic prototype assembly, performance and reliability testing, and the creation of commercialization paths.

• **Craft a capability for design, testing and manufacturing of new products** for human performance monitoring, healthcare, distributed sensors, and consumer electronics.

• **Empower U.S. universities and research organizations to move basic and applied research activities** in fields such as semiconductor and device packaging, printed electronics, synthesized nanomaterials, and micro-mechanical and fluidic systems from MRL/TRL level 4 to 7, while participating in the commercialization process.
Technology Platform Demonstrators

A. Human Monitoring Systems
B. Asset Monitoring Systems
C. Integrated Array Antenna Systems
D. Soft Robotics

Intended to facilitate the identification of critical and pervasive manufacturing gaps. These manufacturing gaps will be addressed by targeted projects addressing one or more of the manufacturing technical thrusts.
Manufacturing Technical Thrusts

1. Device Integration and Packaging
2. Materials
3. Printed flexible components and microfluidics
4. Modeling and design
5. Standards, test, and reliability
Manufacturing Technical Thrusts

1. **Device Integration and Packaging**: Ultra-thin silicon integrated circuits and sensors. Development of new tools for testing, slicing, stretching, and thinning silicon wafers. Electronic device and sensor integration to include data lines and interconnects. Data lines and integration may leverage advance precision printing, high speed automated pick and place of device components and integration of power components.

2. **Materials**: Conductive and active inks and pastes, and novel substrates that flex and stretch, and of low-cost renewable sources such as textiles and cellulose.

3. **Printed Flexible Components and Microfluidics**: For sensors and other discrete device components.

4. **Modeling & Design**: Software and hardware design capabilities to integrate novel manufacturing design rules in a collaborative software-space.

5. **Standards, Test & Reliability**: Materials-to-manufacturing processes to meet industry and DOD reliability requirements through testing and standards.
Hub & Node Structure

**Hub**
- Primary HQ
- Located in California
  - Regional impact to many technology developers
- Open to all FHE MII partners
  - Collaborative projects
  - Self-managed projects
- Prototyping, final assembly
- Education & training

**Nodes**
- Leverages resources for fast start
- Focused on expertise
- Virtual or physical location
- Facilitates collaboration among partners
  - Provides industry ROI
- Feeds devices and technology to MII
- Education & training
- Special membership status
During the proposal process a team of more than 160 participants from 27 different states came together to assist and support FlexTech’s proposal. The companies, universities and other organizations represented ongoing activity at several centers of excellence around the country, some of them taking a leadership role in creating an Institute NODE around a regional or technical interest.

These Nodes form natural teams for responding to project calls and facilitating information to and from the Institute, including activity in workforce training and education. As the Institute is forming, we strongly recommend building partnerships within the Nodes as well as directly with the Institute, particularly if there is technology compatibility or common regional interests.
Massachusetts ~= Medical
Massachusetts Node
Focus on Printed and Roll-to-Roll Integrated Systems

Translational Development Activities:
- Solution-based Materials/Processes
- Nanoinprinting of electronic devices
- R2R Nanomanufacturing
- Process integration and scalability

Design for Manufacturing
- Standards
- Roadmapping

Translational Development Activities:
- NameOPS

Technology Project Demonstrators
- UMass Amherst
- MIT
- NYU

Translational Development Activities:
- Hybrid integration
- Q.C., Manufacturability Assessment
- Custom substrates/materials
- R2R Surface Templating

Commercialization
- FLEXcon
- CHASM

Print & Roll-to-Roll CoE
- Education & Workforce

Print & Roll-to-Roll CoE
- Technology Center
- GE Imagination at Work
- CHASM Technologies

Print & Roll-to-Roll CoE
- Education & Workforce
- XENON
- Raytheon
- Eink
- SI^2
- United Technologies Research Center
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Project Call 1.0  Nov 15 ➔ Dec 15 ➔ Jan 8 ➔ Feb 19

Priorities & Target Timeline (subject to change)

- Award Announcement: Aug 28, 2015
- Preparation of Membership Documents & Annual Program Plan: early Oct ’15
- Membership Opens; Begin Populating Technical & Governing Councils: Oct ’15
- Members & Government Refine Roadmaps: Nov ’15
- Project Call #1 Topics TBD: Nov ’15
- First formal meetings of TC & GC: late Dec ’15
- Project Proposals Due: Dec ’15
- Technical Council Meets: Jan ’16
- 2016 FLEX Conference Meetings: Feb 29 ’16

Project Calls

We anticipate targeted project calls each year based on consensus roadmaps prepared by the Technical Council and endorsed by the Governing Council. The first Project Call is tentatively expected to be released in November 2015. To receive notice of the Project Calls, ensure you are on our Interest List by registering at www.FHEMII.com. If you were on the proposal team, you will automatically be placed on the interest list and receive all communications from the MII.
Project Call 1.0 Topics

• Manufacturing for Human Monitoring Systems
• Manufacturing for Asset Monitoring Systems
• Manufacturing processes and Medical Devices platforms for Wearable Medical/Human Monitoring Systems
MA Technology Platform Demonstrator
Wearable Human Performance Monitoring Sensor Platform

MA Node Manufacturing Development Technology Platform Demonstrator

- Adhesive Backing
- Pulse Transit Time
- Body Temp
- Pulse Oxymetry
- Paper Microfluidics (Biomarker/Metabolite Panel)
- Electrochemical sensor
- Printed Battery
- Power Management, DC-DC Conversion
- Energy Harvesting (light, vibration)
- TFT Multiplexing, Pulse Generator & Signal Processing
- Display
- ASIC Connector (disposable sensor)
- Printed Antenna
- Skin
Platform Demonstrations

Near Term (1-2 Years):
- Disposable wearable sensors, medical devices, and building integrated systems
- Dual Use Manufacturing process development
  - Hybrid pick and place, standard contact pad materials and interface
  - Scalable print and R2R processes
  - High performance inorganic TFT devices
  - Integrated Microfluidic/Electrochemical Sensor passive tag
  - Remotely powered sensor tags

Long Term (3-5 Years):
- System Integration, Scalable manufacturing
- Platform Demonstrations
- Technology Innovation Pipeline
Technology & Process Components

- Printed Energy Harvesting
- Display-wearable readout
- Printed TFT switches/address circuits

- Hybrid ASIC, Analog Signal processing, memory, BLE
- Printed TFT signal generation, sensor multiplexing
- Printed wiring & Interconnects

- Printed Battery & Antenna

Printed Sensors
- Temp, Pulse Ox, PTT, Electrochemical/Microfluidic
Technology, Component, & Process development Activities

**Printed Interconnects (Ag, Cu, Au)**
- Inkjet
- Direct pattern (Imprint, gravure)
- Conductive feedthrough

**Hybrid Integration**
- Wafer/Die thinning
- Pick and place/Die attach (Web-based)
- Interconnect/contact pad interface

**Printed High Performance TFTs**
- Inorganic TFTs (ZnO, AZO, IGZO)
  - ALD, nanoparticle compositions
  - Inkjet, imprint patterning
  - R2R scaling
- Integrated switches, sensor multiplex/address circuits
- Printed logic, memory
- Printed signal generators, signal processing
- Active matrix address circuits

**Printed Sensors**
- Temperature/thermometry
- Pulse Ox
- PTT
- EKG/pulse rate
- Microfluidic/Electrochemical
- Other?

**Sensor Process Integration**
- Materials & coatings
- Patterning
- Integration
  - Electrodes, multi-layers

**System Design & Integration**
- Data filters
- Passive/Active
- Data acquisition and storage
- ADC/signal processing
- Printed antenna

**Power**
- Printed battery
- Printed energy harvesting

**Display**
- E ink
- Quantum Dot LED
- OLED display
Project Components

• **Manufacturing Approach:**
  • five technical manufacturing focus areas

• **Integration to scale-up manufacturing:**
  • support open ended design methodologies that enable integration with downstream scale-up to industrial manufacturing.

• **Test and evaluation:**
  • performance, yield, and cost models based on standard industrial testing methodologies.
The Ask... of a Company for any project

- Multiple industry partners
- Funds to push the your manufacturing needs.
- Anticipate companies coming in with minimum 0.5 FTE support to provide "product/prototype design and performance" directions, specifications, testing and evaluation for portions of the platform development activities that pertain to their interests.
- Industry support would be matched with federal funds (we are still trying to understand how the state funds will work.)

Thoughts:
- We would like COMPANY to provide die criteria and interactions on die thinning, and moving web pick and place chip attachment, maybe including a couple other partners to standardize contact materials / inks, conductive adhesives, and other specs for subsystem integration.
- We would also want COMPANY to provide Si die (standard or custom) in small prototype quantities for sensor system control, communication, and sensor analog interface.
- If COMPANY has activities in these areas that would be great, but a close interaction with team partners working on this problem would benefit COMPANY directly.
- Years 3-5 would see more system integration so maybe more custom development of the silicon die.
- Not a matter of how much $ you need to contribute, rather being part of the regional ecosystem establishment and doing things that are important for your business.
MIT Related Research, Expertise and Capabilities
Team at MIT

• Brian W. Anthony <banthony@mit.edu>,
• Marc Baldo <baldo@mit.edu>,
• Duane Boning <boning@mit.edu>
• Vladimir Bulovic <bulovic@mit.edu>,
• Karen K Gleason <kkgleasn@mit.edu>,
• David E Hardt <hardt@mit.edu>,
• Anastasios John Hart <ajhart@mit.edu>,
• Sang-Gook Kim <sangkim@mit.edu>, 
MIT Translational Research in FHE Areas:

• Microcontact printing - equipment, tools and stamps, modeling
• Inspection and real-time process control
• In-line metrology, and visualization
• Materials and devices
• Flexible mems
• ...
In-situ metrology systems, Precision print-head control

UV-Illumination

Fluorescent Image Carrier

Glass Impression Cylinder

Camera

Continuous R2R Contact Tracking, Control, Alignment

In-Process Control – Pattern Fidelity

Pattern Deformation, or Quality Map

Nanoimprint Spatial Modeling & Design Optimization

Imprint of 200 nm-thick polymethylmethacrylate 495 kg/mol, c. 165 °C, 40 MPa, 1 min

Experiment

Simulation

Residual layer thickness (nm)

0.1 mm

200 nm

0.1 mm
MIT Related Research, Expertise and Capabilities

Roll-to-Roll Microcontact Print (µCP): Large Area, High Rate – Equipment, and Seamless Stamps

High-speed R2R CVD

Vapor Printing of Electrodes & Sensors

Conformally coated fibers: Breathable electrodes
Questions...?

... your FHE related manufacturing activities and needs?
... what is important for your current and future FHE manufacturing business?

Brian W. Anthony, banthony@mit.edu