Flexible and Structural Electronics for HealthTech

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Flexible & 3D Electronics for HealthTech Applications

Technology Challenges and Some Solutions

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Technology Challenges of Medical and Wearable Devices

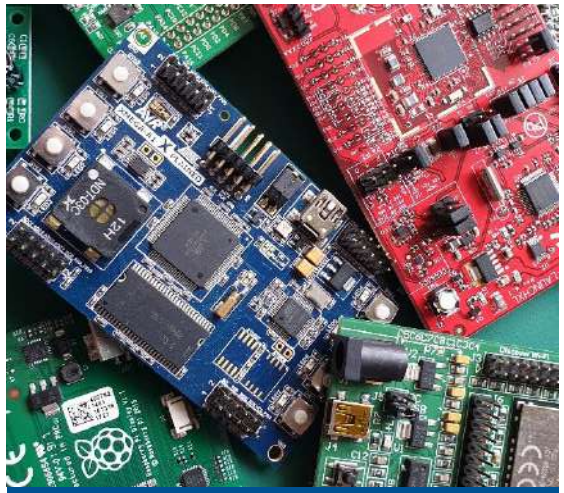
- Product design - Form factor
  - Light weight
  - Flexible
  - Comfortable to wear
- Power sources
  - Light weight
  - Long life
  - mobile
- Robustness
  - Washable
  - Harsh environments
- Wireless connectivity
  - Indoors and remote
  - Security
  - Data standards
- Simple to use
  - Technical competence
- Data collection
  - Simple
  - Unobtrusive
- Adoption
  - Consumers
  - Professionals
  - Manufacturers
  - Regulation

Medical and Healthcare Devices

Some examples…

- Temperature measurement
- Blood oximetry
- Heart rate
- ECG – Electrocardiogram
- EMG - Electromyogram
- EEG - Electroencephalogram
- Glucose and other bio-sensors
- Breath analysis
- Breathing rate
- Step and exercise
- Walking gait
- Movement and exercise
- Oral dose of medicines
- Dosage adherence
- Drug quality assurance for patients
- Trauma monitoring
- Wound monitoring

Electronics as we know it…



Rigid circuits boards

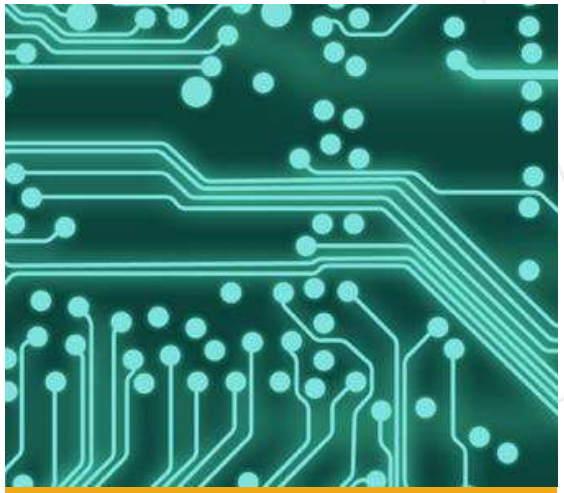
Standard “FR4” circuits provide the bedrock of the vast proportion of PCBs for electronic systems

Multi-layer circuits

Multi-layer circuit boards – 16 layers or more – allow for highly dense circuit packing and small footprints for PCBs

Complex packages

High level of functionality and very high pin counts allow complex circuits to be built with a minimum number of components

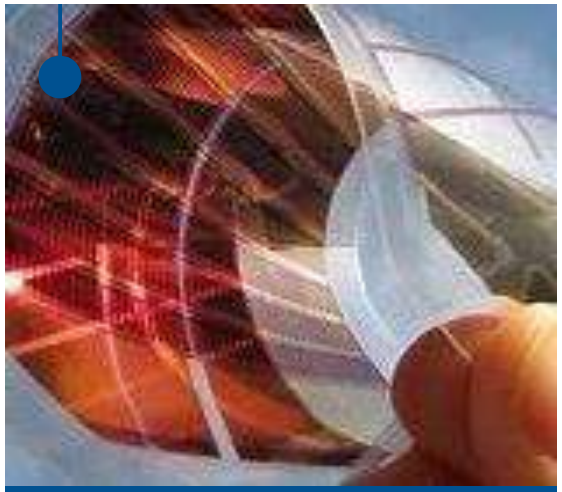


Manufacturing capability

Many 1000’s manufacturing plants world wide with huge capacity and highly sophisticated manufacturing capability

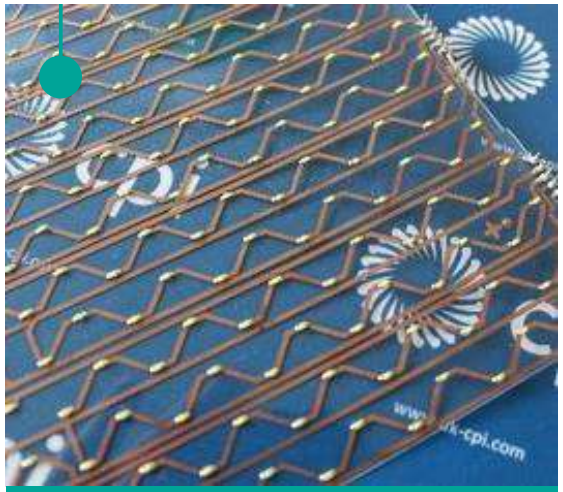
Conventional PCB Manufacture

A New Form of Electronics…



Bendable and Flexible

Electronics which can be conformable to curved surfaces or integrated into 3D objects



Large Area Circuitry

Circuits can be printed and assembled in continuous roll production allowing 10's or 100's of meters of circuits to be produced

High Volume

Roll to roll printing and electronics assembly has the potential to provide high volume products with possible cost savings

Structural Electronics

Circuits are formed within the structure of products or assemblies – embedded within injection moulded parts, or moulded directly onto thermoformed parts

Flexible and Structural Electronics

What is Flexible and Structural Electronics?

Uses additive technologies that brings together conventional electronic components and printed electronics onto flexible, stretchable or freeform 3D surfaces.

This approach brings the benefits of two families of technologies combining the high performance of integrated circuits (chips) with the flexibility or freeform designs provided by printed electronics.

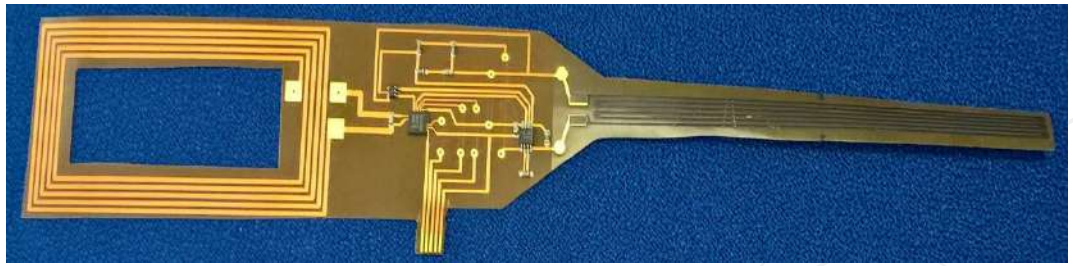
Enabling electronic functionality to be added to places which aren't possible using rigid electronics

Printed and Flexible Sensing

Integrating sensors to make functional and connected applications

- Temperature sensing
- Humidity sensing
- Electrical bio-signals
- Bio-sensing
- Chemical / pH sensing
- Strain sensing
- Pressure sensing
- Level sensing

Thin, conformable and light weight



Film and Paper Based Electronics

Conducting circuits can be printed onto films using conventional additive printing processes such as screen and flexographic printing

Substrates can be very thin e.g. 35um PET or stretchable such as TPU. Some fabrics can also be used

Electronic components can then be added using novel conducting adhesives in place of solder that is used on standard electronics boards

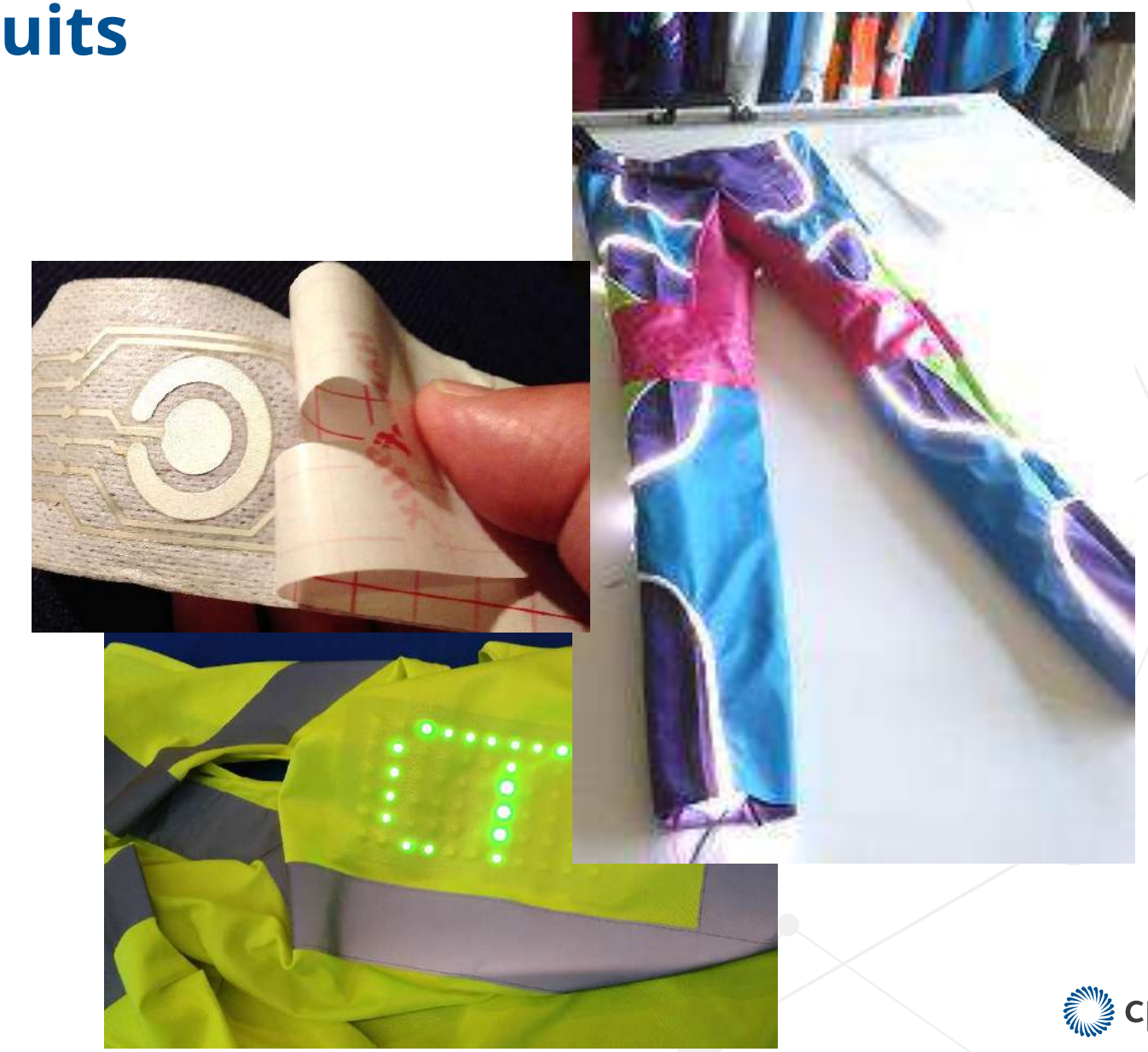
These circuits can be laminated into labels or packaging materials to create smart packing for condition monitoring of medicines or formed into wearable smart dressings

Fabric and Wearable Circuits

Electronics can provide new creative elements for fashion designers

Sensors built directly on fabrics can be used to help monitor health conditions

Safety can be enhanced with active clothing



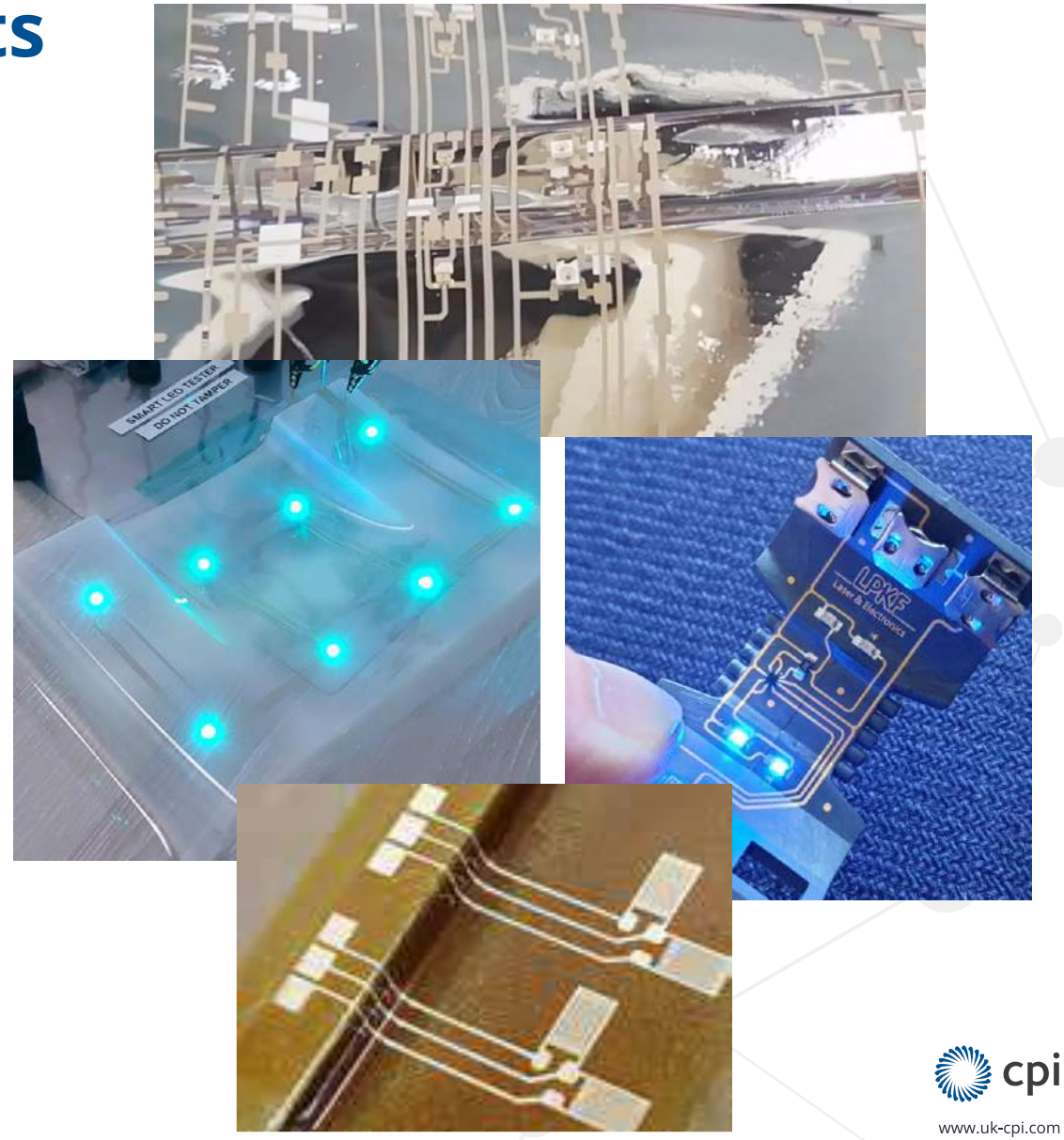
In-Mould Electronics - 3D Circuits

Circuits can be printed directly onto 3D surfaces, removing the need for a separate circuit substrate

Aerosol jet printing and techniques such as Laser Direct Structuring can be used for this

Components then attached to the part using conducting adhesives.

Can also create circuits on flat plastic parts which are then vacuum formed to create 3D products with electronics directly attached



Flexible and Formable Electronics

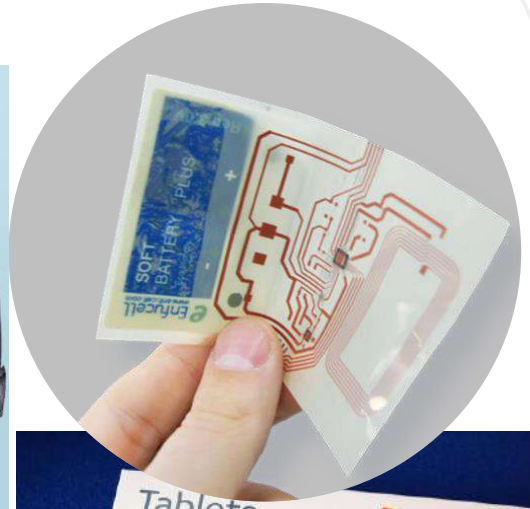
- *Versatile Form Factor*

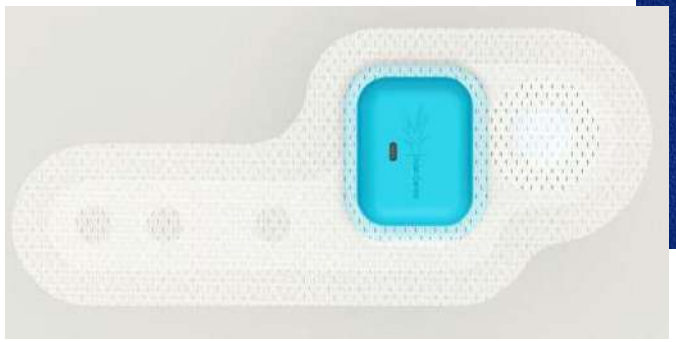
Sensor systems for wearables and healthcare often require flexible and thin form factor device

Necessary to ensure

- Comfortable in use
- Discrete
- Functionality

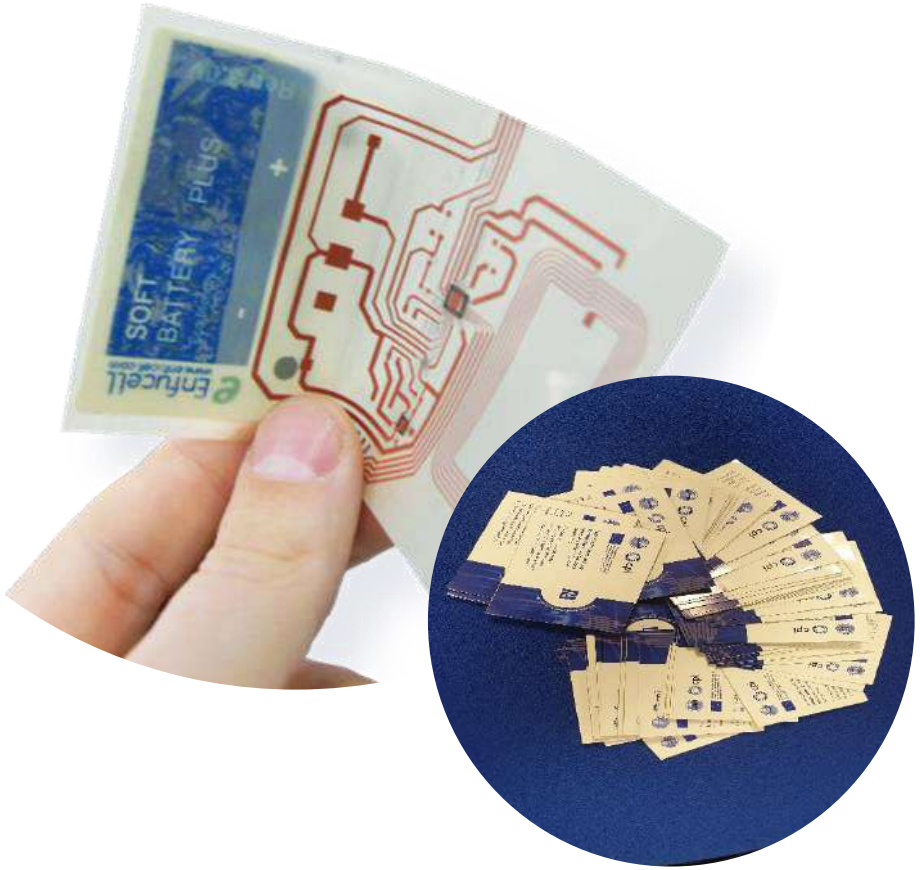
For some devices may also create assemblies which can be moulded or integrated in other forms





*EENews Jan.2019

Healthcare Devices – Some Examples



Digitally enabling the pharma supply chain

CPI worked with a consortium of partners including large pharma to develop flexible smart tags for condition monitoring and global track and trace of medicines

NFC smart tags with temperature and humidity logging for carton level information through the clinical supply chain.

Reduce losses in clinical supply chains

Supports growth of the pharma industry and better patient outcomes

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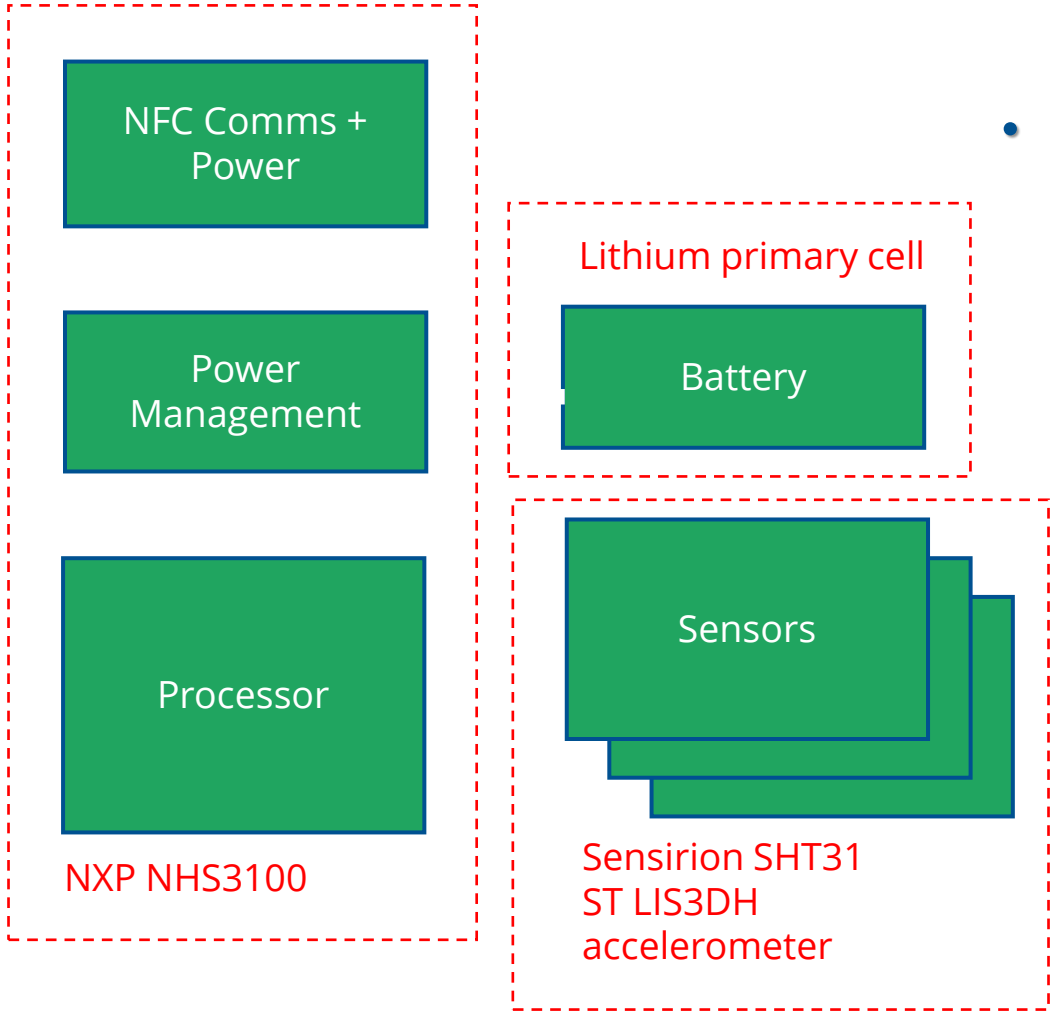
gsk GlaxoSmithKline

AstraZeneca

Smart Label Architecture

Processor:

- NXP NHS3100 selected:
  - NFC power and communications
  - Cortex M0+ core
  - On board Temperature
  - Bare die option



- **Battery:**
  - Low profile and flexible
  - Few 10's mAh capacity
  - Lithium chemistry:
    - 28mAh 3V

- **Sensors:**
  - Sensirion Temperature and Humidity sensor
  - SHT31 selected for T and RH
    - Up to +/- 0.1°C and 1.5% RH
  - LIS3DH 3 axis accelerometer from ST Microelectronics with integrated ADC

Smart sportswear for professional athletes

KYMIRA DYCOTEC MATERIALS UKRI Innovate UK

Integrating flexible, durable biosensors into sportswear

In partnership with Innovate UK, CPI collaborated with Dycotec Materials and KYMIRA Ltd to develop a thin, stretchable sportswear demonstrator that improves exercise effectiveness and supports recovery from injury while being as robust and as comfortable as conventional clothing. The device's accuracy rivals the most sophisticated motion capture labs.

Outcomes and Impact

- Scalable prototype with an inertial measurement unit for reporting the orientation and movement of limbs
- Remote sensing capabilities demonstrate medical device potential

Smart helmets to capture data related to traumatic brain injuries during impact

HP 1T

Improving safety through smart helmets

CPI developed a printing process for pressure sensors that were distributed across a flexible surface that when embedded into a helmet, would measure location and force of an impact.

OUTCOMES AND IMPACT

- From the prototypes produced by CPI, HP1 Technologies were able to demonstrate functionality to a number of potential customers which has helped to grow their business

Wearable physiotherapy for stroke rehabilitation

KnitRegen

UKRI Innovate UK

Automated neural stimulation supports physiotherapy for stroke rehabilitation

KnitRegen's concept makes use of smart textiles to provide physical stimulation to nerve bundles in the arm for stroke rehabilitation.

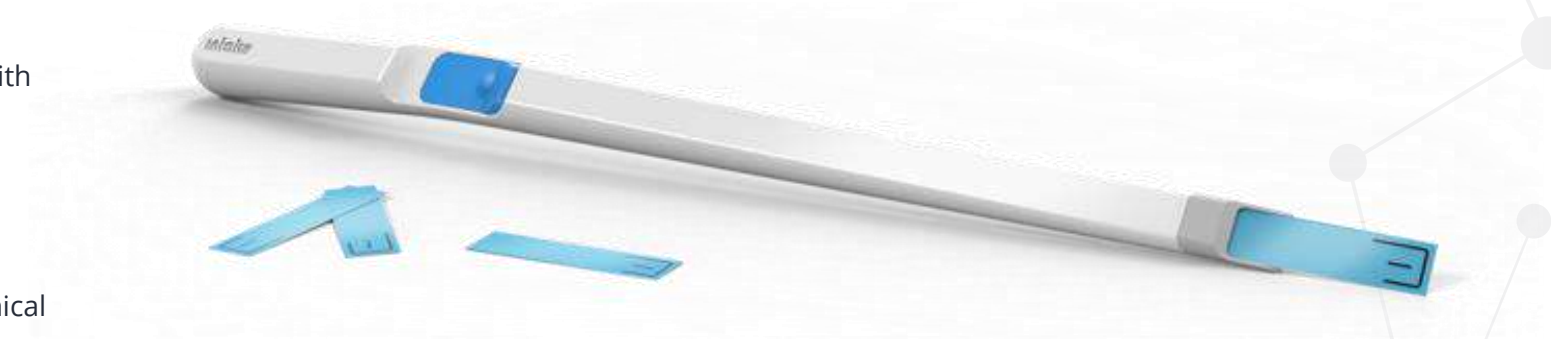
Outcomes and Impact

- KnitRegen have design concepts which have potential for manufacture.
- CPI helped the company to progress their concept development towards a manufacturable solution.

Printed biosensors for urine analysis

Enabling point of care analysis of renal health

Innovations in scalable nano-ink formulations and printing processes, enabling multiplexed electrochemical IVD devices with high sensitivity, selectivity and reproducibility to be developed.



OUTCOMES AND IMPACT

- Produced sensors simultaneously detect a range of urinary biomarkers including creatine, unlocking way forward to clinical trials
- When commercialised, will enable high-frequency at-home testing for diabetics to measure their kidney's health for earlier interventions and reduced healthcare service provider costs

Wearable temperature monitor for neonatal care

QHS Quality Hospital Solutions

Supporting midwives with critical temperature monitoring for new-born and premature babies

Accurate temperature monitoring of new-born babies can help to save lives and prevent critical injury from having long term impacts on the babies as they grow.

Outcomes and Impact

- Developed a novel and easy to use continuous temperature monitor for new-born babies which overcomes the short-comings of existing approaches.
- The accurate monitoring of body temperature in the minutes and hours immediately after birth will have significant benefits on the clinical outcome of premature births.

Thank you

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