From E-Textile to E-Thread®
Dominique Vicard
CTO Primo1D
Agenda

- A « Smart Textile » perspective
- The E-Thread® technology
- The Primo1D Company
A “Smart” Textile? – We have a standard...

- “Smart textiles are textiles or textile material systems having additional intrinsic and functional properties not normally associated with traditional textiles”.

FD CEN/TR 16298 Norme Européenne
Another “Smart” Textile Definition?

- “Smart textiles are those materials that can sense and react to external stimuli or trigger which may be mechanical, chemical, thermal, electrical or magnetic”

Several Sources, including: Smart Textiles--Assessment of Technology and Market Potential

2010 Frost & Sullivan
A Closer Look at the Definition...

- **“Sense”**
  - Temperature, Humidity, pH, Ions, Strain, Bio, Attitude, Movement, EM, Electricity, etc...

- **“React”**
  - Shape, Force, Visual, Audio, Temperature, Energy, etc...
    - The Passive way: Phase change materials, Shape memory materials, Chromic materials, Piezoelectric materials, Nanostructured materials, etc...
    - The Active way: Communication, Computers, Programs, Protocols, RF, etc...
Phase Change Materials

- Materials existing under 2 phases (liquid, vapor, solid)
- Transition between 2 phases consumes/produces energy
- Thermoregulation

Thermoregulated clothing and textile - Outlast – Certified Space Technology
Shape Memory Alloys

- Alloys having the property of memorizing their shape and being able to retrieve this shape under a thermal stress.
- Capability to switch between shapes
- Memorization of shapes, folds, etc...

Folds created by shape Memory alloys - Aniela Hoitink and Isabel Cabral
Piezoelectricity

- Capability of getting polarized under a mechanical constraint, or vice-versa
- Capability to produce a current while moving
- Energy harvesting, Actuation

Piezoelectric yarns able to act as microphones or loudspeakers- MIT
Electro Chromic

- An Electro Chromic material is able to change color under an electrical stimulation (reversible)
- Information display, lighting effects

Ludivine Meunier - GEMTEX - « INTELLITEX » project – textiles electro chromic displays
Nanostructure

- Atomic or molecular assembly in which at least one dimension is bounded between 0,1 et 100 nanometer.
- Lotus, Butterfly Wings effects
The Active Way: Microsystem

Energy

Communication

Configuration

Measure

Timing

Storage

External Loads

Energy Processing Units

Power Management Unit

Sensor Management Unit

Com Management Unit

Load selectors

Digital

Analog

Projet Managy – CEA-LETI
What for (in the wearable space)?

- Safety
  - Protection Equipment
- Healthcare and Wellness
  - Monitoring, Curing
- Fashion
  - Visual Effects
- Sports
  - Performance, training

And numerous other applications in non-clothing textiles
Safety

Proetex Project – Sofileta – Brunet-Lion – Continuous monitoring of life signals: heart beats, breathing, etc... - Bio-signals monitoring: sweat, dehydration, electrolytes, O2, carbon monoxide – danger monitoring: under clothing temperature – Image LHD Lion
Health and Well Being

AiQ: sports monitoring / Phillips: Blue Touch / Bioserenity – spin-off from ICM (Institut du cerveau et de la Moelle Epinière) – A Smart Cloth with biometric sensors recording body parameters, for epilepsy monitoring.
Shows

Luminous Tex at the World Mobile Center / Luminous necklaces for the Olympic Games - Moritz Waldemeyer
And outside Clothing and Decoration?

- Geotextiles
- Composites
- Buildings
- protections

All those applications gain from an Active Monitoring « Smartification »
- Ground reinforcement - Soil Stabilization
- Sealing - waterproof pockets creation
- Filtering
- Erosion Control

Geotexan – Road Textile Reinforcement
Composites

- Reinforced plastics such as fiber-reinforced polymer
- Lighter, as resistant, with no corrosion
- Aeronautics, car industry, street furniture
Public Works, Buildings

- Tents, roofs
- Frontages
- Isolation
- Road Works

Saint-Eloi - Cugnaux, la Saudrune: Sewage processing center covered with a textile roof
- Dyneema®: laminated polyethylene fiber UHMwPE (Ultra-High Molecular Weight Polyethylene): currently the most performant material for ballistic protection. Initially designed for aerospace.

Doursoux – Tactical Vest – Made in France - 67% cotton 33% polyester Téflon coated. Dyneema ® BulletProof 10 ans de vie
Then, What is E-Textile?

- The step before « Smart-Textile »
  - A textile containing electronics (may be dull)
- The result of a long migration of electronics toward textile
  - Step 1 : Side by Side
    - Electronics is attached to textile through external elements (pockets, pouches) and remains stiff
  - Step 2 : Hybrid
    - Electronics is attached to textile through closer coupling and becomes flexible and washable
  - Step 3 : Integrated
    - Electronics is integrated in textile or even in yarns
  - Step 4 : Intrinsic
    - Electronics is made of textile
A couple of examples

- Sensitex (Smart Phone Control)
- Hunting Dog Equipment (Kevlar GPS pouch)
A couple of examples

- Biometric T-Shirt OMSignal with its « little USB black box »

  Step 2 : Hybrid

- Force Sensor made of woven PVDF - Kevin Magniez - Deakin University CSIRO and RWTH Aachen

  Step 4 : Intrinsic
E-Textile: where are we now?

- In the Labs: Integrated or even Intrinsic
- On the market: Side by Side and Hybrid

But...
Imagine electronics in a yarn...
A disruptive innovation from the CEA, strongly protected by patents

Electronics embedded into a textile yarn, in a unique form factor

Invisible, inseparable, durable, easy to integrate into textiles and plastics
The E-Thread® technology

From semiconductor...to textile
... through micromechanics

A competitive technology for high volume manufacturing.
E-Thread® RFID Product

- Carrier Wire (Core)
- S Covering Yarn
- Z Covering Yarn
- Polymer Protective Coating
RFID UHF Tags: How to compare?

- E-Thread® versus prior art:
  - **Inalterable**: being buried inside the material, the tag remains strongly protected.
  - **Inseparable**: cannot be untied from the material/object it belongs to.
  - **Imperceptible**: cannot be easily detected – so tiny it will not alter the material.

95mm x 8.2mm x 0.2mm

190mm x 0.1mm x 0.1mm
Application Fields

- Function is defined by the chip
  - Today: RFID
    - RFID applications (traceability, inventory, anti-counterfeit/anti-theft, process automation, IoT, web-link)
  - Tomorrow: Sensors Chip:
    - Unlimited applications (sensing, actuating, monitoring)
      like: SHM, Sensing Materials, In-Situ process monitoring
A world of applications

Traceability
Supply Chain optimization
Inventory management
Anti-theft
Anti-counterfeiting
Production control
Customer shopping experience

Decoration
LED’s lighting effects

In Situ Monitoring
Health and Sport monitoring
Preventive maintenance

Source: IdTechEx « RFID in Apparel 2012-2020 » and Primo1D

- RFID tags for textile retail
  700M$, 5 Billions tags

- RFID tags for Laundry
  50M$, 50 Millions tags

- RFID tags in plastics, rubber, tires,…

- Sensors in textiles, plastics, cables,… (sport, health, automotive, aeronautics,…)

- LED’s decoration in high end textiles and plastics (luxury, automotive)

Marke t

Barrier for adoption
Existing
Emerging

High
Small
How does the product look like?

- Our first application is clearly traceability, with RFID as E-Thread® Chip in a yarn, dedicated for the industrial laundry market.

- This product is conditioned under the form of a yarn as shown beside.

- The chip is so small and so well integrated that it’s difficult to show a nice picture of it.
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But we try.
Company profile

- Created in August 2013, a spin-off from CEA-Leti,
- We turn material smart by embedding electronics in a unique form factor,
- A world of applications for RFID traceability, LED decoration and Smart sensors,
- A unique technology at the crossroads of microelectronics, micromechanics and smart packaging domains,
- A senior management team from the industry,
- An industrial model with strong partnerships and ecosystem.
- First production : Q4-2015
Our Mission & Vision

A unique solution for traceability, anti-theft, anti-counterfeiting, in situ measurement and decoration...

...thru a sparkle of intelligence at the heart of materials and objects, from creation to recycling...

... to become leader in the domain of embedded electronics into textile and plastic materials.
Thank you for your attention!