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DOE – DoD Multi-topic Workshop
Fort Worth, TX
R2R Breakout Session
October 8, 2014
• Solicit input from industry to guide focus areas and scope for future IMI
  – Six potential topics identified. BAAs for two IMI expected to be released Nov. 2014 and January 2015.
  – Information requested includes existing manufacturing capability, regional hubs, applications, potential market, evidence of need

• **Selection criteria:** technology needing scale-up for widespread adoption, industry relevance, national security requirement, economic benefit, business case for sustainability.

• **RFI re-opened to more fully address quantification of business case, industrial relevance, and manufacturing challenges**
Objective for the re-release to get more information for:
• Data on market demand for Flexible Hybrid Electronics.
• Size and composition of industrial sector affected by FHE technologies.
• What is the evidence for sustaining FHE industry base in the US? How does the Institute and a physical Center evolve after the 5 year IMI funding?
• What is the Roadmap for delivering products?
  – IMI start at TRL 4 / MRL 4 with initial production demonstrations in 2-3yrs
  – What are the initial sustaining products from Industry at 5 years?
• What market segment to address first?
  – High value low rep [100's]
  – High rep low cost [1000-1M parts]
  – Possible combination
• Possible Institute Structure for the IMI?
• Industry participation model for the first 5 years and after Federal IMI Funding concludes
What are Flexible Hybrid Electronics?

- **Flexible Hybrid Electronics**: Highly tailorable devices on non-traditional substrates that combine thinned components manufactured from traditional processes with components that are added via “printing” processes.
  - Thinned, compliant electronic, electro-mechanical, and communication components fabricated in foundries
  - Integration by pick and place, plate-to-plate processes, imprinting, lamination, etc.
  - Sensors, passives, interconnects, and power components fabricated by alternative methods compatible with EMS processing on non-traditional substrates.
  - System, Circuit and Component design tools for integration

- **Need**: Develop rules & tools to enable an overarching design framework including interface standards, metrology, and interoperability of fabrication processes

Alternative perspectives on flexible hybrid electronics are welcome/encouraged.
Flexible Hybrid Electronics

More product flexibility, lower costs, shorter time to bring products to market, and overall innovation and new business opportunities.

Flexible Hybrid Electronics

Flexible substrates
Nanomaterials
sensors, batteries, interconnect etc
Low cost manufacturing
e.g., R2R, printing

Low cost hybrid integration and assembly

Flexible thin high performance chips
Processors, wireless communication

Rapid Fielding and Distributed Manufacturing

“Print”
“Place”
“Fab”
<table>
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<tr>
<th>DOD Application</th>
<th>Commercial Counterparts</th>
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<tr>
<td>Sensor suite for battlefield triage</td>
<td>Sensor suite for triage in natural disasters</td>
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<tr>
<td>Rugged, conformal structural health monitors for sustainment &amp; inspection</td>
<td>Lightweight, conformal structural health monitors for civilian infrastructure</td>
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<td>Transient, smart sensor clouds for guarding posts and monitoring cleared buildings</td>
<td>Building/area access tape &amp; cargo monitoring tape</td>
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<td>Custom production of mission tailored, flexible electronics at forward locals</td>
<td>Low cost smart tags with power and RF for logistics and inventory tracking</td>
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<td>Reliable electronics in mechanically harsh environments for weapons applications</td>
<td>Reliable consumer electronics and electrodes for health care diagnostics</td>
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<td>Non invasive human performance monitors for operational efficiency, safety and training</td>
<td>Point of care monitoring of athletes &amp; first responders to safely elevating performance</td>
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<td>Prosthetics and neuro synthetic devices for enhanced quality of life of injured veterans</td>
<td>Prostheses for quality of life improvements for seniors and paralysis victims</td>
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Pervasive Considerations:

- Fabrication/Integration
- Device Design
- Standards and Testing
- Materials
FHE Manufacturing Challenges

NEED ADDITIONAL PERSPECTIVES & FEEDBACK

Materials
- Substrates
- Inks
- Barriers

Printing Process Develop.
- Direct write
- Laser patterning
- Transfer print
- Process Modeling

Thin Film Device Fab. Dev.
- Wafer thinning
- Epitaxial lift-off

Fabrication/Integration
- Packaging (interconnects, pick & place)
- Substrate Handling (plate to plate, etc.)

Device Design
- Software Development
- Interface Modeling

Standards, Testing, Qualification
- Materials & Manufacturing Standards
- Metrology & Test Standards
FHE IMI Mission

Need RFI Feedback

• Need to define “success” for FHE IMI. What would the outcome be in five years?
  – RFI will inform answer; it has not been predetermined.
• Potential Mission Statement: “Develop a flexible hybrid electronics manufacturing base for sensors and devices on non-traditional substrates.”