Conductive Textiles: Towards True Wearable Technology

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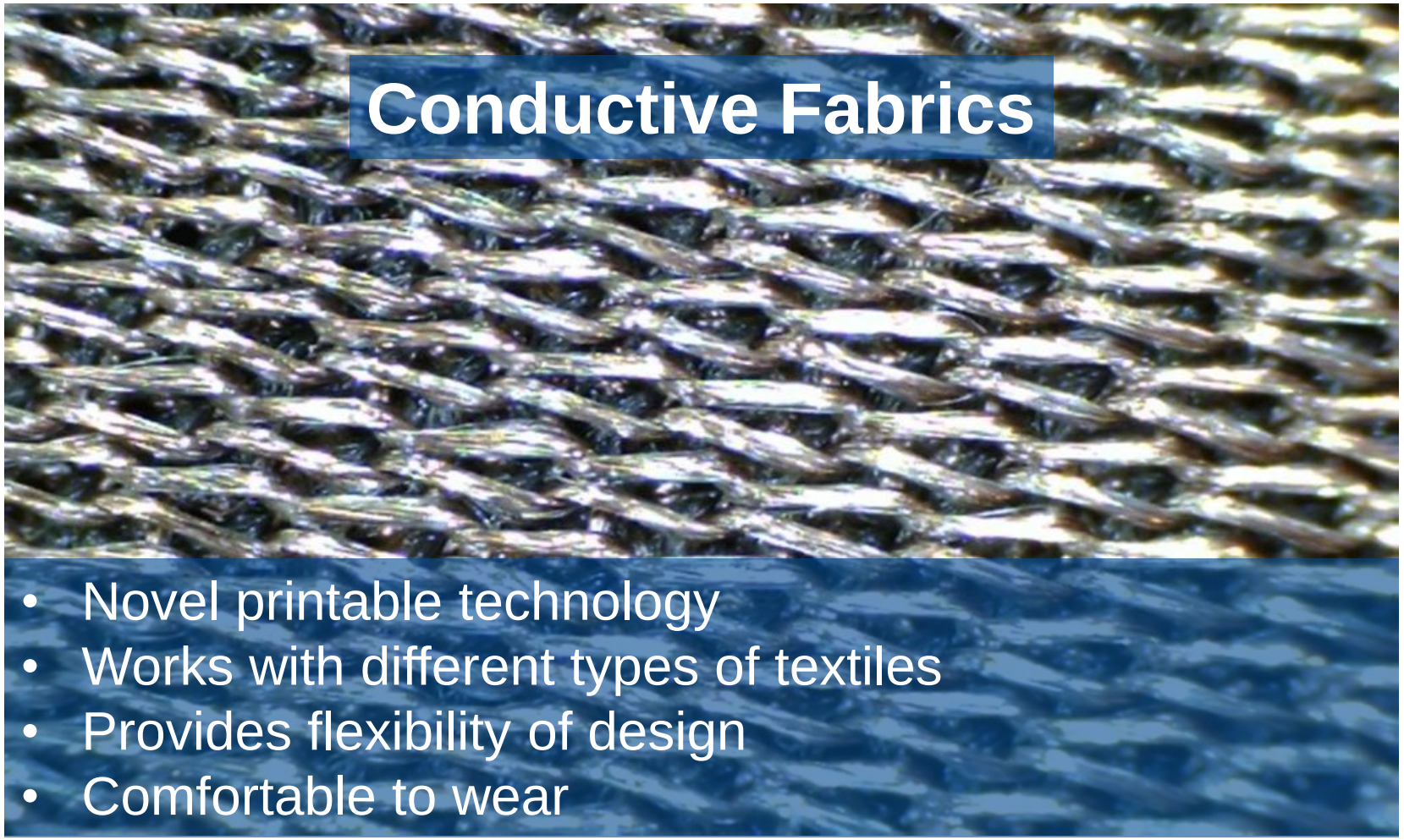
Date: 14 November 2015

National Physical Laboratory

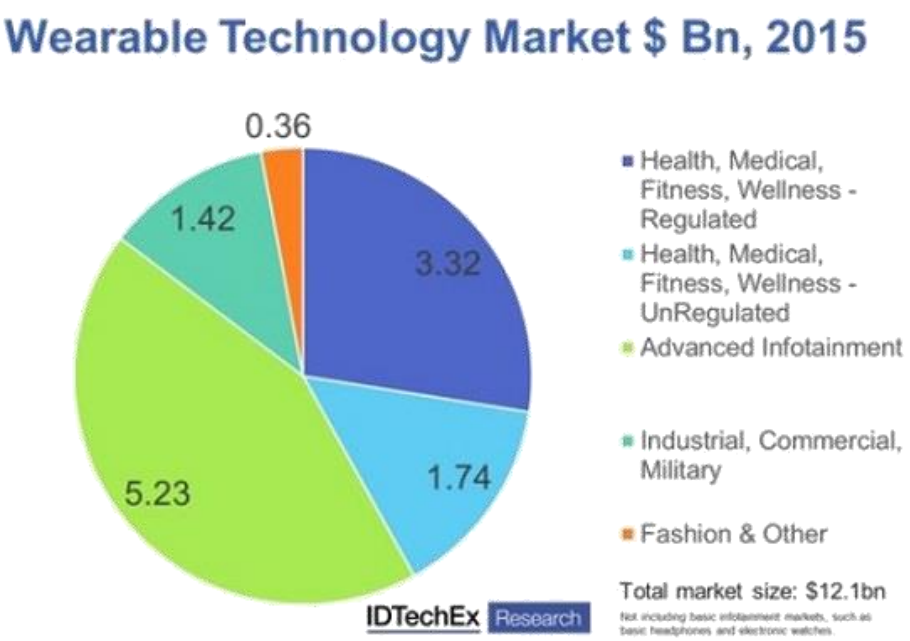
Who we are….And what we do….

- The UK's national standards laboratory
- Founded in **1900**
- World leading **National Measurement Institute**
- ~700 staff; 500+ specialists in **Measurement Science**
- State-of-the-art laboratory facilities
- The heart of the UK's **National Measurement System** to support business and society
- Experts in **Knowledge Transfer**
- **Multidisciplinary R&D** and technical services for public and private sector

NPL: Patent Technology



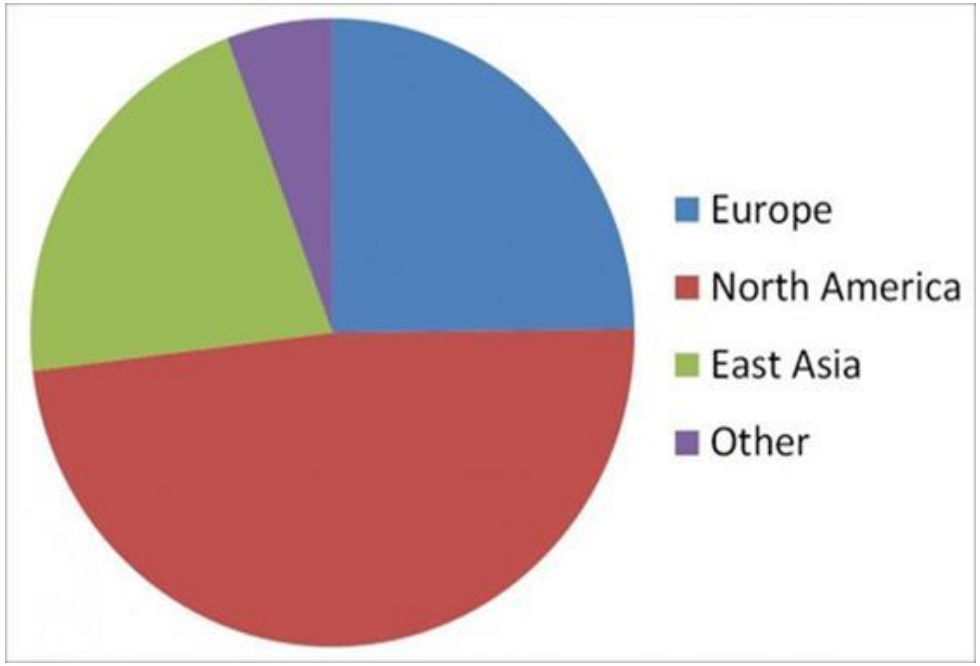
Why Wearable Technology?



Increasing demand for wearable electronics from industries such as:

- Medical and Healthcare
- Sport and fitness
- Consumer electronics
- Fashion and entertainment
- Protection and Safety
- Transportation

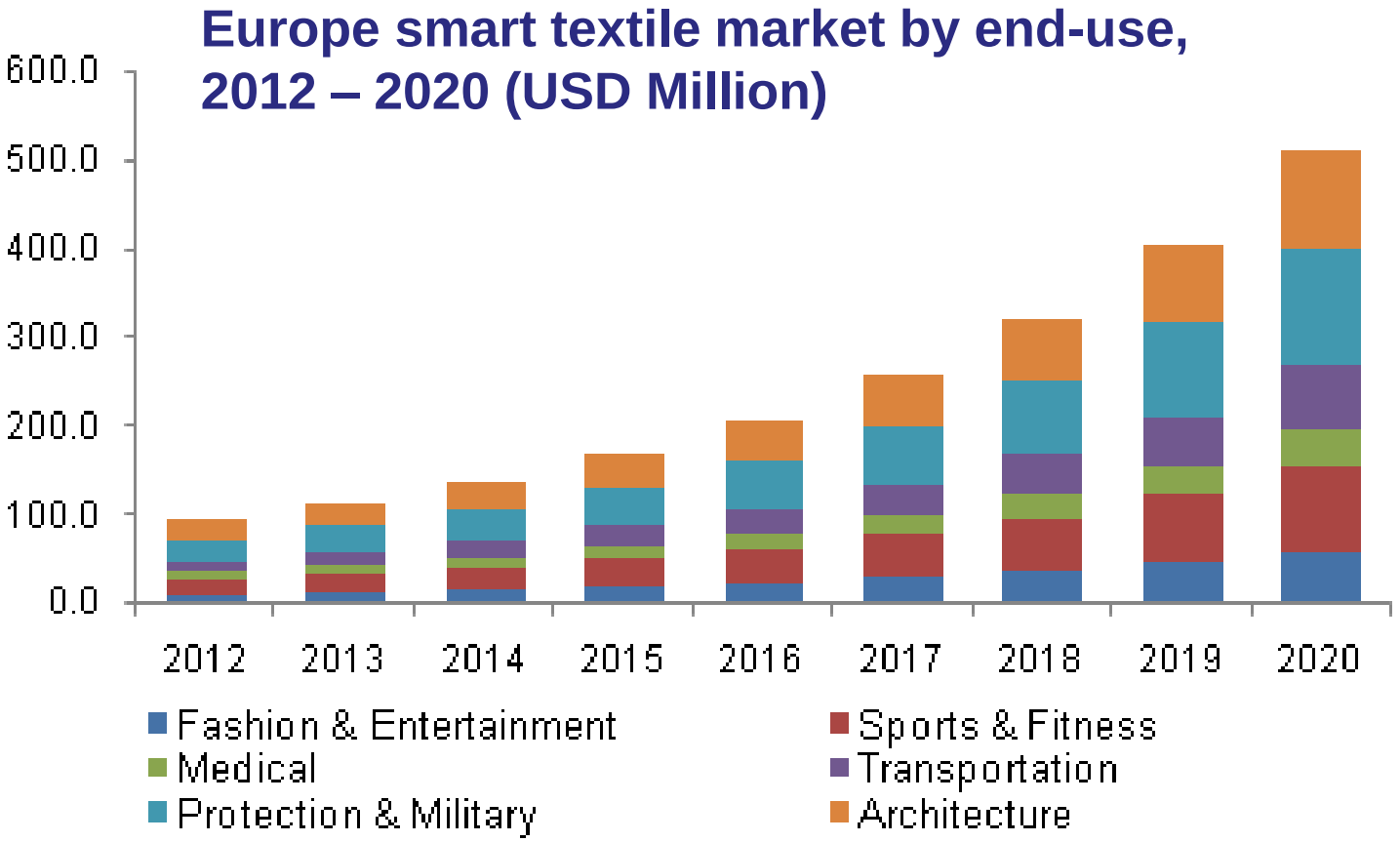
Market Value and Growth



Source; IDTechEx

- The wearable electronics business powers from over $14 billion in 2014 to over $70 billion in 2024. ***(IDTechEx)***
- ***Smithers Apex*** are forecasting the Compounded Annual Growth rate (CAGR) of 30% 2016-21
- The overall size of the global smart textile market is expected to grow at a CAGR of 24.1% from 2013 to 2020. ***(PRWEB)***

Market Value and Growth



http://www.grandviewresearch.com

Sports & Healthcare

Image courtesy of Philips Blue Touch Pain Relief Patch

Image courtesy of alktomyshirt.com

Image courtesy of LEO fitness wearable

Image courtesy of Edema ApS

Image courtesy of Zegna Urban

Fashion and Entertainment

Image courtesy of Sound reactive Thunderstorm dress Amy Winters

Image courtesy of t-shirttv.com

Image courtesy of Reuters

The Future of Wearables

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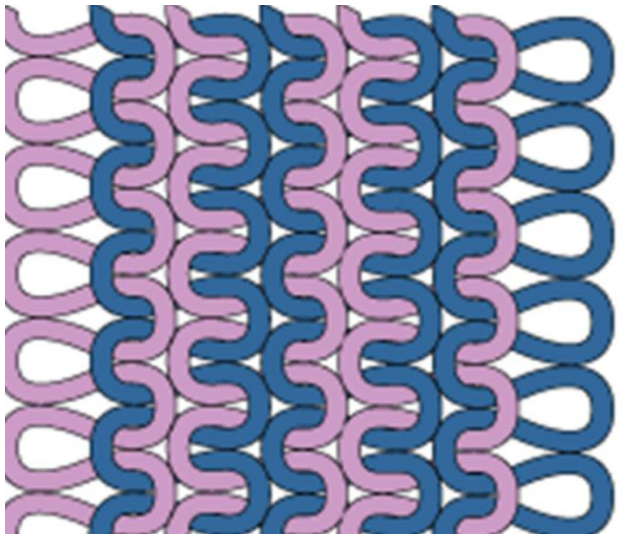
Wearable

Visible

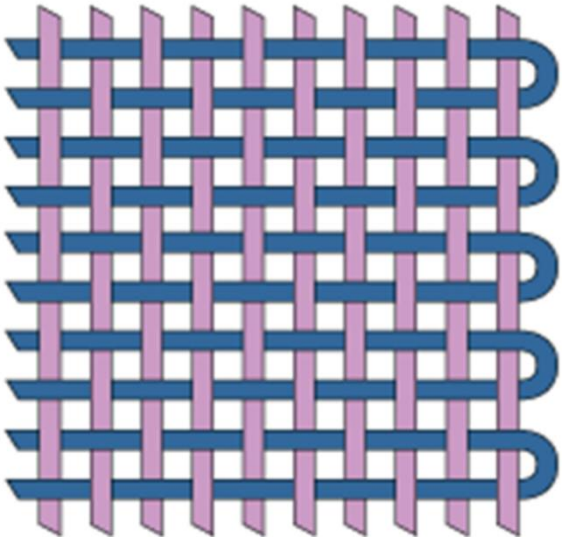
True wearable

Hidden

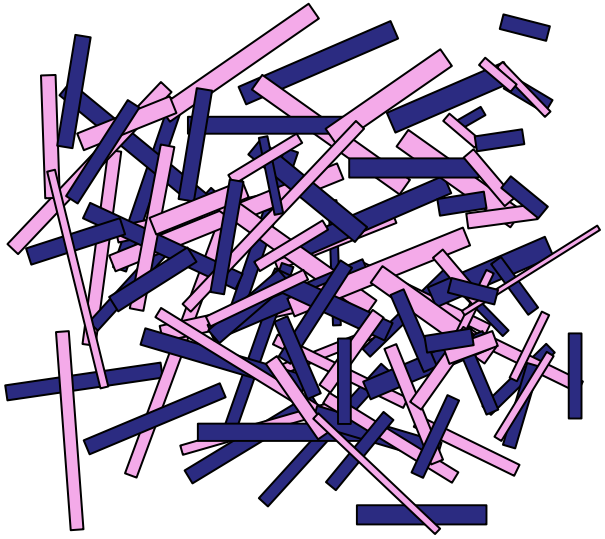
Fabric Manufacturing Types



Knitted Fabric

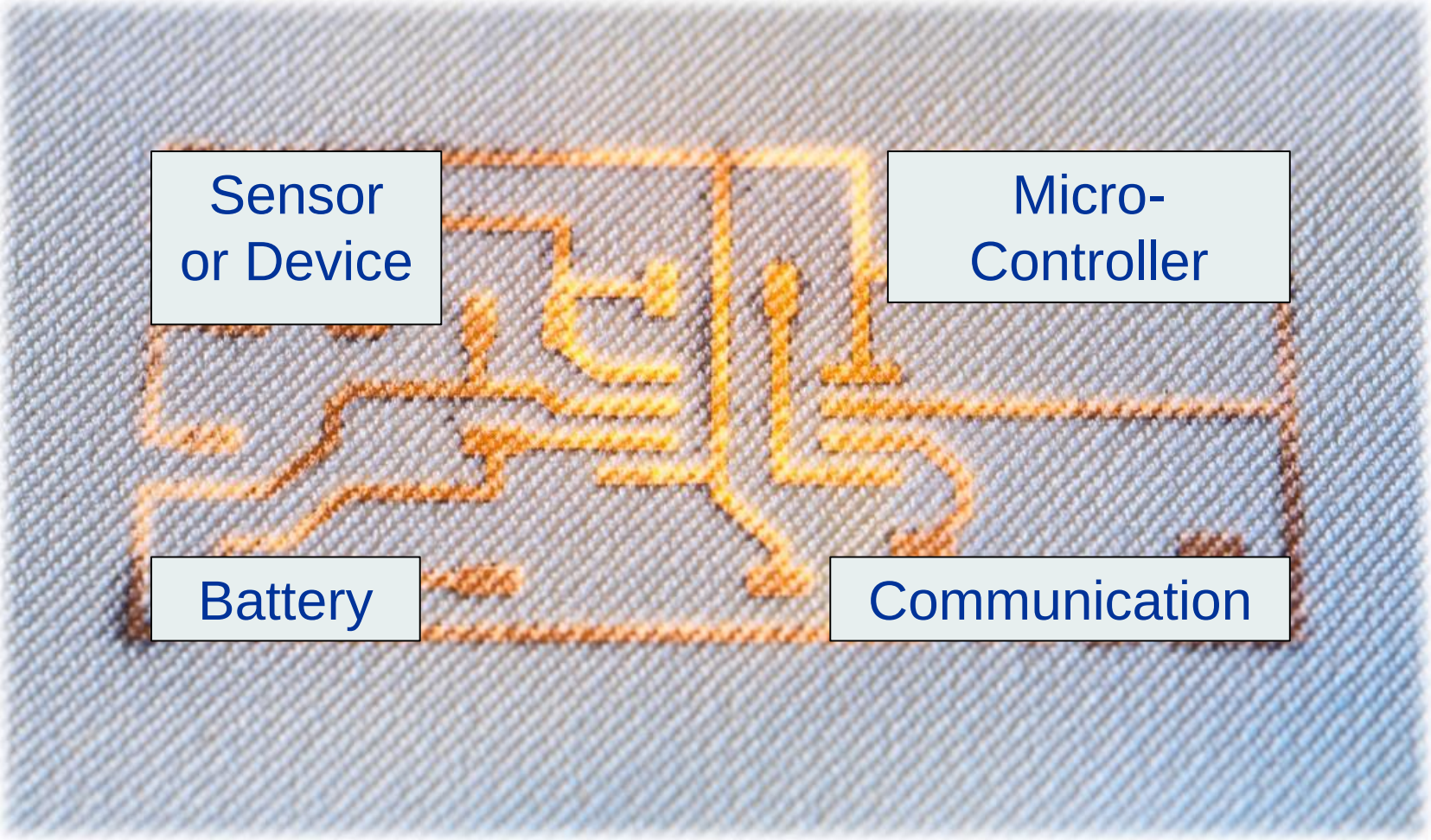


Woven Fabric



Non-Woven Fabric

Interconnect Solution



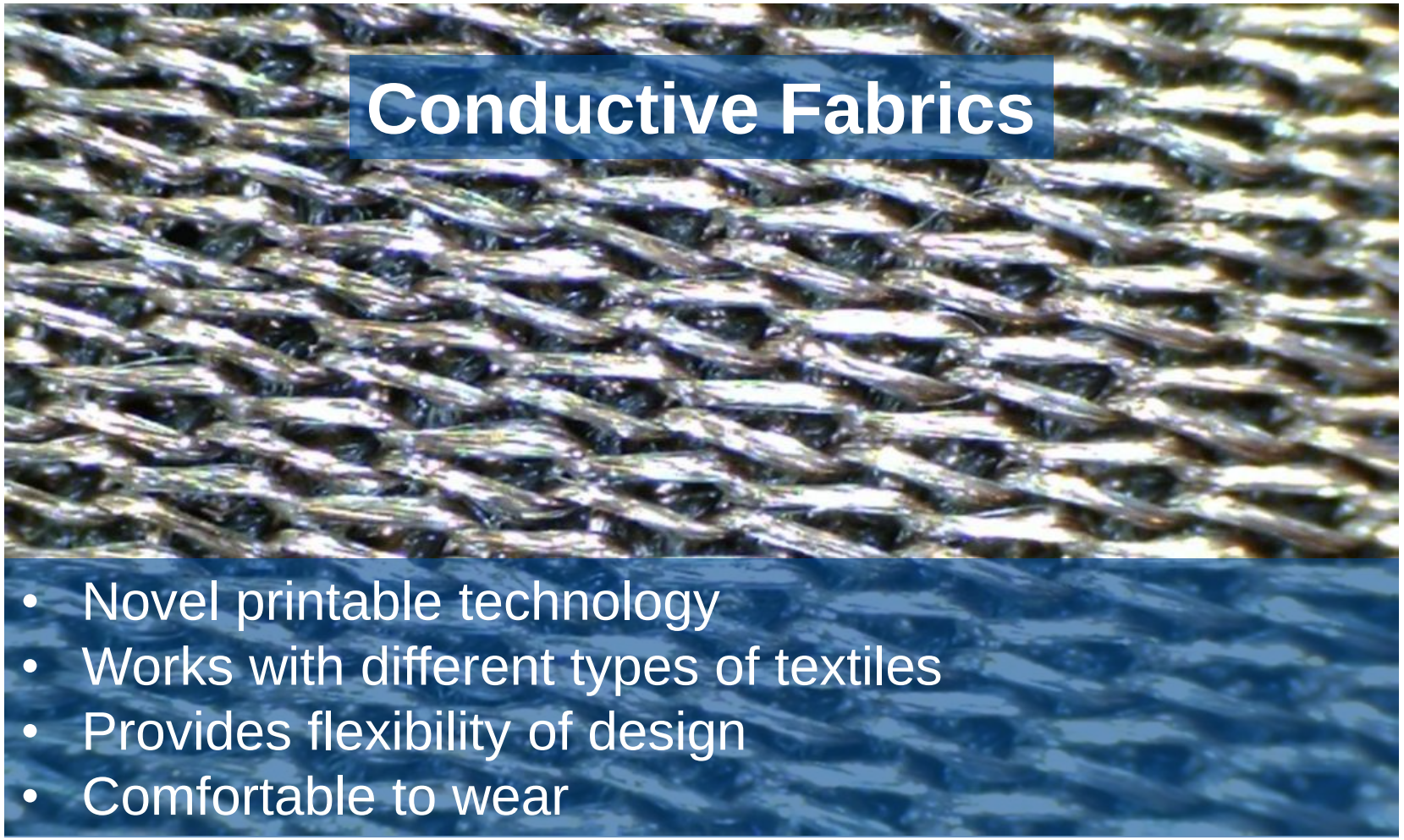
Available Technologies:

- Adding metal wires or threads into the textile.
- Printing/deposition of conductive polymers.
- Printing metallic inks on to the surface.
- Plasma deposition on the threads.

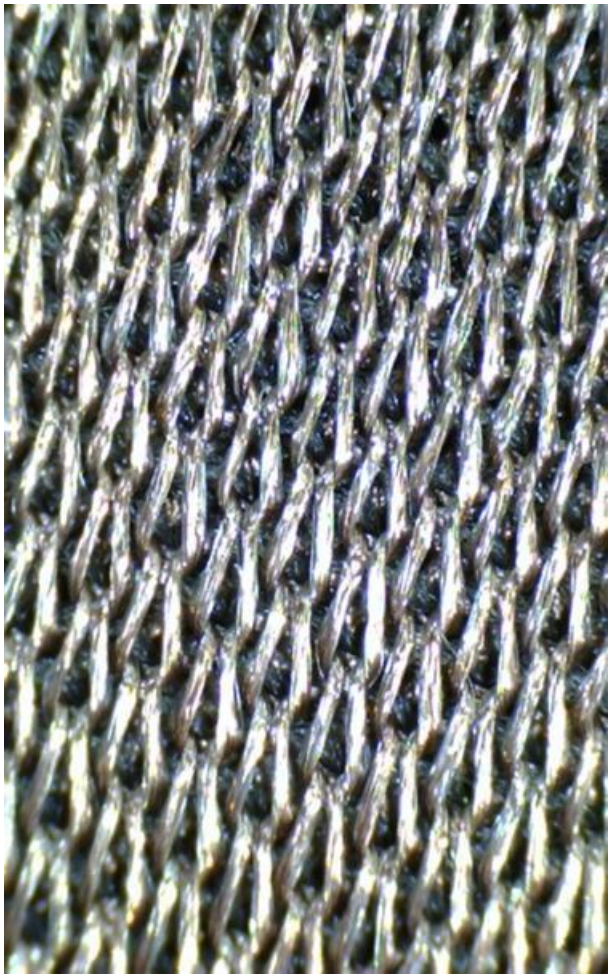
Current Challenges

- To run a connection in any direction on any textile.
- Weaving and knitting present severe limitations in this regard
- Textiles should feel comfortable to wear
- Additive processes are more flexible, and in principle will work with all textiles

NPL: Patent Technology

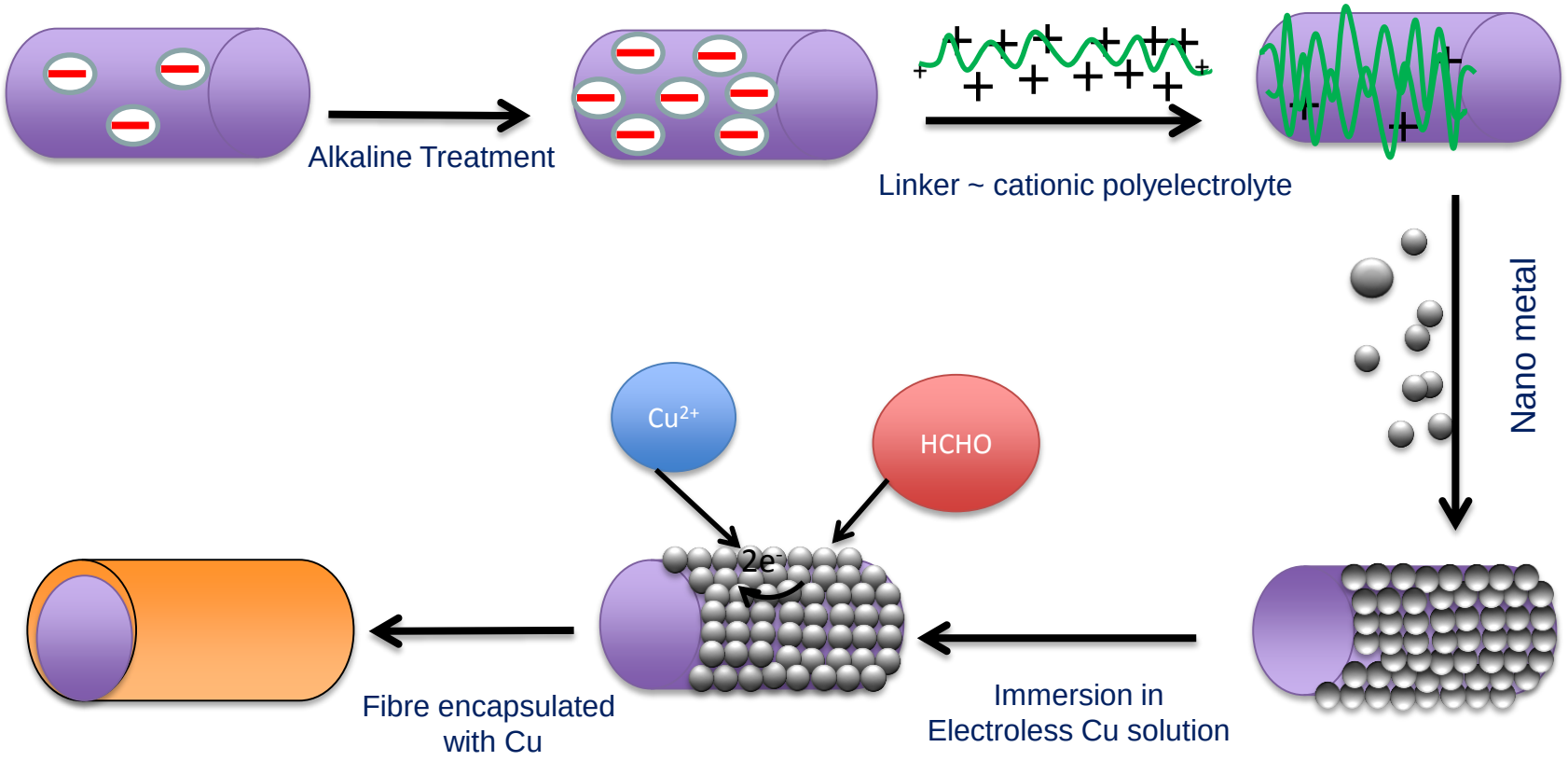


NPL Conductive Fabric

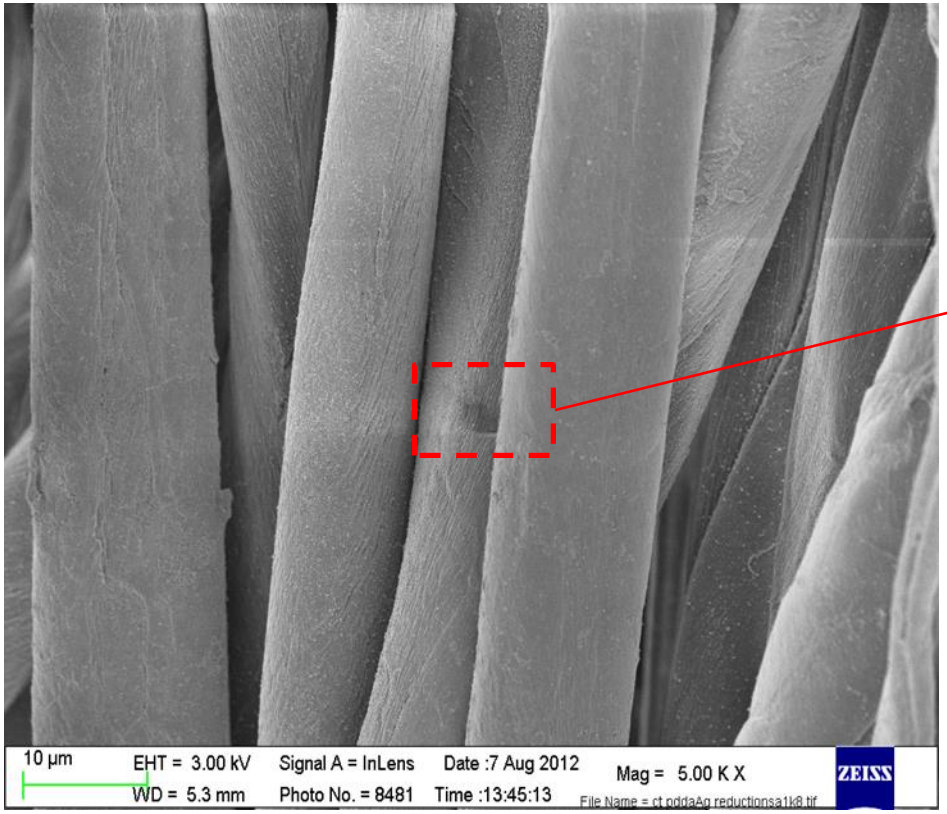


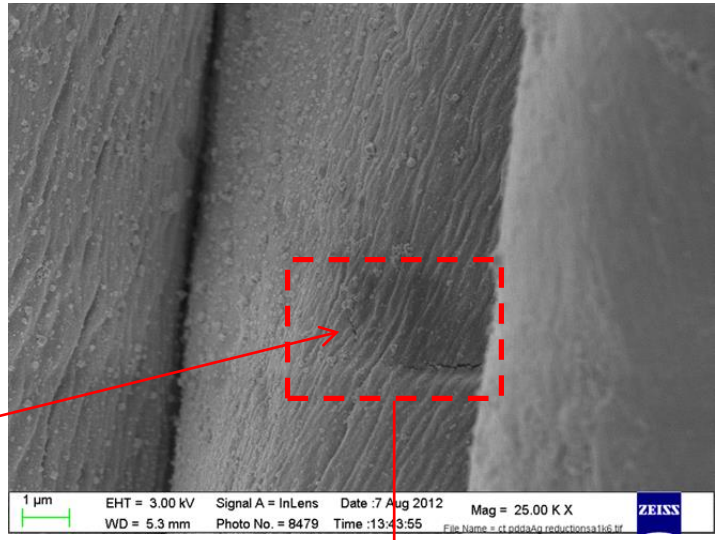
- Unique patent-pending technique, developed at NPL.
- All individual fibres coated with nano-metal (typical thickness = 20nm).
- Additive deposition is throughout the fabric with excellent adhesion, that allows the fabric to stretch and does not effect the drape and handle

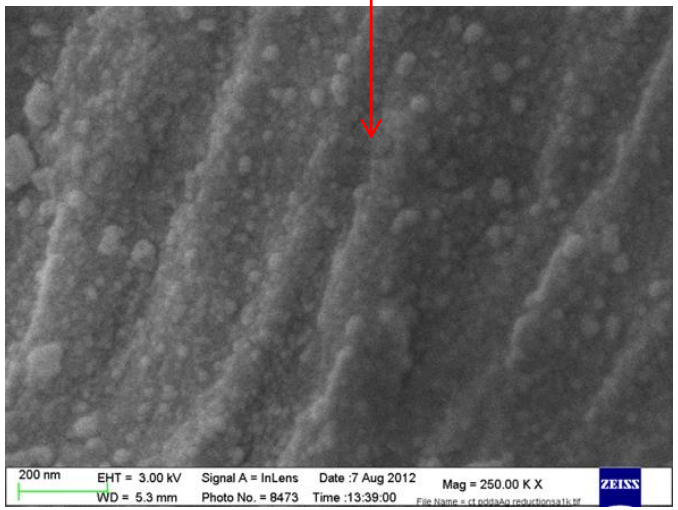
Conductive fabric Process



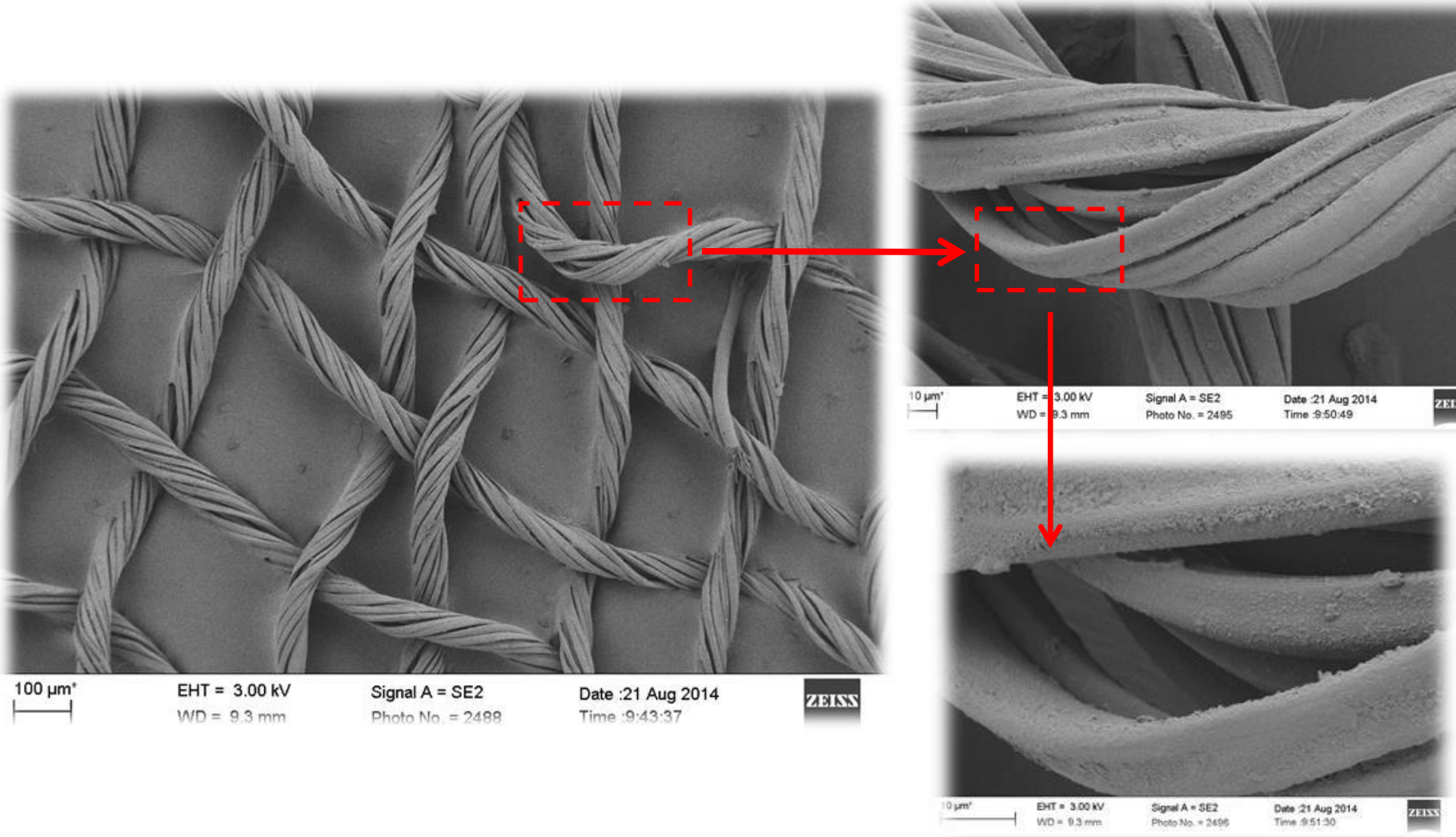
Nano-metal coated Cotton fabric



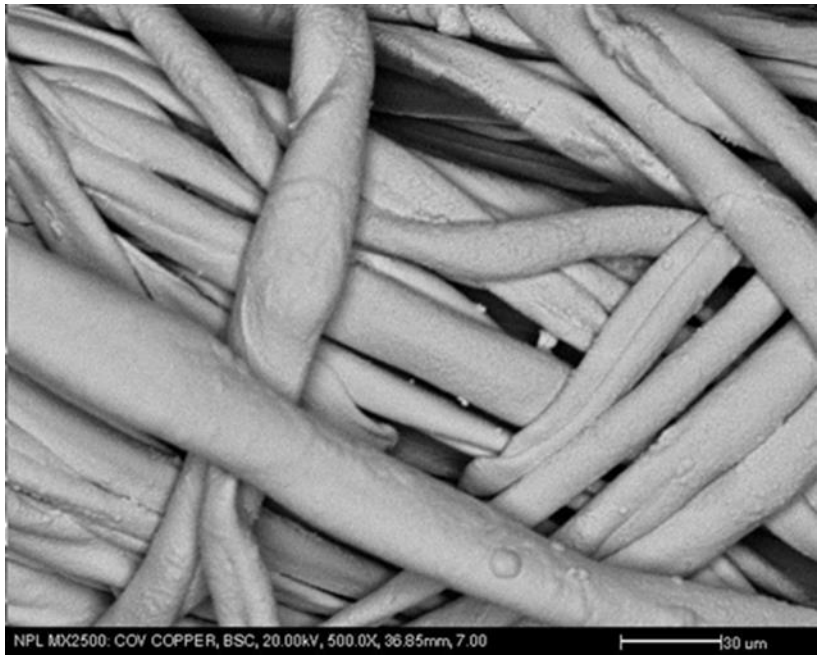


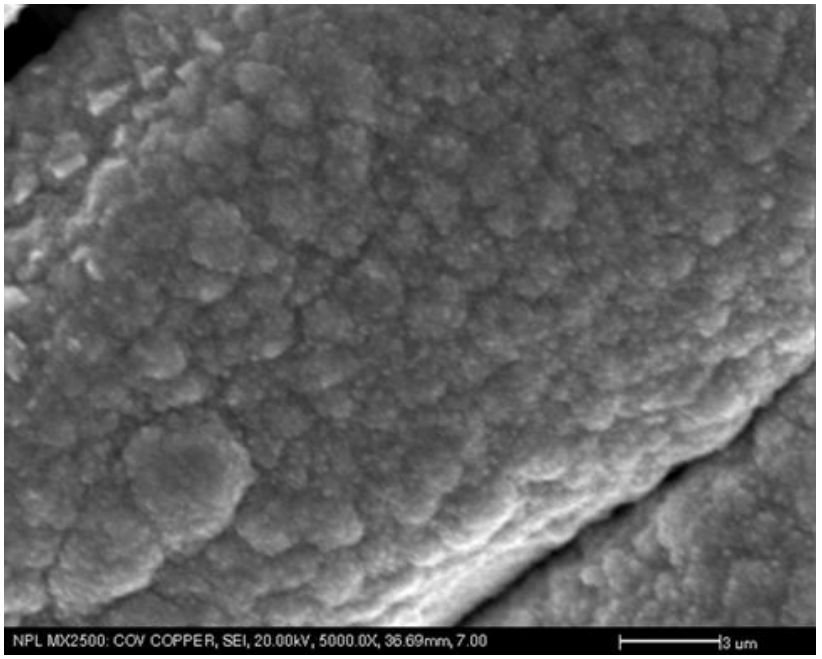


Nano-metal coated silk fabric



Additive Metallic Layer Thickening

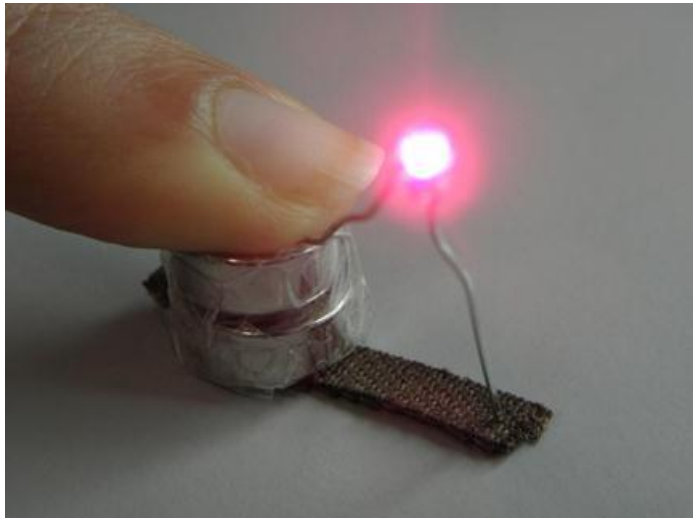




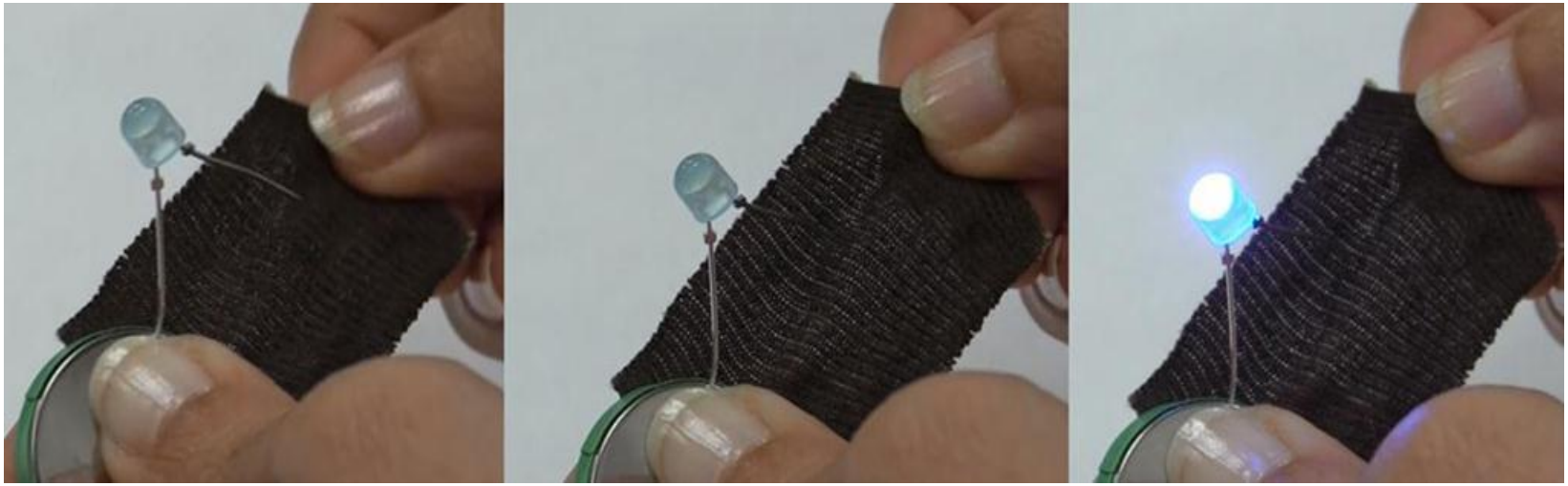
SEM images of electroless plating

Electroless plating to bring conductor layer 1µm
Resistivity R= 0.2Ω/□(Cotton)

Woven Fabric



Knitted Fabric

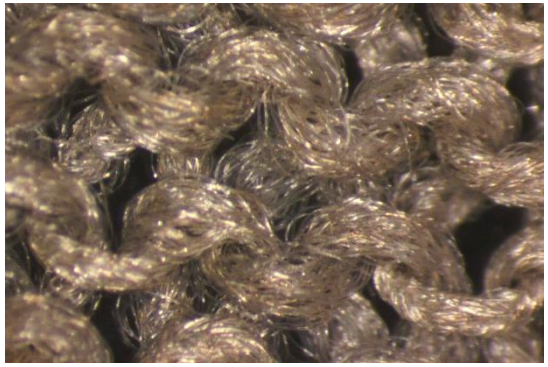


http://www.youtube.com/watch?v=skgGYFpT1Vc

Coating a Wide Range of Fabrics

National Physical Laboratory

Jersey Cotton Tubular
(R=0.2 Ω/□)

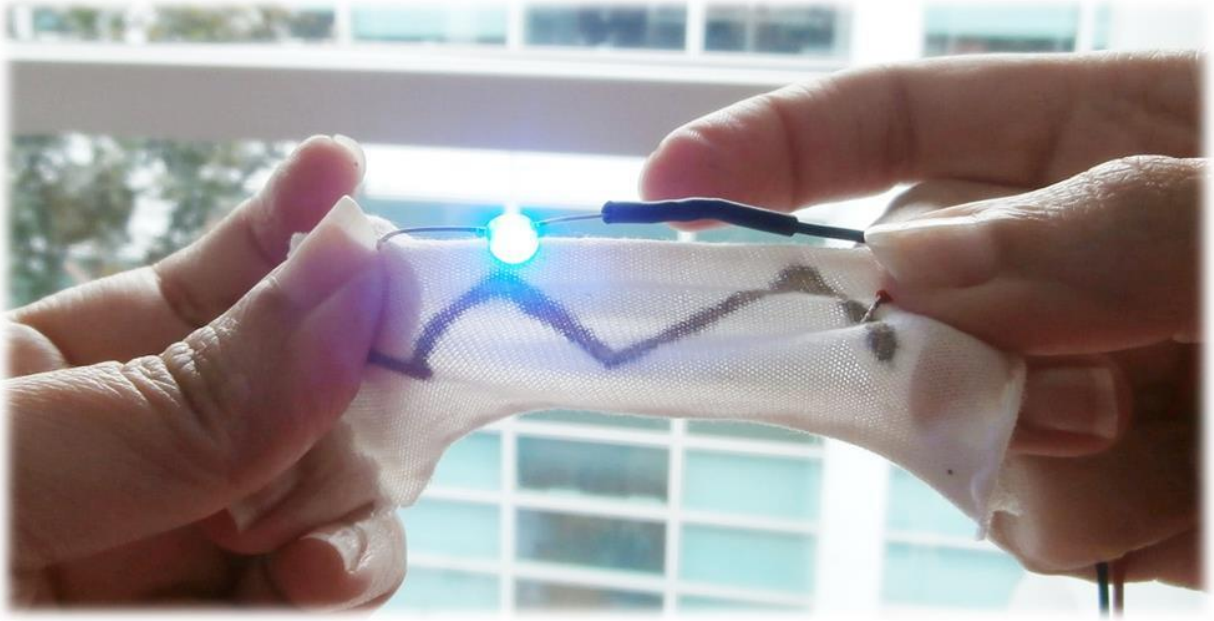


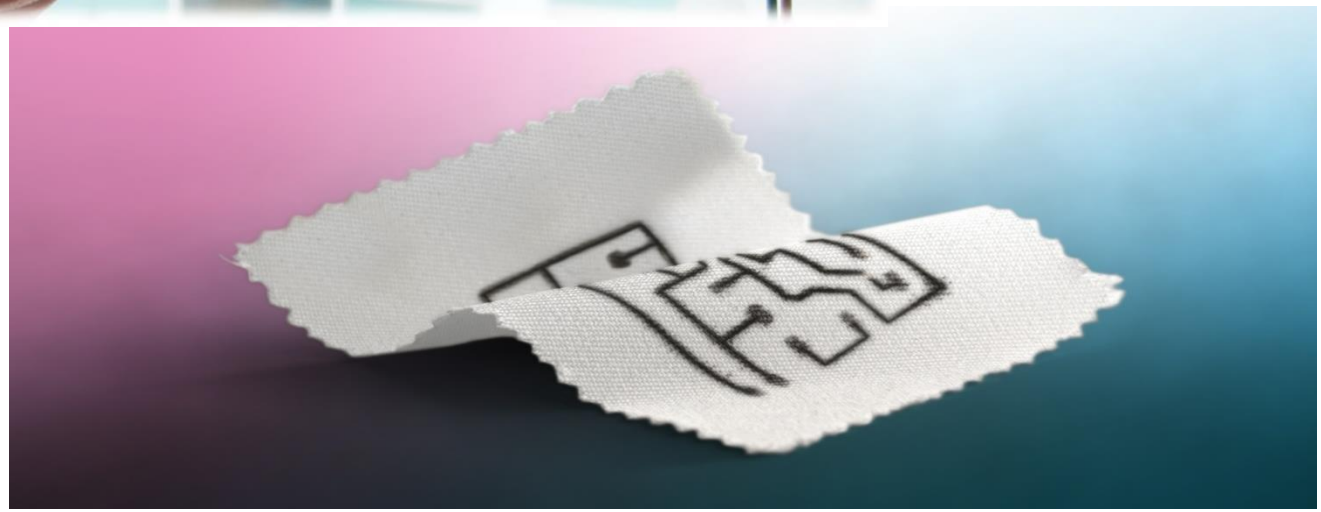
Polyester (R=0.1 Ω/□)

Linen(R=0.06 Ω/□)

Non Woven (R=0.006 Ω/□)

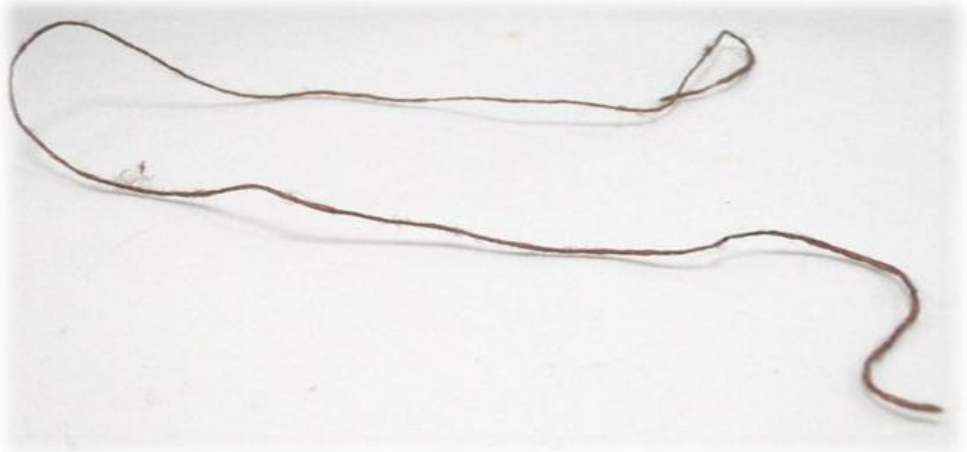
Patterning



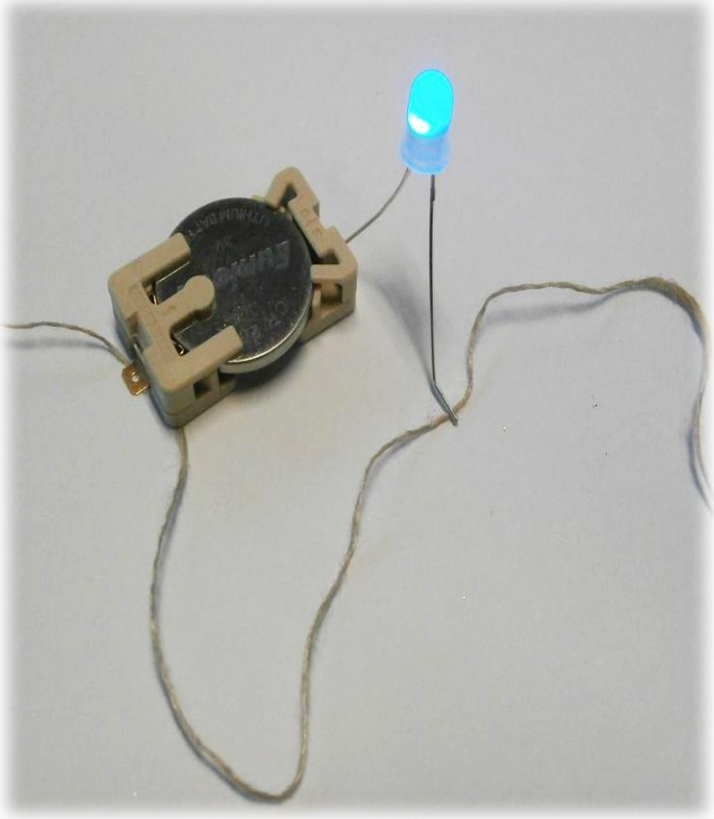


Conductive Thread

Fibres before Cu plating of threads

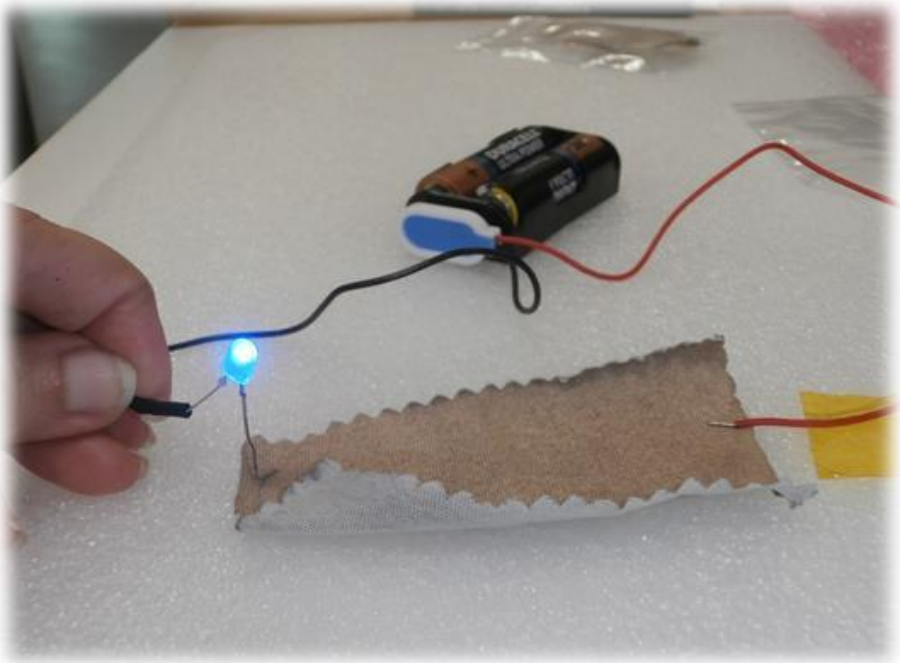


Cu plated thread

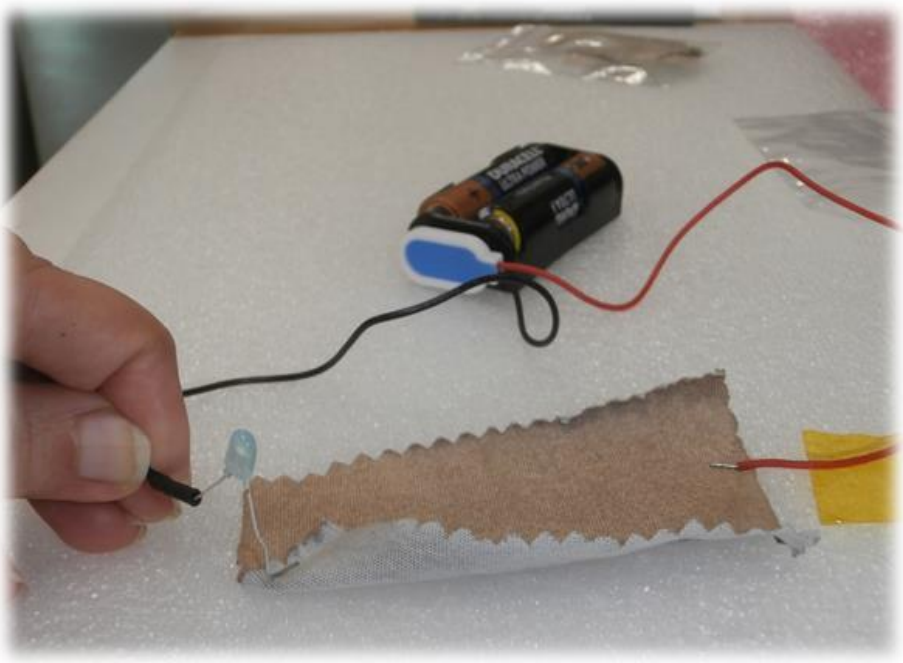


Conductive thread used in a circuit to light an LED

Sprayed

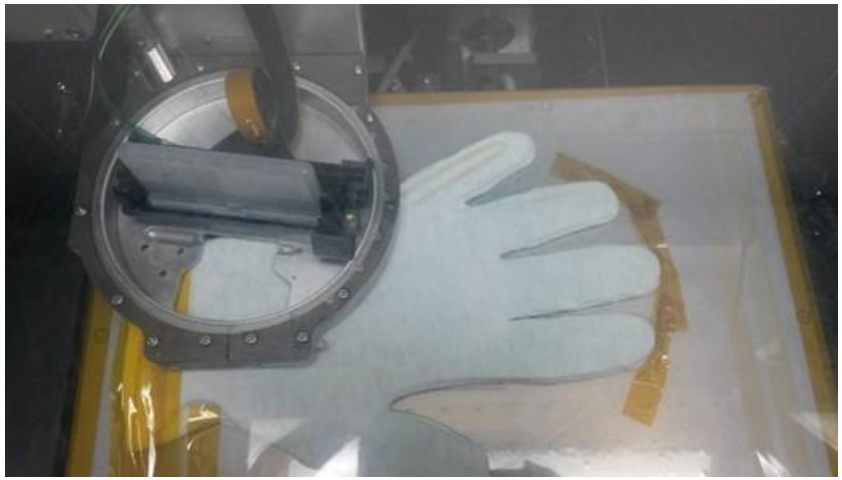


Conductive



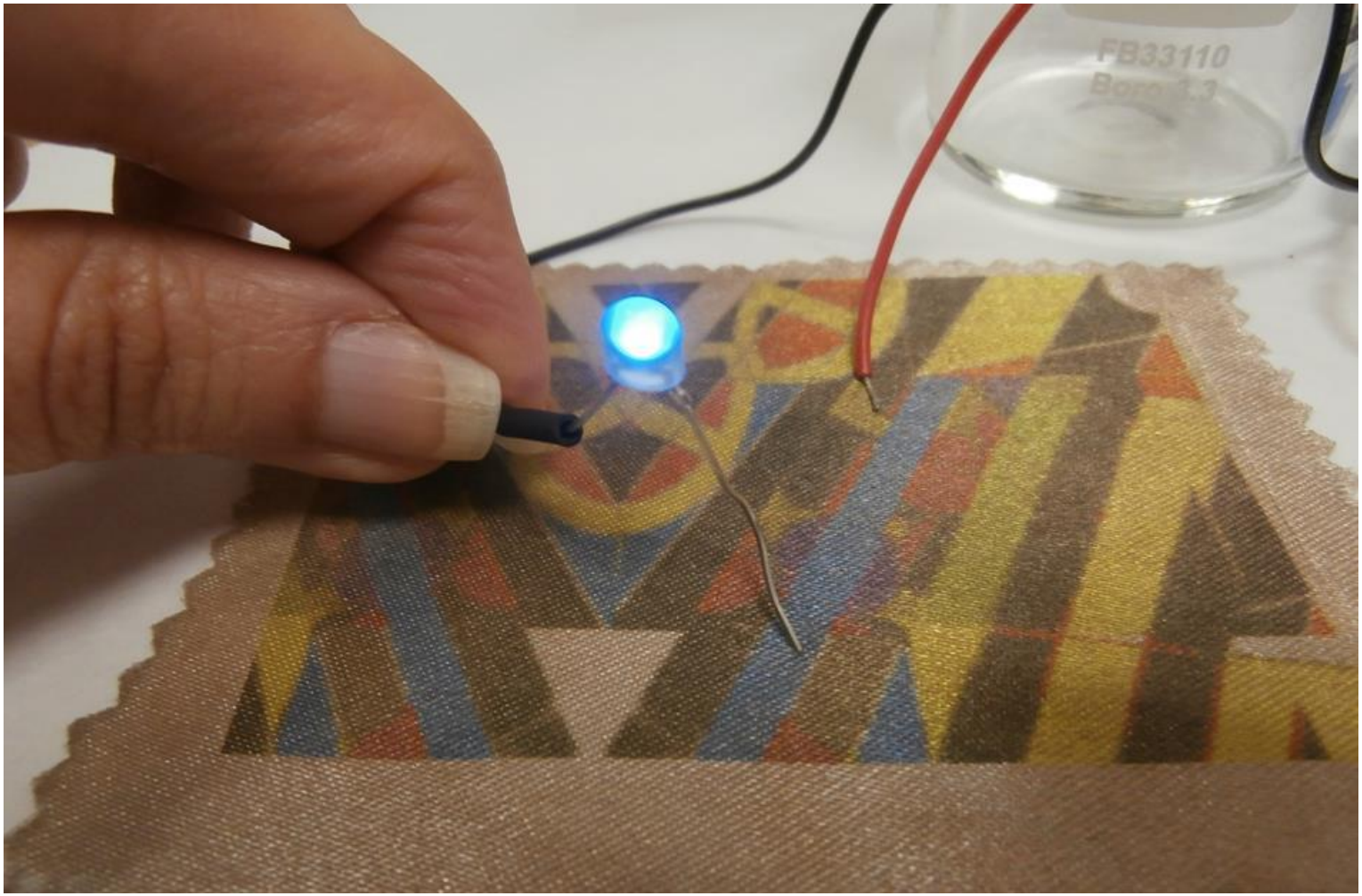
Not Conductive

Inkjet Printed



DMP Printer

Dyed Fabric



Conductive Fabric With Thermochromic Ink

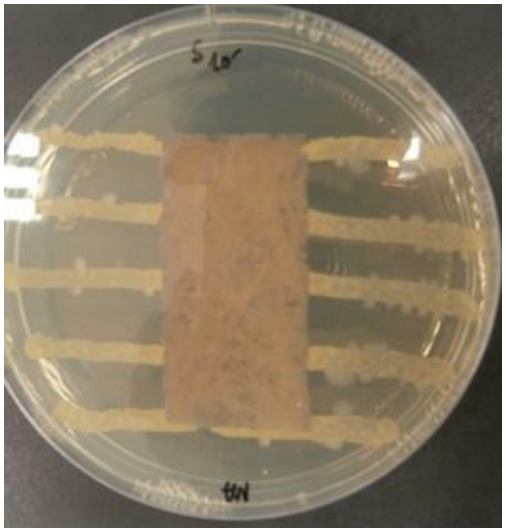
National Physical Laboratory

a) Without Current

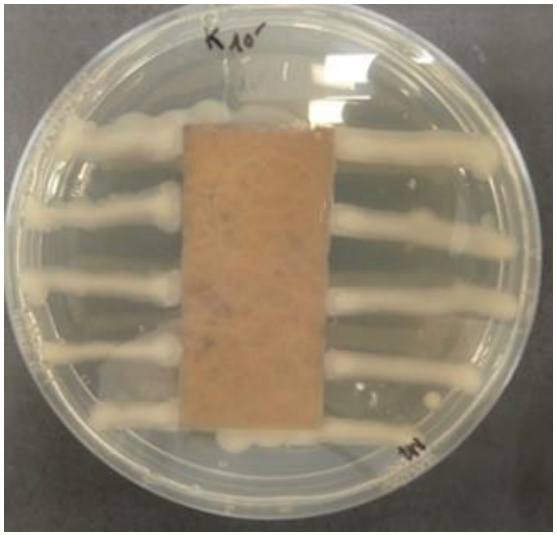
b) Using current

Antimicrobial Effect (Nonwoven)

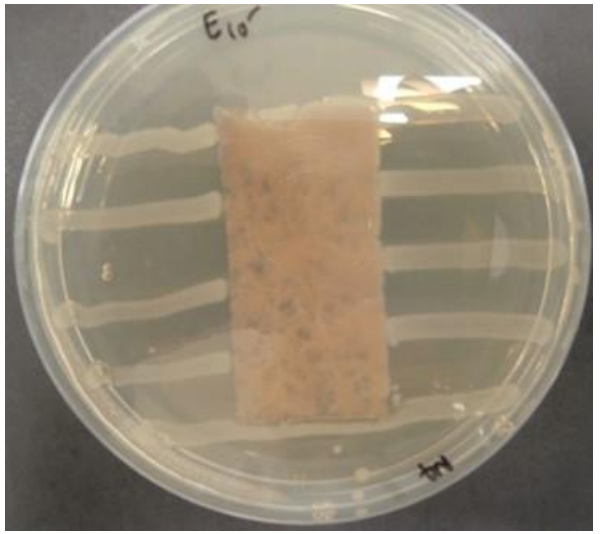
AATCC 147_2004 method *Nanosilver stage*



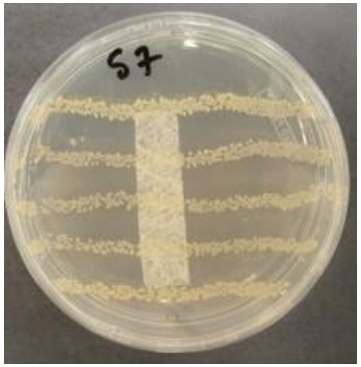
Staphylococcus aureus
(ATCC 25723)



Klebsiella pneumoniae
(NCTC 5055)



Escherichia coli (K12)



Bare Sample

Wash Test

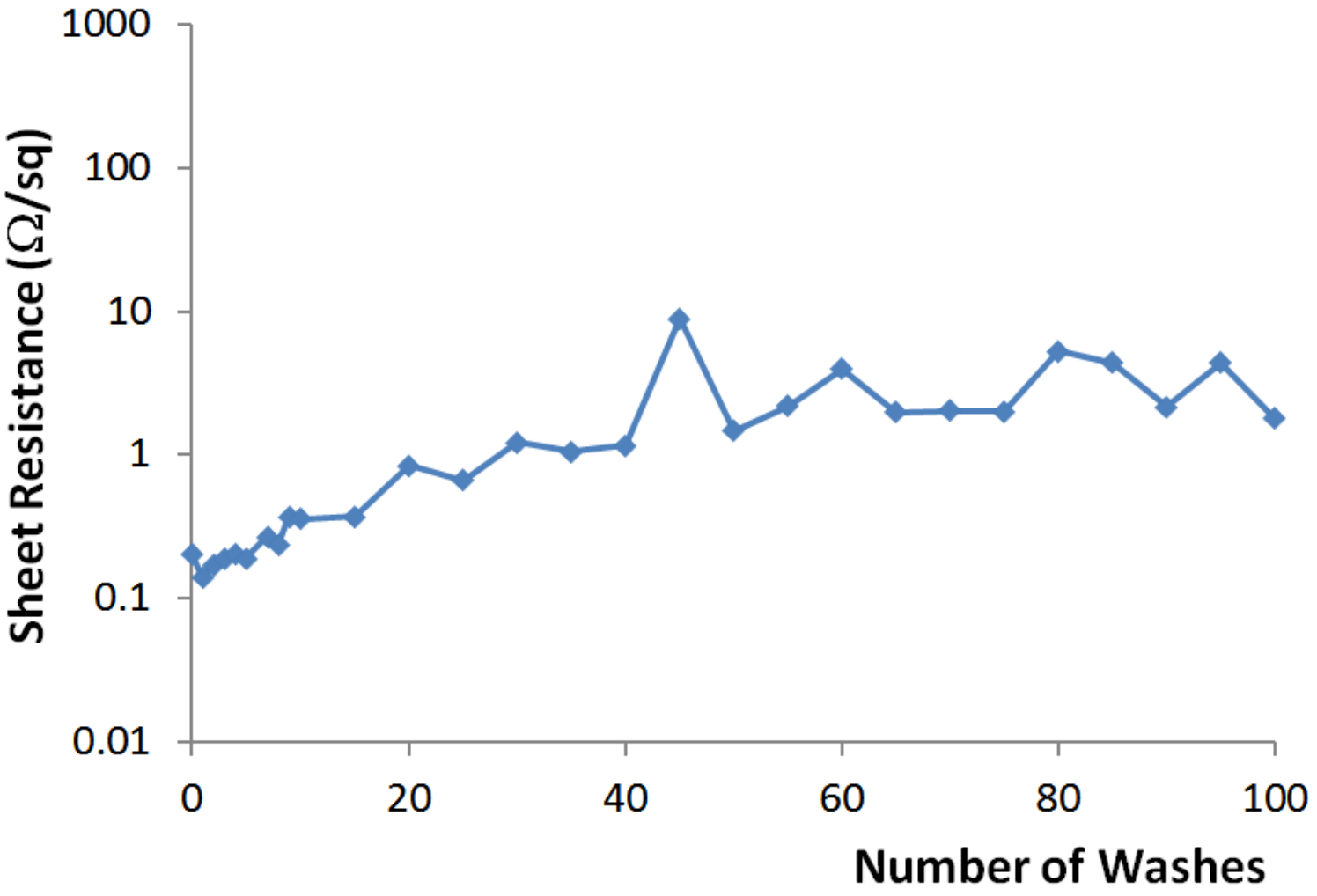
To evaluate the robustness of the adhesion of the nano metal layer attachment to textiles fibers

- Wash test was devised based on what would be expected from potential end users of conductive textiles. Therefore a washing machine and commercially available detergent used (Fairy Non-Bio)

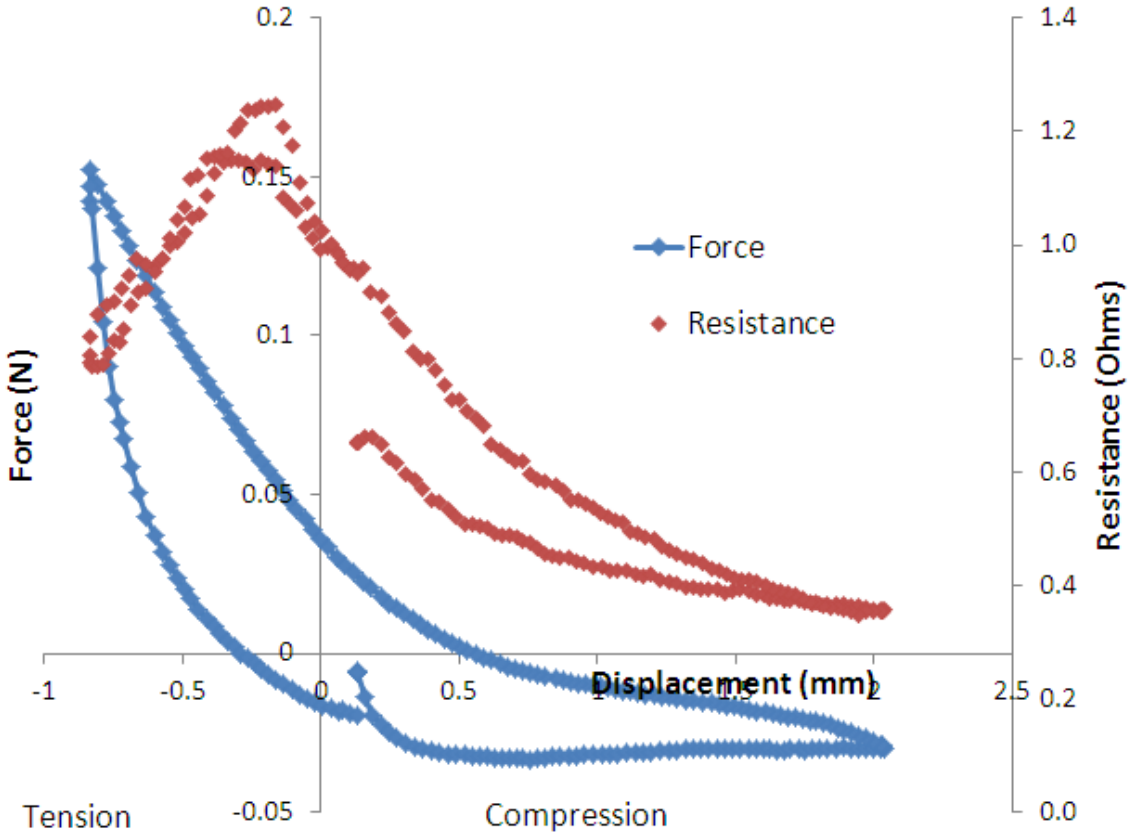
- Effluent water was collected and tested using ICP-OES

- Measured values of the change in resistance with following successive wash cycles

Wash Cycles (Cotton Jersey)



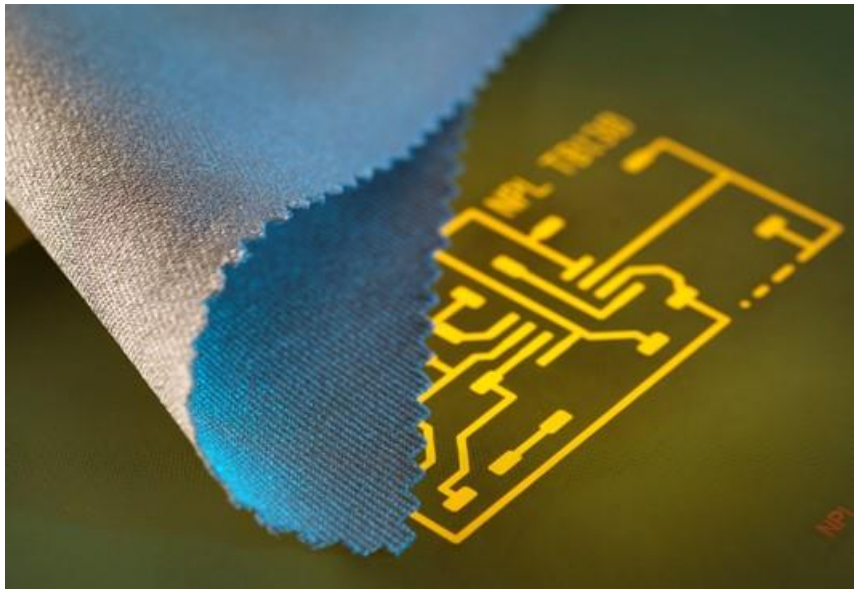
Stretch versus Resistance



Knitted fabric

Key Advantages of NPL Process

- Suitable for woven, knitted and non-woven.
- Comfortable to wear, no effect on drape and handle
- An aqueous process
- Can be inkjet printed
- Free form tracks
- Can be dyed
- Can be antimicrobial
- Can be stored prior to plating



Looking for partners to help us:

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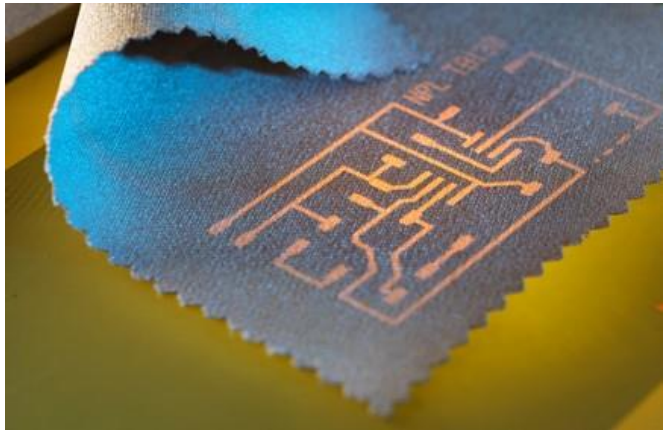
- *integrate the NPL technology into commercial products for specific applications.*

- *manufacture the NPL conductive fabric on a large scale.*

Visit us in ***Hall 08 - Stand A101a***

Or contact: ***businessdevelopment@npl.co.uk***

*Or visit****: www.npl.co.uk/smart-textiles***



Thank you
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