Collaboration for Breakthrough Innovation in Human Performance Monitoring for the Warfighter

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Collaboration is critical to solving issues and innovating new products.
What’s needed for breakthrough applications is almost invisible upstream in the supply chain.
Collective focus on challenges and opportunities shortens time to market.
SEMI Technology Community

Products & Services

- Industry Events
- Industry leadership committees
- Funded R&D
- Pilot Manufacture

SEMI
- 7 Global Regions
- Advocacy & Talent
- Technology Leadership

MEMS & Sensors
- Standards
- Flexible Electronics
- Fab Owners Assoc.
FHE System Schematic

Flexible, Hybrid Electronics (*simplified*)

- **Mostly Printed**
  - Interconnect
  - Antenna

- **Can Be Printed**
  - Power
  - Display
  - Communication Interface
  - Sensors

- **Not Usually Printed**
  - Processor
  - Memory
  - Medium to far field communications and location
  - High performance circuits

Source: FlexTech Alliance
**SEMI • FlexTech Activities**

**Mission:** Create a collaborative environment to accelerate the risk reduction of technology, manufacturing, and supply chain development

**Flexible Hybrid Electronics Supply Chain Development**
- CMOS Integration
- Radio and communications
- Sensing, warnings, wearable displays

**Flexible, Wearable Human Performance Monitoring**
- Human Performance Monitoring Applications
- 20+ members

**Flexible Hybrid Electronics Manufacturing**
- Manufacturing Gaps
- Public-private partnership
- 50+ members
Projects & Partners

Sensor Systems
- Wearable Devices for Dynamic Assessment of Hydration & Hydrogen Status
- Wearable Flexible Hybrid Electronics Biometric Performance Monitor
- Design & Fabrication of Prototype Biosensor Monitoring Devices
- Microfluidics System Packaging
- Wearable Dynamic Hydration Assessment System

Materials
- Biometric Sensors - Integrated Development Platform for Human Performance Monitoring
- Printed Microfluidic Performance Assessment for Sweat-Based Biomarker Sensor Platforms
- A Scalable Flexible Substrate and Assembly Process
- Flexible Printed Electronic Device
- Materials Registry

Power
- Flexible Electromagnetic Field Sensing Array
- Self-Powered Communicating Sensors
- Sensor Labels
- Flexible Printed Battery
- Thin Film Power Source
- Solid State Thin Film Lithium Rechargeable Battery

Hybrid Integration

Design & Integration

Challenges & Opportunities
- Wearable Technologies for Dynamic Assessment of Hydration & Hydrogen Status
- Flexible Electronics for Biometric Performance Monitoring
- Microfluidics for Sweat-Based Biomarker Sensor Platforms
- A Scalable Flexible Substrate and Assembly Process
- Flexible Printed Electronic Devices
- Materials Registry

Challenges
- Integration of Flexible Electronics with Wearable Devices
- Power Management for Wearable Applications
- Design of High-Performance Biometric Sensors
- Microfluidics for Sweat-Based Biomarker Detection
- Assembly Processes for Flexible Electronics

Opportunities
- Development of Wearable Devices for Hydration & Hydrogen Monitoring
- Integration of Flexible Electronics into Performance Monitoring Wearables
- Use of Microfluidics for Biomarker Detection
- Scalable Assembly Processes for Flexible Electronics
- Integration of Flexible Power Sources
Flexible Silicon

CMOS wafer prep

Pick & Place
25 micron total packaged thickness

3D Additive Interconnection
additive print interconnect

Roll to Roll Manufacturing

Ultra-thin CMOS
Assembly & multi-layer flexible PCB

Program supported by:

American Semiconductor Inc.

molex
one company a world of innovation

FlexTech
SEMI Strategic Association Partner
Wearable Performance Monitor

**Objective:** Develop Flexible, Non-invasive Wearable for Dynamic Assessment of Hydration Status

NBMC Consortium Project 16-10: A Collaborative team of 7 industry and university members lead by GE developed

1. Ion Selective Electrodes – Na+ and K+ concentration in sweat
2. RF Impedance Patch – subcutaneous hydration tomography and spectroscopy

Program supported by:
Thin Flexible Power Source

Packaged Battery Thickness (microns)

Energy Density (Wh/l)

- Self-recharging Ultra-thin Power Pack
- Primary & rechargeable battery Capacity 30-90 mAh
- Adv. Packaging & Integration
- Printing & Lamination

ITN Energy Systems Inc.  ENrG Inc.  Lucintech Inc.

Power Module Integration + Advanced Materials + Photovoltaics

Primary battery Capacity 30-1000 mAh

Program supported by:

Imprint

Panasonic

FlexTech SEMI Strategic Association Partner
Medical, Health and Wellness Applications

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

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

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

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

Performance Monitoring
- Improved health and wellness
- Athletic performance enhancement

Monitoring Requirements
- Cost effective
- Unique accuracy & precise
- Low maintenance
- Automated analytics
Summary

• Target the needs of the military – sustaining and augmenting peak performance of the military personnel

• Align to commercial industry advances and ecosystem development to ensure a stable and advanced supply chain

• Take advantage of other disruptive technologies and address the challenge of incorporating into flexible electronics
  – Artificial intelligence and machine learning
  – Edge computing and new SW/HW architectures
  – Advanced MCU-memory-sensor interfaces
  – Multi-modal sensor data acquisition and management
Thank You