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ADVANCES OF BIOMEDICAL E-TEXTILE ENGINEERING

- ETEXTILE CONFERENCE , London, Nov 12, 2019

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- I. Textile Bioengineering and Wearables
- II. Textile Electronic Bioengineering
- III. E-Textile wearable projects in UM
- IV. Standardization of E-Textile wearables

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The journey of electronic components from immobile to mobile, and finally to wearable textile-based electronics
[Nanomaterials 2015, 5(3), 1493-1531]

1876: Bell's telephone
1939: Complex Number Calculator
1946: ENIAC
1971: Personal computer: kenbak-1
1973: Mobile phone: DynaTAC
1983: Laptop: Epson HX-20
1990: Wearable computer
2007: Smart phone: iPhone
2013: Stress-free e-skin
2013: Smart wearable devices: Google glass, Apple Watch
2030-: Future smart textile-based technology

Immobile → Mobile → Wearable

The only thing you have wear everyday is **Clothing** !!!

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Textile & Bioengineering

I. TEXTILE BIOENGINEERING AND WEARABLES

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電子產業與紡織產業的融合
Textiles & Electronics

E-Textiles: Where textiles meet electronics

- E-textiles sits at the intersection between electronics and textiles. Industry definitions vary extensively, mainly with regards to the extent of inclusion of aspects of 'smart fabrics' or 'intelligent textiles' on the textile-industry side.
- There are closely related fields on both sides of e-textiles, specifically:
 - Wearable IoT and IoT from the electronics industry
 - Technical or intelligent textiles from the textile industry
- For the purpose of IDTechEx's analysis, the defining feature of e-textiles is the presence of logic, or other ICs, as electronic textiles (rather than just functional or electric). Whilst this is reflected in the forecast shown, the links to related industries on both sides will be studied in detail throughout the report.

Source: IDTechEx's adaptation of PPT image

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E-Textile Wearable IoT_ICT Ecosystems

紡織可穿戴-物聯網系統

The diagram shows four overlapping circles representing different domains:

- Textiles 紡織** (Top)
- Electronics IoT 電子** (Left)
- Life Sciences 生命科學** (Bottom)
- Computing 網絡ICT** (Right)

External labels for the intersections and overall ecosystem:

- E-Textile IoT ecosystem 電子紡織物聯網
- E-Textile IoT_ICT Ecosystems-Health Big data 電子紡織物聯網健康大數據
- Textile Electronic Bioengineering 紡織電子生物工程
- Textile Informatics Bioengineering 紡織信息生物工程

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DEFINITION OF E-TEXTILES 電子紡織品定義

E-Textiles 電子紡織品 (i.e. electronic textiles) are defined as textiles that enable electronic components such as sensors, batteries, lights, chips and small computers and electronic circuits to be embedded 植入 and/or built 構建 from fibers and textile structures.

e-Fibres 電子纖維 → e-Yarns 電子紗線 → eFabrics 電子織物

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LEVELS OF INTEGRATION

- Level 1: embedding electronics in textile 第一代: 電子原件植入紡織品
 - Electronic device is added in a way that it is removable without destroying the product, e.g. via a pocket, touch-and-close fastener, push button, etc
- Level 2: Fabricating electronics into textiles 第二代: 電子原件貼入紡織品
 - Electronic device is attached to textile in a way that it is not removable without destroying the product, e.g. stitched, welded, glued, etc. to the textile materials.
- Level 3: Hybrid electronic textiles 第三代: 電子原件織入紡織結構
 - Electronic device consists of one or more components are made of textile or textile finishing and combined with permanently or non-permanently attached electronic components, e.g. an LED lamp attached to a conductive track woven into a fabric.
- Level 4: Fabric chips 第四代: 全紡織電子材料→織物芯片
 - All components of the electronic device are made of textile materials or by textile engineering processes. [3]

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Level of Integration and development stage of E-textile wearables

電子紡織可穿戴技術發展階段與集成程度

WEALTHY MYHEART OFSETH CONTEXT

Phase 1: Physiological electrical sensors and fiber optics (第一代 植入)

Phase 2: New wearable biosensors in textile patches (第二代 貼片)

Phase 3: Full garment wearable biosensors (第三代 全服裝)

Phase 4: Full scale textiles with biosensors and physiological sensors (第四代 全紡織)

STELLA Stretchable electronics Place-it PASTA, i-TEX

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TEXTILE BIOENGINEERING 纺织生物工程

- Textile biomedical engineering integrates physical, chemical, or mathematical sciences and material and textile engineering principles for the study of biology, medicine, behavior, and health. It advances fundamental concepts, creates knowledge from the molecules to the organ systems level, and develops innovative biologics, materials, processes, implants, devices, and informatics approaches for the diagnosis and treatment of disease, for patient rehabilitation, and for improving health.
- 纺织生物医学工程是融合物理、化学、数学和材料与纺织工程学的原理，进行生物学、医学、行为和健康交叉研究。它提升了基本概念，建立了从分子到器官系统的知识体系，并研发具有创新性的生物制剂、纺织材料、工艺、植入物、可穿戴装置以及信息学办法，以预防、诊断和治疗疾病为目的，为病人康复和改善健康服务。

Li, Springer 2007

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Textile Bioengineering and Wearables

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Textile Bioengineering

Textile Material Bioengineering

Thermal bioengineering

Biomechanical Engineering

Sensory Bioengineering

Biomedical Engineering

Electronic Bioengineering

Textile Bioinformatics Engineering

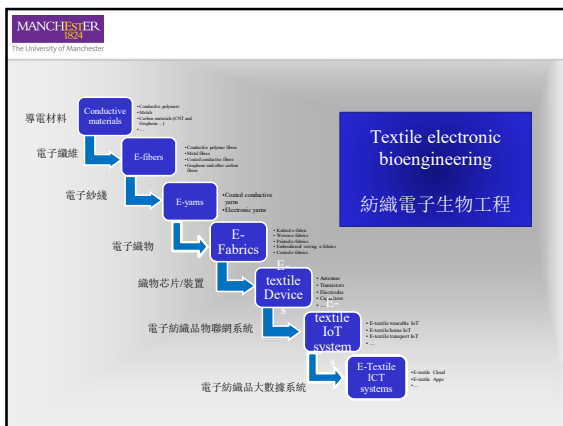
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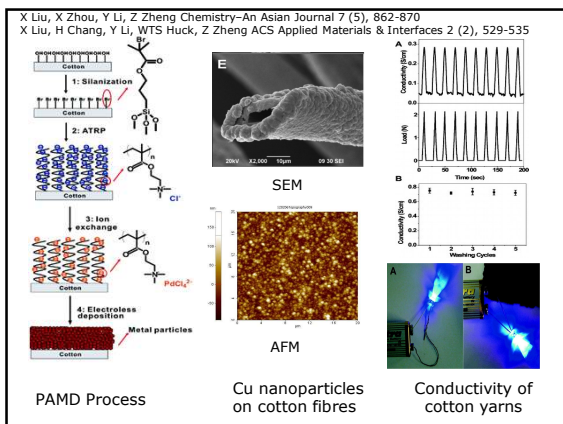
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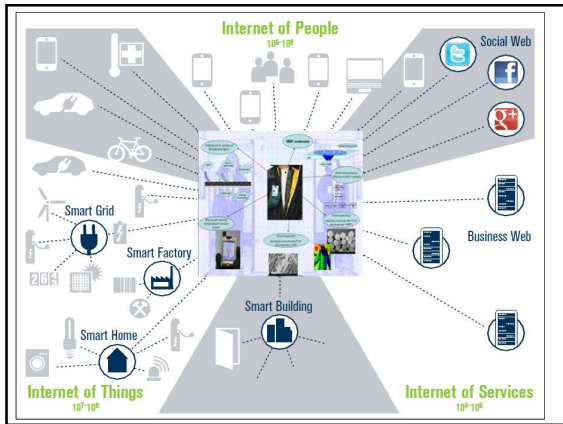
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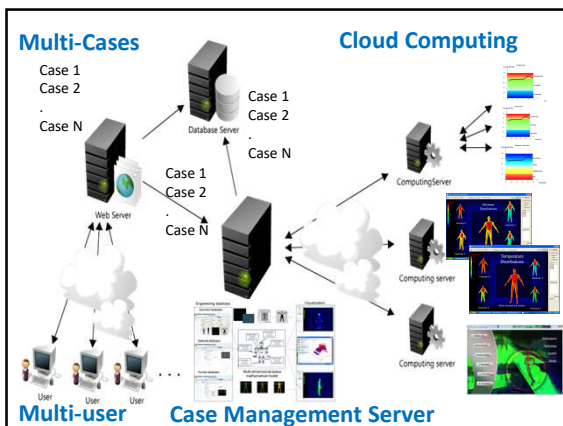
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III. E-TEXTILE WEARABLE PROJECTS IN UK

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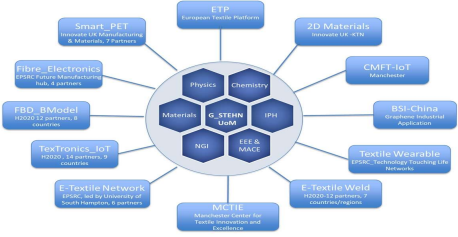
Graphene smart textiles

1: GRAPHENE SMART TEXTILES FOR E-HEALTHCARE

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New E-Textile Initiatives in UoM

- UoM has supported a new e-textile flagship
- **G_STEH: Graphene_Smart Textiles for E-Healthcare**



The diagram shows a central hub labeled 'G_STEH UoM' with 'Physics' and 'Chemistry' above it, and 'Materials', 'IPH', and 'NGI' below it. Surrounding this hub are various project boxes: Smart_PET (University of Liverpool & Materials, 2 partners), Fibre_Electronics (EPIC Future Manufacturing Hub, 8 partners), FBD_BModel (Horizon 2020, 9 partners), Textronics_IoT (Horizon 2020, 9 partners), E-Textile Network (Horizon 2020, 10 partners), ETP (European Textile Platform), 2D Materials (Horizon 2019, 10 partners), CMFT-IoT (Manchester), BSI-China (Horizon 2020, 10 partners), Textile Wearable (EPIC, Technology Training Ltd, 10 partners), E-Textile Weld (Horizon 2020, 9 partners), and MCTE (Manchester Centre for Textile Innovation and Education).

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RESEARCH & INNOVATION
Participant Portal

Horizon 2020: E-textile Weld

2: WELDING OF E-TEXTILES FOR INTERACTIVE CLOTHING

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Project "ETEXWELD"

Welding of E-Textiles for Interactive Clothing



The banner features the text 'HORIZON 2020 ETexWeld Welding of E-Textiles for Interactive Clothing' and 'Project # 641269'. It includes logos for the European Commission and various partner institutions.

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RESEARCH & INNOVATION
Participant Portal

Horizon 2020: FBD_BModel

3: FASHION BID DATA BUSINESS MODEL PROJECT

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項目名稱 Project title:
A Knowledge-based business model for small series fashion products by integrating customized innovative services in big data environment (Fashion Big Data Business Model)

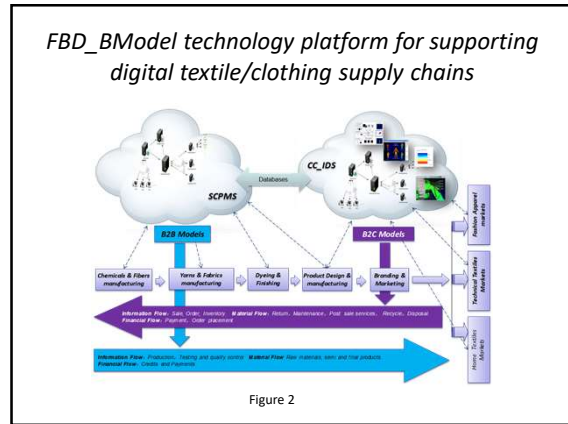
項目縮寫 Project Acronym: FBD_Bmodel

項目編號 Project Number: 761122

項目日期 Project Duration: 20/12/2017-19/12/2020

項目經費 Project Funding: €3,750,000

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VI. STANDARDIZATION OF E-TEXTILE WEARABLES

IEC, ISO, CEN, BSI, AATCC, ASTM

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Standardization of Smart Textile Wearables

IEC-International Electric Commission

- **TC124- Wearable Electronics and Technologies**
 - The 1st IEC TC 124 Plenary meeting, Seoul, S.Korea, 18-19 Sept 2017
 - The 2nd IEC TC 124 Plenary meeting, Manchester, UK, 14-15 May 2018
 - The 3rd IEC TC 124 Plenary meeting, Busan, S. Korea, 22-26 Oct 2018
- **Working Group 2: E-Textile Wearables**
- **Convenors:** Prof. Henry Yi Li (UK) and Mr. Satoshi Maeda (Japan)
- ISO TC38 WP37 Smart Textiles
- CEN Smart Textiles
- BSI Smart Textiles
- AATCC RA111. Electronically-Integrated Textiles Test
- ASTM D13.50. Smart Textiles
- IPC D-70 E-Textiles

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TC124 WG Structure

Call for experts for TC124

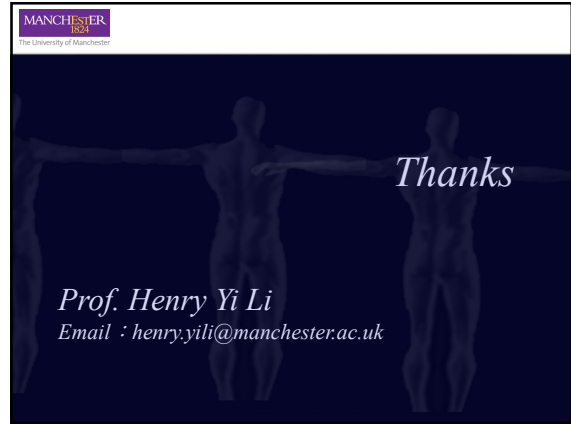
- **WG1 (Terminology)** (Convenor: Ms. Veronica Lancaster (US), Mr. Laurent Houillon (FR))
 - ✓ To produce terminology definitions for wearable electronic devices and technologies
- **WG2 (E-textiles)** (Convenor: Mr. Henry Yi Li (UK), Mr. Satoshi Maeda (JP))
 - ✓ To develop measuring and evaluating methods for textile materials, devices, and systems with electrotechnical functionality
- **WG3 (Materials)** (Convenor: Mr. Joachim Zietlow (DE))
 - ✓ To define specific terms and to determine assessments, requirements, and specifications for materials of wearable electronic devices and packages excluding E-textiles
 - ✓ To analyze the effectiveness of the existing methods specific to the materials of wearable electronic devices and packages excluding E-textiles
 - ✓ To develop measuring and evaluating methods for materials for wearable electronic devices and packages excluding E-textiles
- **WG4 (Devices and Systems)** (Convenor: Mr. Deok-kee Kim (KR))
 - ✓ To develop measuring and evaluating methods for devices and packages including implantable, patchable, ingestible, excluding E-textiles
 - ✓ To develop standards related with systems, applications, and services excluding E-textiles
 - ✓ To develop standards related with power sources excluding E-textiles
 - ✓ To develop standards related with interfaces and connectivity excluding E-textiles

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