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Energy Harvesting 2015

19 March 2015, London

Powerweave: the concept

FP7 European project

Development of Textiles for Electrical Energy Generation and Storage

<u>Objectives</u>:

- Develop a knitted or woven fabric that will generate power from sunlight or ambient lighting and store the energy within itself
- Develop photovoltaic fibres
- Develop energy storage fibres

Powerweave: the concept

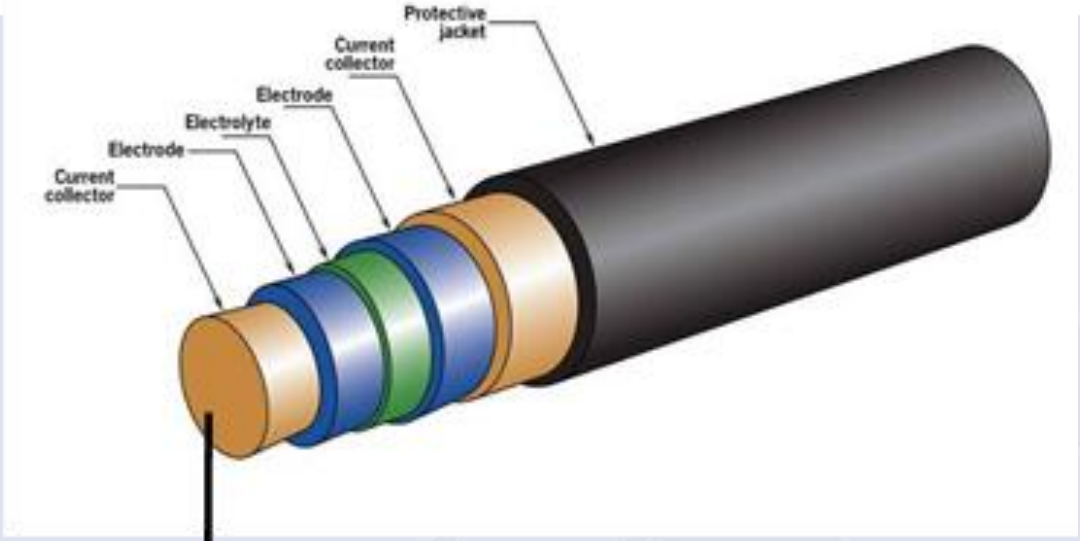
4 years - started in June 2012

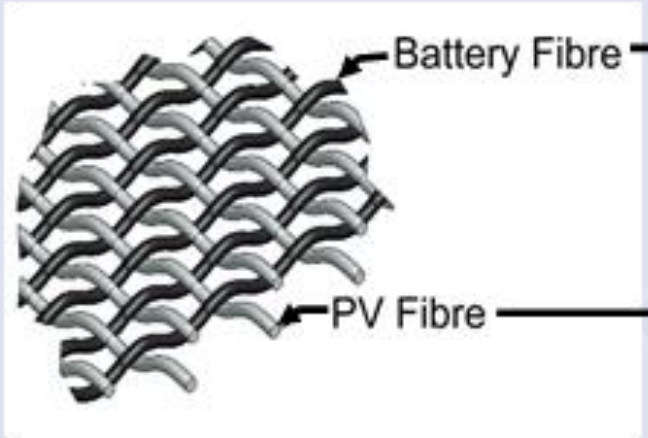
Coordinated by TWI Ltd, UK

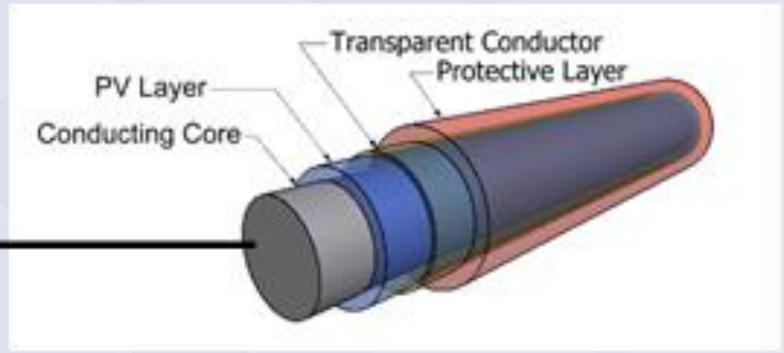
With 7 industrial partners and 6 research partners

From 7 countries

Powerweave: the concept







Powerweave

Powerweave: the concept

Exploitation

- Airship – Lindstrand Technologies

Small scale mobile airship with electric propellers powered with
The Powerweave gas envelope

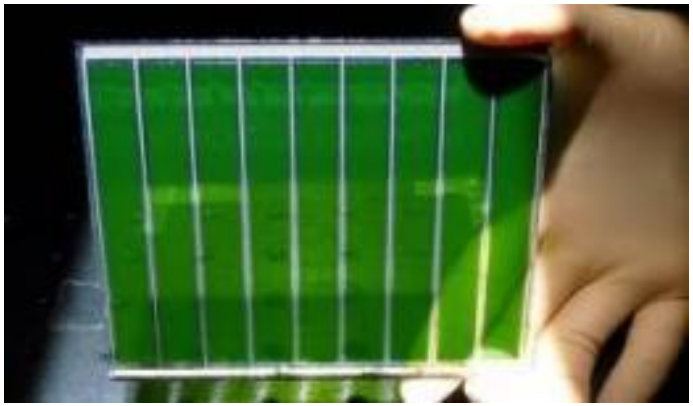
- Agricultural fabric – Bonar Technical Fabrics

Greenhouse shading for southern European climates providing power for ventilation, pumping water and lighting in remote location.

POWERWEAVE: RESULTS ON FIBRES

PV Fibre

- Dye sensitized solar cell

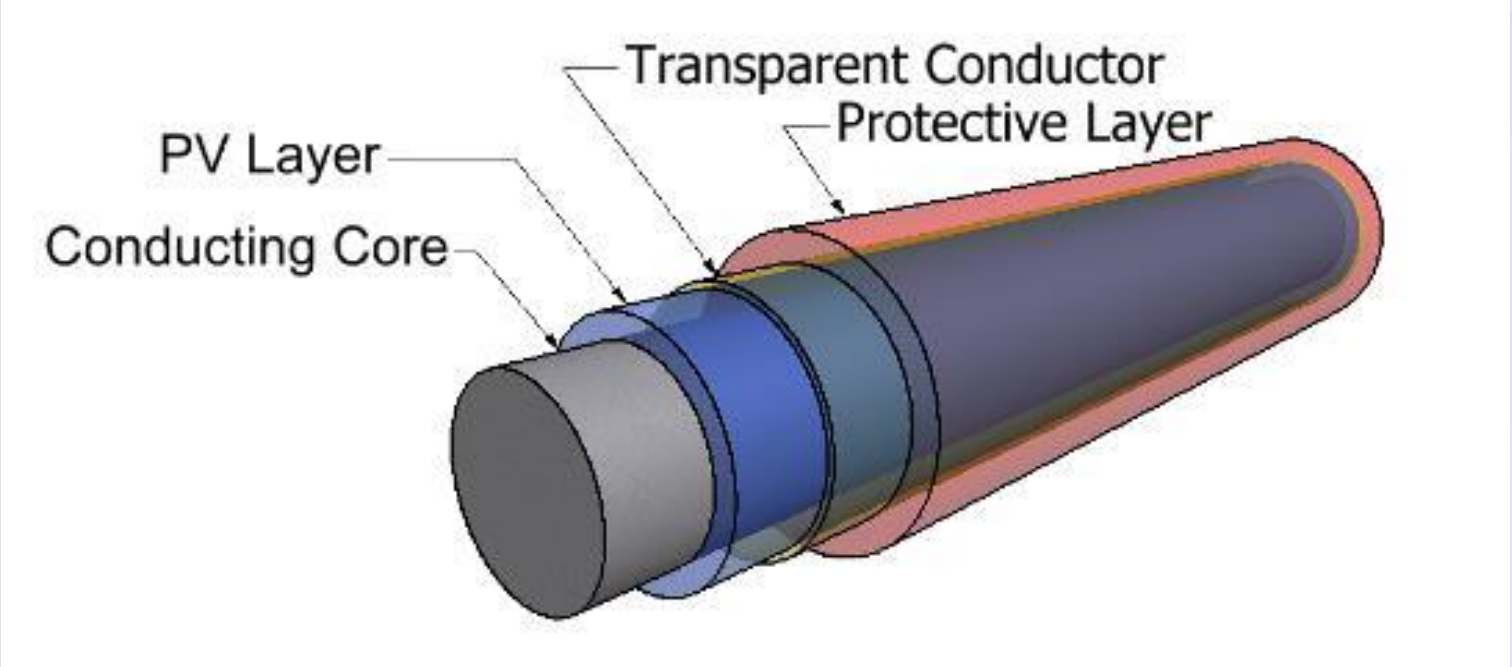


Invented by Prof. Michael Grätzel at EPFL
Recently developed to 20% efficiency by EPFL

Much less sensitive to angle of incidence of radiation than silicon cells
Low cost processing equipment and materials compared to silicon

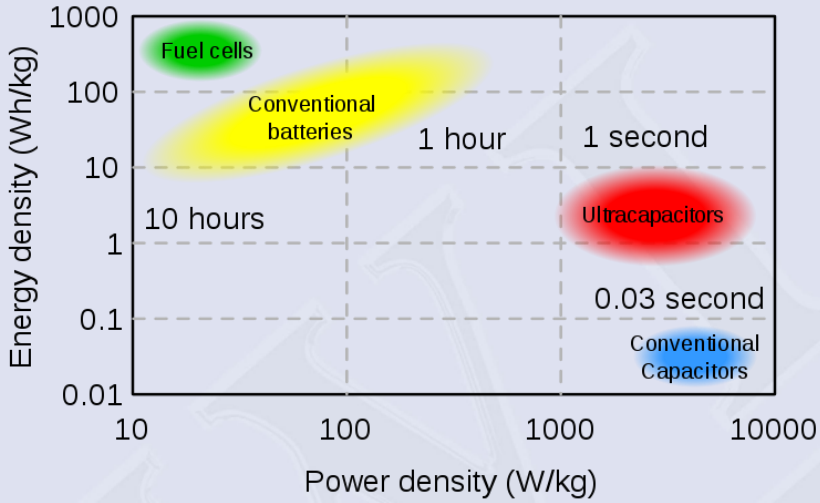
Challenges: - Transfer to fibre shape
- Interconnect the fibres
- Weave the PV fibres without damage

PV fibre structure



Energy Storage Fibre

- Choice between thin film Li-ion cells and supercapacitors
- Li-ion cells have been demonstrated with 5um thin films by Brunel and Loughborough Universities.
- Li-ion cells have better energy density, up to 200Wh/kg vs 30 for supercapacitors



- Supercapacitors have high power density, high lifetime and low internal resistance
- Supercapacitors can be constructed from commonly available, low cost materials, carbon and biomass based

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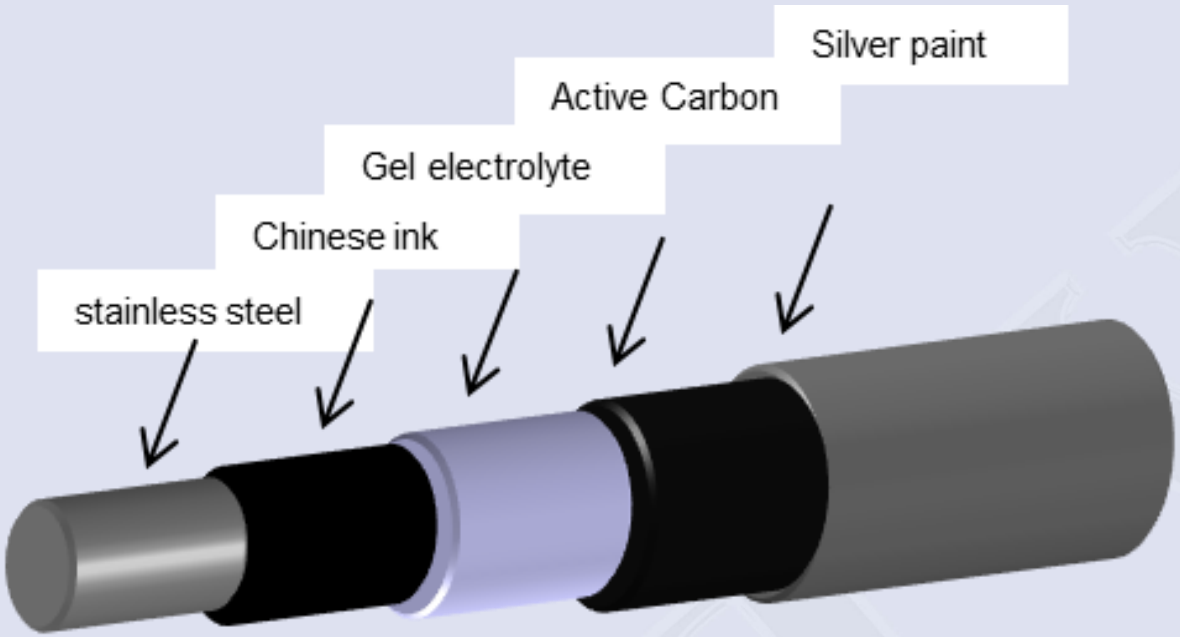
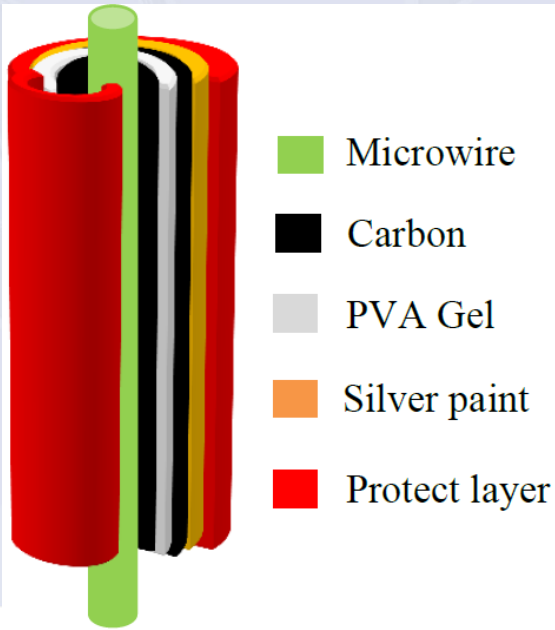
Storage fibre: thread supercapacitor

Schematic of four coating layers on a 50 microns stainless steel wire [1]





1) Fabrication and Characterisation of Flexible Coaxial Thin Thread Supercapacitors
Fulian Qiu, David Harrison, John Fyson and Darren Southee

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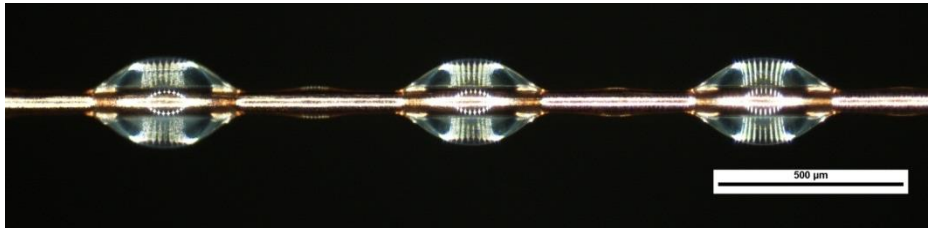
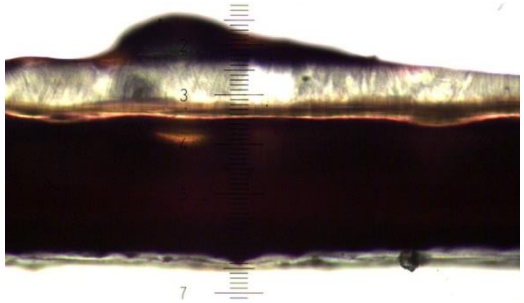
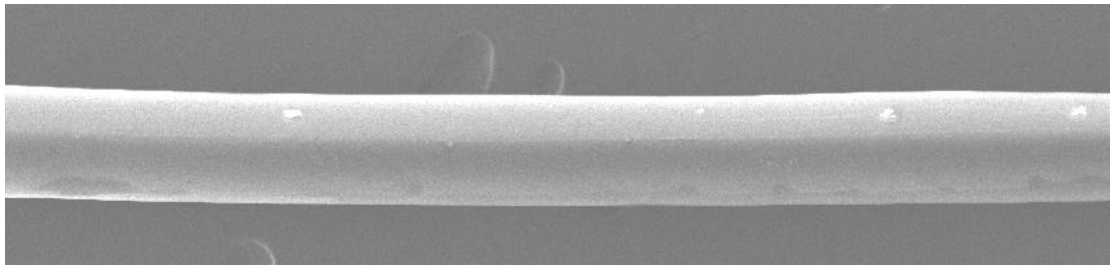
Fibre coating results

- Coating of thin layers







Homegeneity

Adhesion

Thickness

Roughness

POWERWEAVE: RESULTS ON TEXTILE

Results on textile

- 2 structures selected for weaving

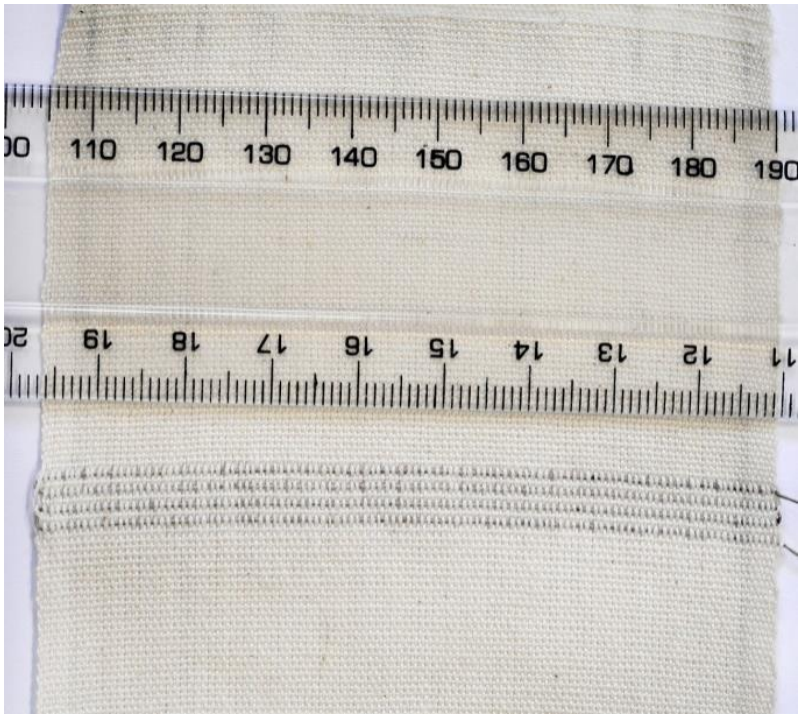
semi-transparent

fully opaque

The outer protective layer was successfully tested for weaving

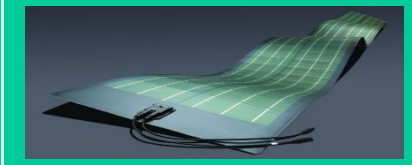
Results on textile

- First prototype of energy storage fibres



POWERWEAVE: EXPLOITATION

Key characterics of power textiles

Features	 Glass panels	 Flexible panels	 Power textiles
High power efficiency	√	-	X
Storage capacity	X	X	√
Low installation cost	X	√	√
Easy distribution	X	X	√
Adaptability	X	X	√
Production scalability	-	-	√
Life time	√	√	-
Cost	X	X	X

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Power textile impact – PEST Analysis

Political

UN Millenium Development Goals
"Universal energy access is a foundation for all the Millennium Development Goals". UN Secretary General, Ban Ki Moon

Contribute to EU Renewable Energy Strategy – aims to get 20% of its energy from renewable sources by 2020

Economic

Increased employment within manufacturing within the European textile industry
Reduced energy costs impacts on agricultural and food production costs.

Societal and Environmental

Reduction in carbon footprint and CO2 emissions
Off grid energy source increasing availability in Africa

Technological

New innovative development, contribution to new scientific knowledge and applications

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Photovoltaics in greenhouses

- **Photovoltaic technology is already used in the greenhouse-industry - the result is a fixed shading which can be negative for the cultivation of plants**

- **→ Power textiles allows rollable shading with semi-transparency, adaptable to climate and seasonal changes**

- **Market size at a modest 1% market penetration equals (NL, Mediterranean &China only): 4.5 million m²**

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Transport Applications

- **Power textiles enable renewable, ‘free’ non polluting & non flammable fuel**
- **Power textiles provide a more flexible alternative to 2nd and 3rd generation flexible solar panels for airships, sails, car soft tops & inflatable structures**
- **Power textiles are the only technology which includes power storage capability**

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Wearable Technology Market

- **The wearable technology market was worth $2.7 billion in revenue in 2012 and is expected to reach $8.3 billion in 2018.**
- **Power solutions are critical to making wearable technology feel like a natural, consistent part of our lives.**

The headphones have an integrated flexible solar cell that covers the full headband which capture solar energy whilst out and about

Bags with photovoltaic panels are used to power personal electronics and even laptop computers.

Powerweave

Textiles are everywhere – power will follow

Thank You

Please visit us at www.powerweave.eu