

Forum Produktion 2020

Einsatz von Schlüsseltechnologien für eine innovative und kreislauffähige Produktion



 Bundesministerium
Klimaschutz, Umwelt,
Energie, Mobilität,
Innovation und Technologie



Smart textiles, Integration, Challenges and the Future

Dr. Barnaby Caven

Research Institute of Textile Chemistry and Textile Physics,
Universität Innsbruck



Smart textiles, Integration and Challenges

Dr. B. Caven

Research Institute of Textile Chemistry/Physics

<https://www.uibk.ac.at/textilchemie/>

it is western Austria's largest institution of higher education and research. For further information visit: www.uibk.ac.at.

Research Institute of Textile Chemistry and Textile Physics

- Founded in 1982
- Part of Faculty of Chemistry and Pharmacy of the University of Innsbruck
- Total 25 members as of May 2020
- 2 Full Professors, 1 Asst.-Professor
- 7 PhD students, 6 PostDocs
- 2 Locations at HLT Dornbirn and VEG Building
- Modern laboratories in textile chemistry and polymer materials
- Intensive industry collaboration
- ~400 peer reviewed scientific publications, ~40 patents



Institute's cross-functional research areas



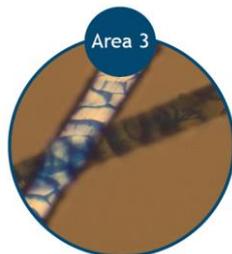
AREA 1 | HYBRIDS & COMPOSITES

Research focused on combining materials and their subsequent properties



AREA 2 | E-TEXTILES & ENERGY

Development of energy storage & harvesting systems and integration of electronics into textiles



AREA 3 | SURFACES & INTERFACES

Modification of surfaces to enhance existing functionalities or to impart new ones

BMK Endowed Professorship Advanced Manufacturing 2016-2021

Human capital development and research infrastructure

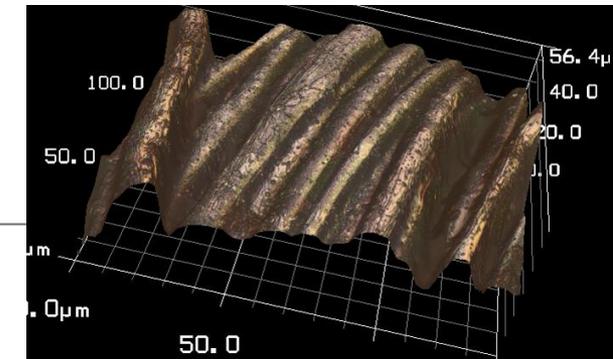
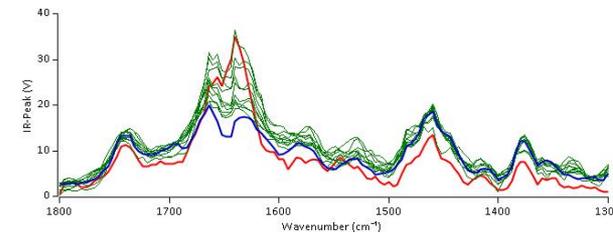
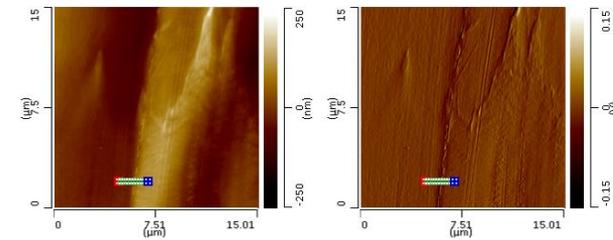
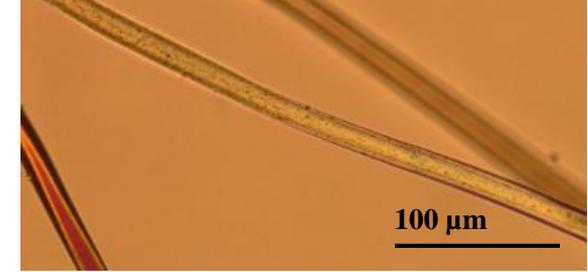
- 3 completed and further 7 ongoing PhDs
- 6 completed Master thesis
- 1,5 M€ infestation in modern devices since 2016

Cooperation between academia and industry

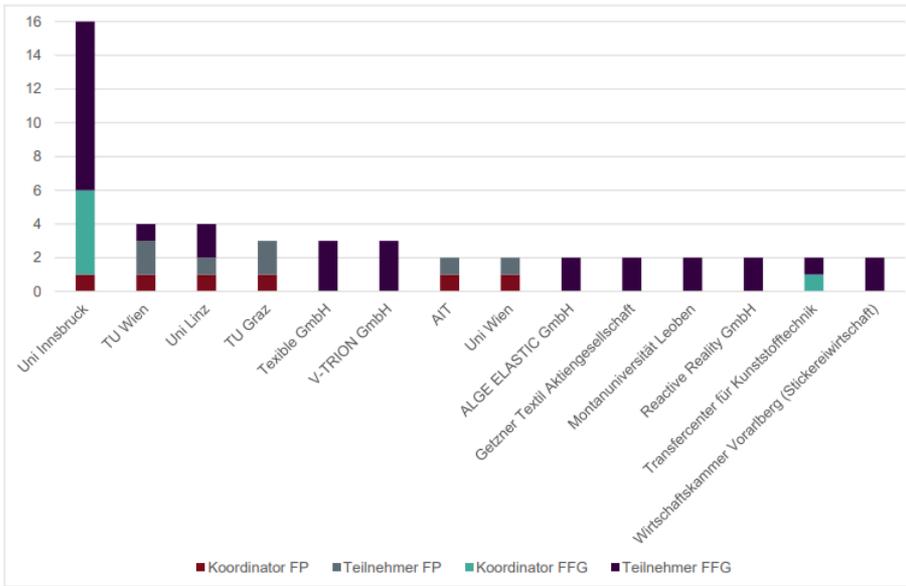
- ~2,3 M€ third party funding in several cooperative projects since 2016

Research networks & reputation

- 30 journal publications, 5 patent applications
- 22 conferences presentations

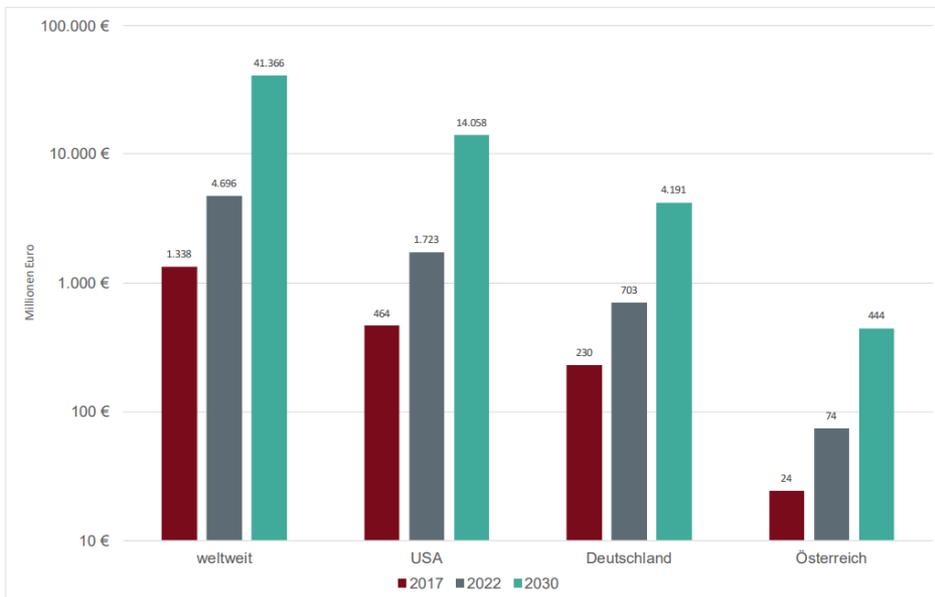


Smart Textile and research in Austria



A report by AIT „Smart Textiles Studie“
 Endbericht zu Projekt 871418 im Rahmen der
 28. Ausschreibung der Produktion der Zukunft

Abbildung 15 Schätzung/Prognose Marktvolumen Smart Textiles 2017, 2022 und 2030



Smart textiles

“Smart materials and structures can be defined as those that sense and react to environmental conditions or stimuli, such as mechanical, thermal, chemical, electrical, magnetic or other sources.”

Xiaoming Tao, *Smart fibres, fabrics and clothing*, 2001

Passive smart
only sense

Active smart
sense and react

Very smart
sense, react and adapt

Intelligent
capable of responding or activated
to perform a function

Smart textiles or E-textiles

Popular conception appears to equate “Electronic textiles (E-textiles)” with “Smart textiles”

- Wikipedia equates the two terms

At a recent industrial workshop, no one knew of a “smart” textile that did not incorporate an electronic component

But, we prefer to use the term “E-textiles” for the broad field focused on integrating electronic or digital components in textile structures (which includes wearable electronics or wearable computing)

...and that is an area of our focus

The Original Smart Textile



©Colourbox



@VentileFabrics

Developed in *ca.* 1943

Extra-long cotton staple fibers spun into low-twist yarns, which are then tightly woven

Exposure to water causes the fibers to swell, which then blocks water penetration

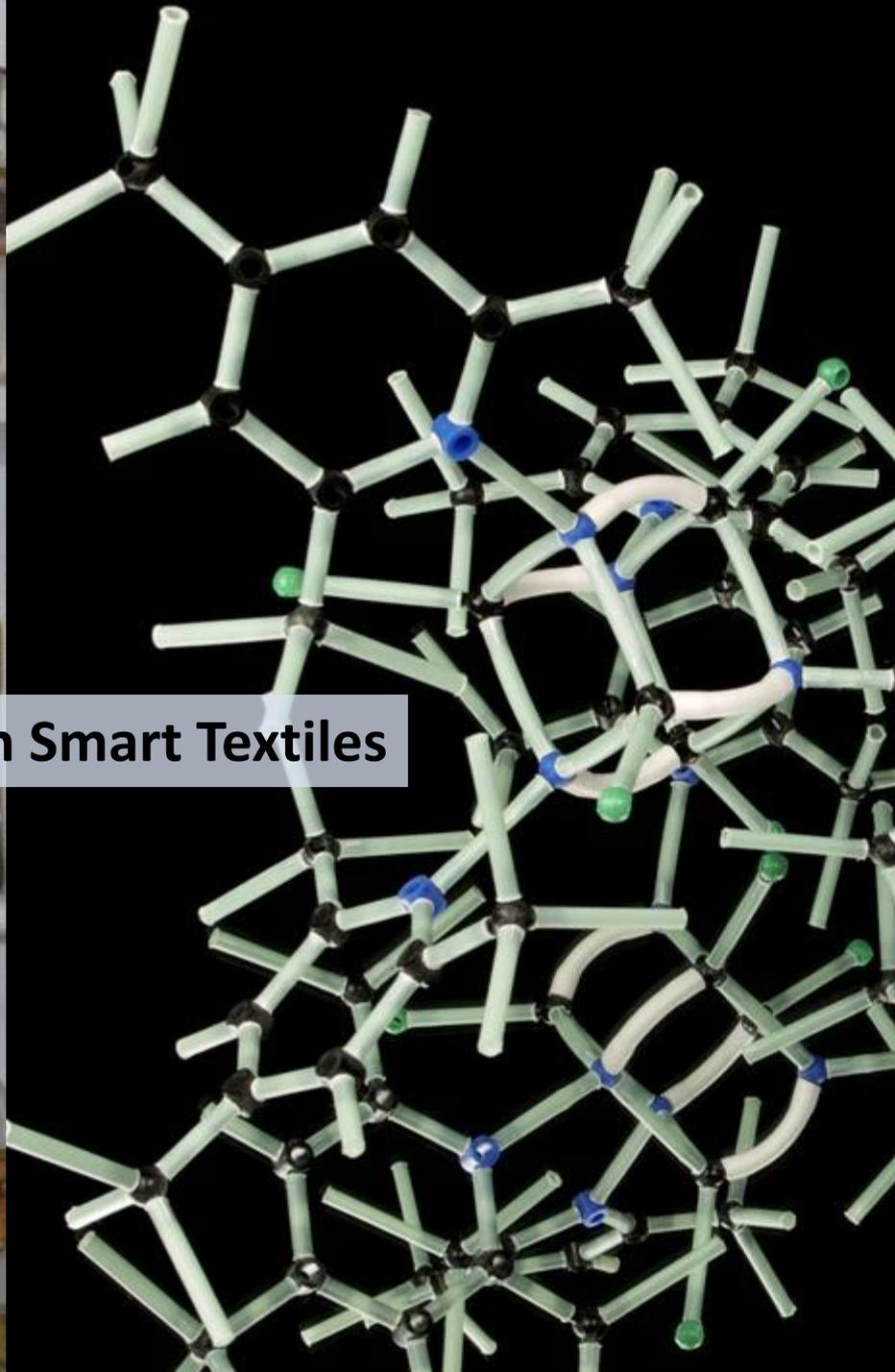
Thus, water repellency may be achieved without the use of any finish

E-textiles and Smart textile challenges

- Water is still a problem
 - Components and connections can't withstand normal usage
- Cost
 - Raw material
 - New production techniques
- Recyclability – Sustainability
 - Valuable components, difficult to recycle
- Integration
 - A rigid structure ruins the handle of the textile

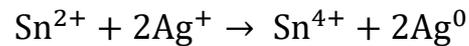


Our research in Smart Textiles

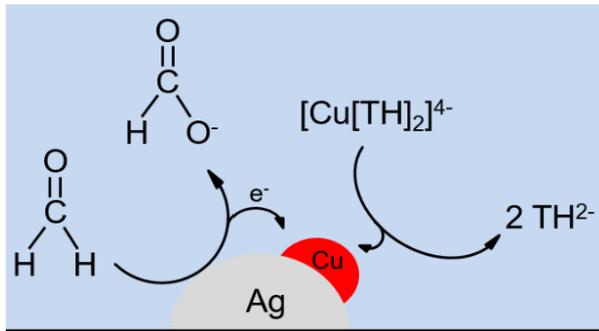


Currentless Cu deposition on cellulose fabrics

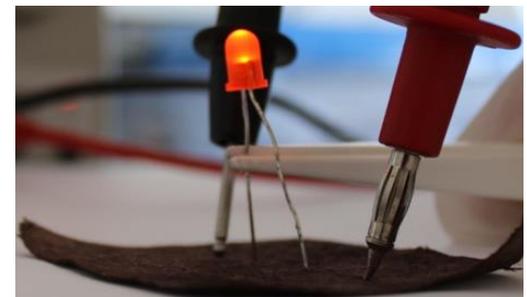
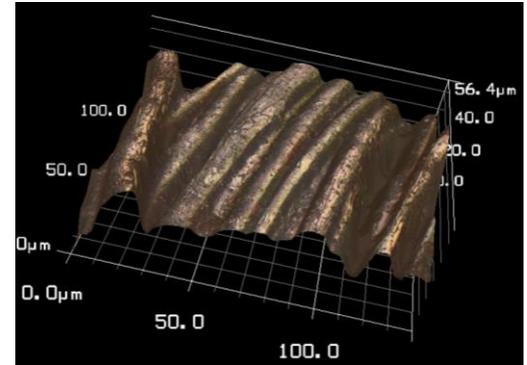
- Seed formation



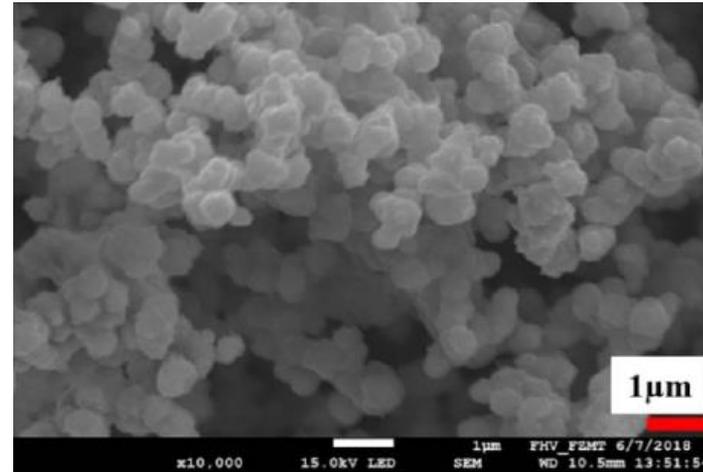
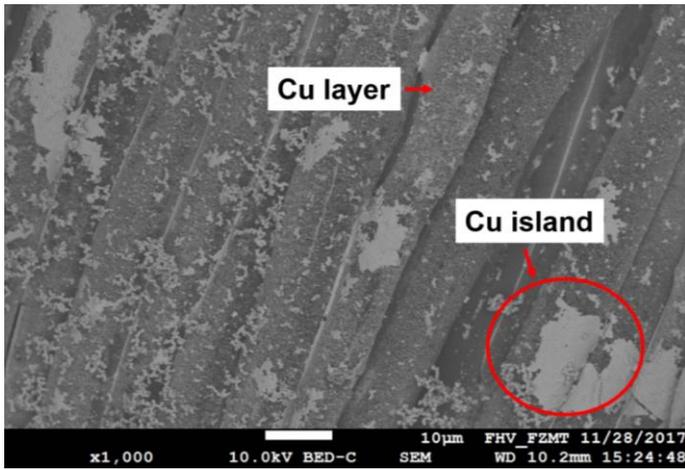
- Metal deposition on nanosized seed template



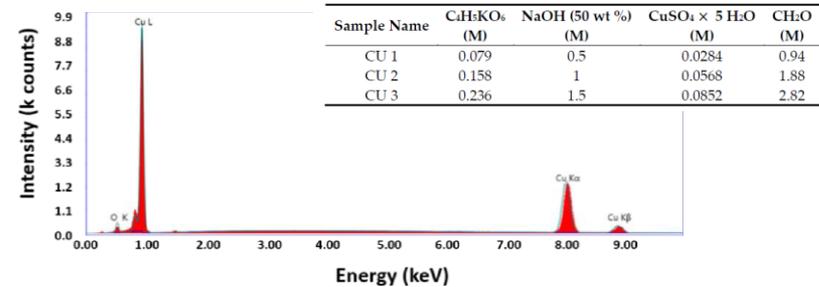
- Very high ratio between total fibre and conductive layer contents
- Nano-sized conductive layer thickness



Cu formation on cellulose fibre surface

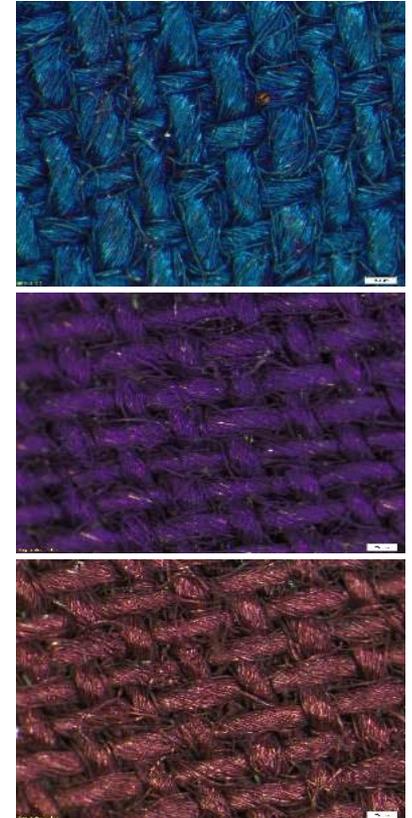
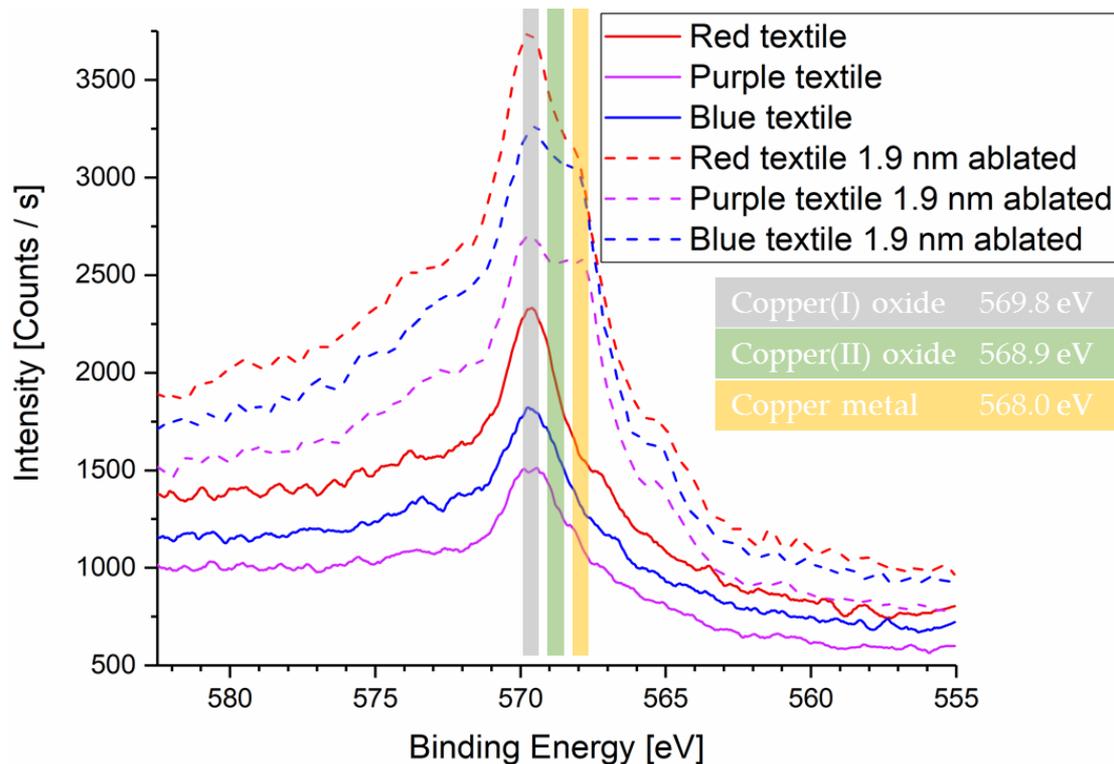


W. Root et al, *Surface & Coatings Technology* 348 (2018) 13–21
 W. Root et al, *Polymers* 2019, 11, 784



Color effects as results of

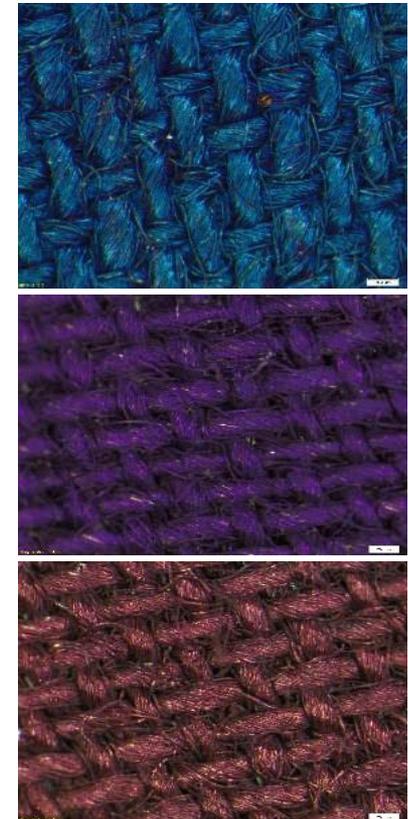
- Differences in particle sizes and structures of copper deposits
- Physical effects such as surface plasmon resonance, Rayleigh scattering, etc.



Color – Electrical conductivity

- Color of deposited copper changes as function of pre-treatment, bath temperature and duration of treatment
- The effects are related to differences of particle size and structure of deposits
- The electrical conductivity is sensitive to particle size and deposit structure

| Color (deposition time) | Primary Particle size [nm] | Ag content [mg/g sample] | Cu content [mg/g sample] | Sheet resistance [Ω /square] |
|-------------------------------|----------------------------------|-----------------------------|-----------------------------|---|
| Red (30 min) | 35 \pm 4 | 18.6 \pm 0.3 | 159.1 \pm 2.4 | 3.23 |
| Purple (48 min) | 58 \pm 8 | 20.4 \pm 0.5 | 170.1 \pm 2.4 | 0.93 |
| Blue (72 min) | 80 \pm 9 | 18.0 \pm 0.2 | 174.5 \pm 3.1 | 0.57 |

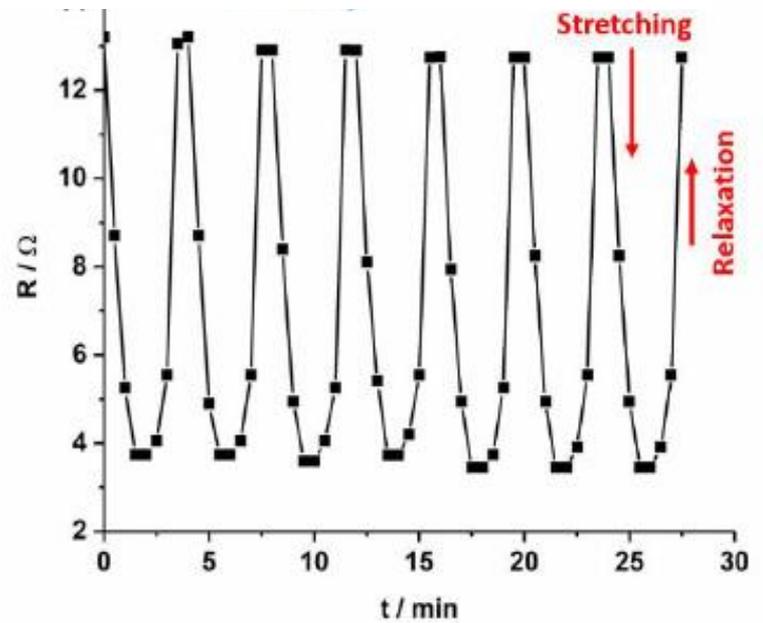
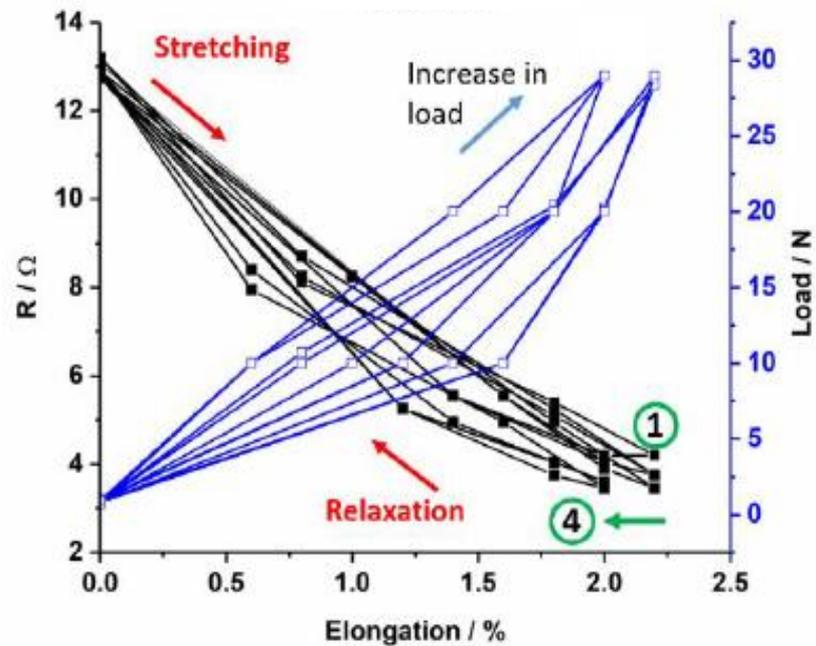


[1] W. Root et al, *Surface & Coatings Technology* 348 (2018) 13–21

A glowing lightbulb with a filament, set against a dark background. The text "Resistance is the new conductivity" is overlaid on the bulb.

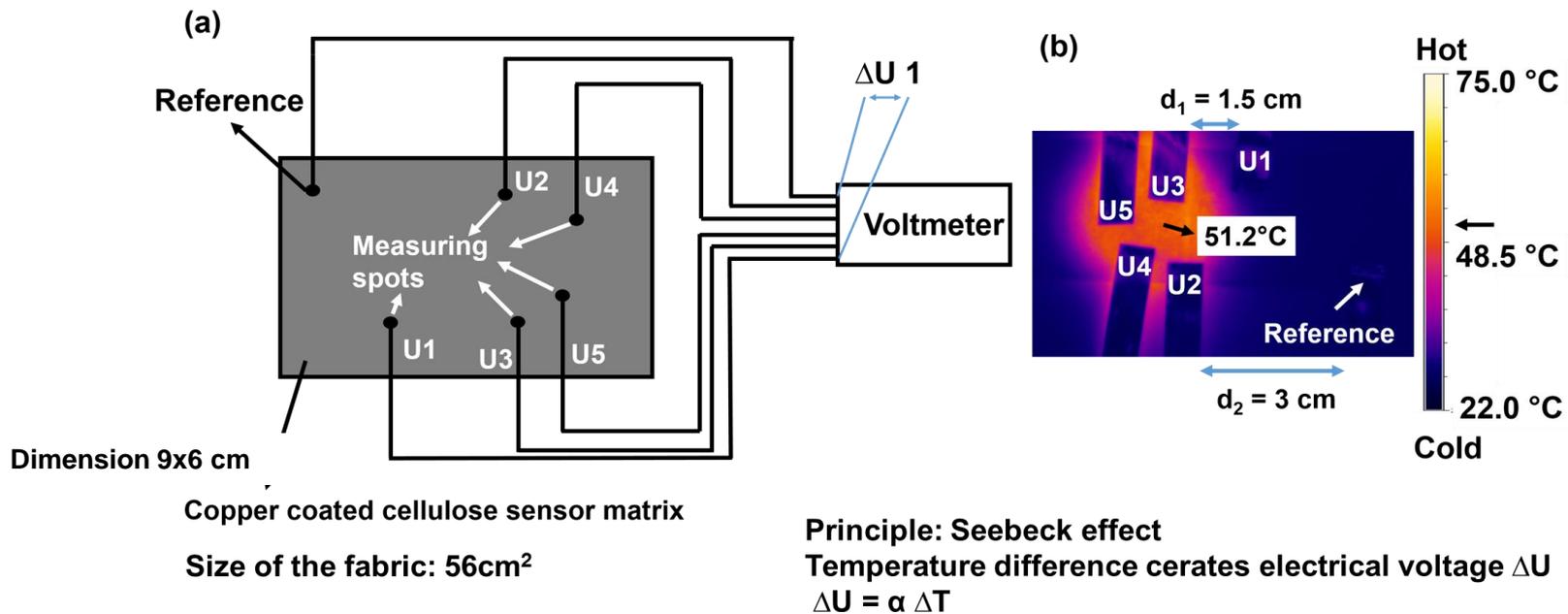
Resistance is the new conductivity

Application as strain sensor



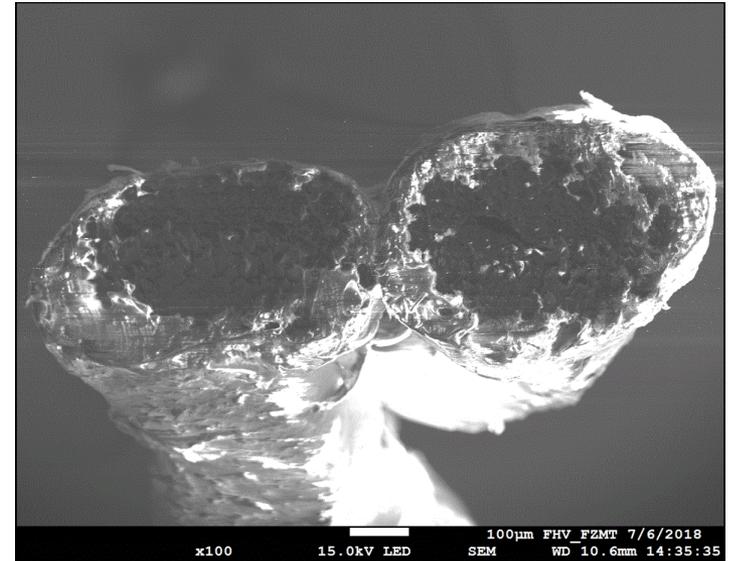
W. Root et al, *Polymers* 2019, 11, 784

Application as multipoint temperature sensor



Development and characterization of fibre-based pressure sensors

- Pressure sensors that can be integrated into textiles structures
- Capacitive pressure sensors based on layered structures often influence textile properties negatively.
- strand-based sensors are a promising strategy for the production of lightweight and easy-to-integrate textile sensors that preserve the flexibility and elasticity of the substrate
- Fibres sensor formation:
 - Cotton fibre + coating Carbon-Nanotubes + SBR-Insulation



Development and characterization of fibre-based pressure sensors

Early stage development of gesture/motion recognition

Field of application:

Automotive, communicative, medical and sports



Smart Textiles in the Health Sector

VASCage



R&D CENTRE

VASCage is a new and unique R&D Centre on Vascular Ageing and Clinical Stroke Research.



SCIENCE MEETS INDUSTRY

We combine the international expertise of top scientists and leading research companies.



OUR VISION

Our vision is to extend the lifespan free of disability, the healthspan.



OUR STRENGTHS

- > outstanding clinical and epidemiological expertise
- > the alliance with several large hospitals
- > broad access to patients
- > an own clinical trial platform



OUR SHAREHOLDERS

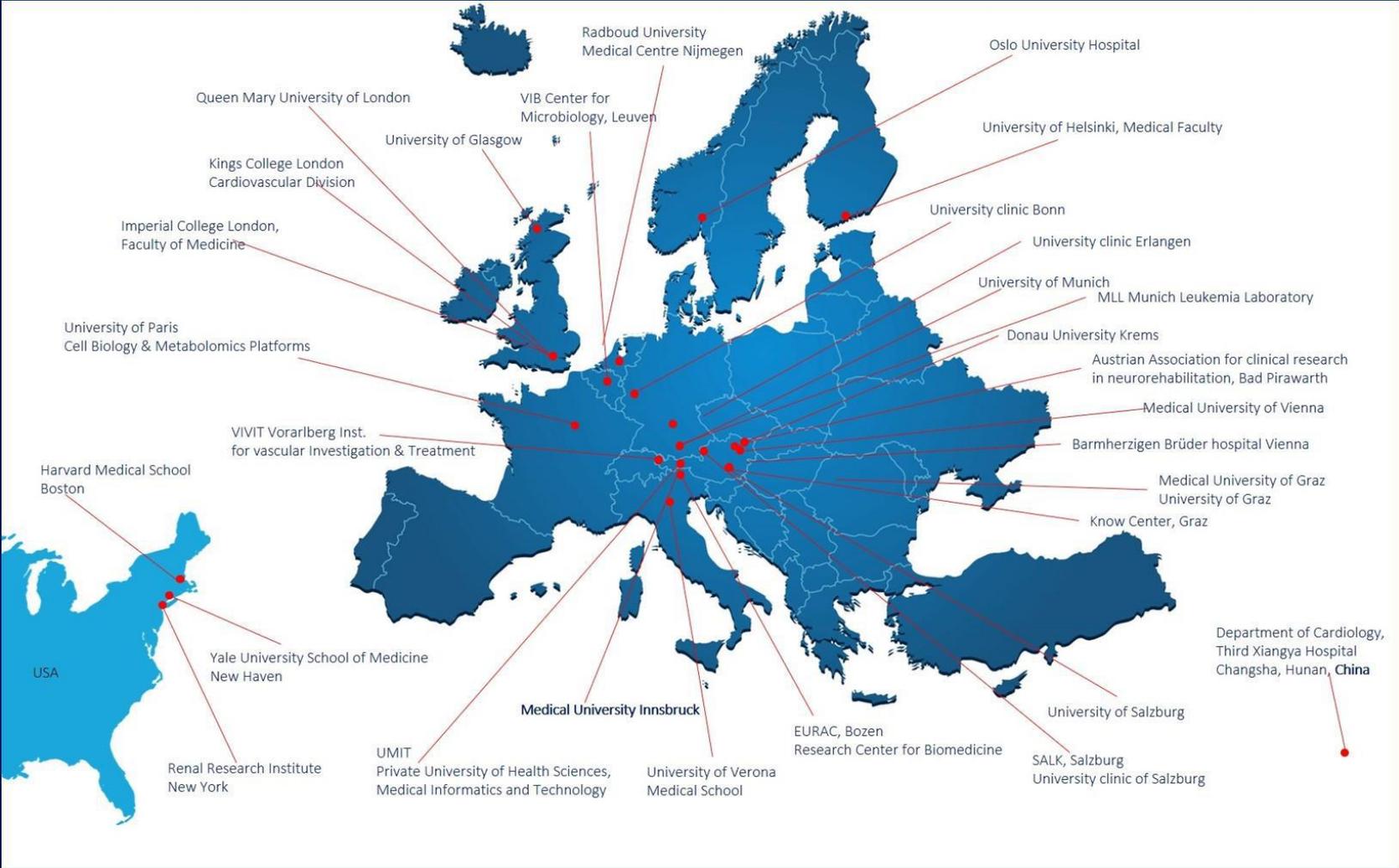
- > Medical University of Innsbruck
- > University of Innsbruck



OUR FIGHT AGAINST STROKE

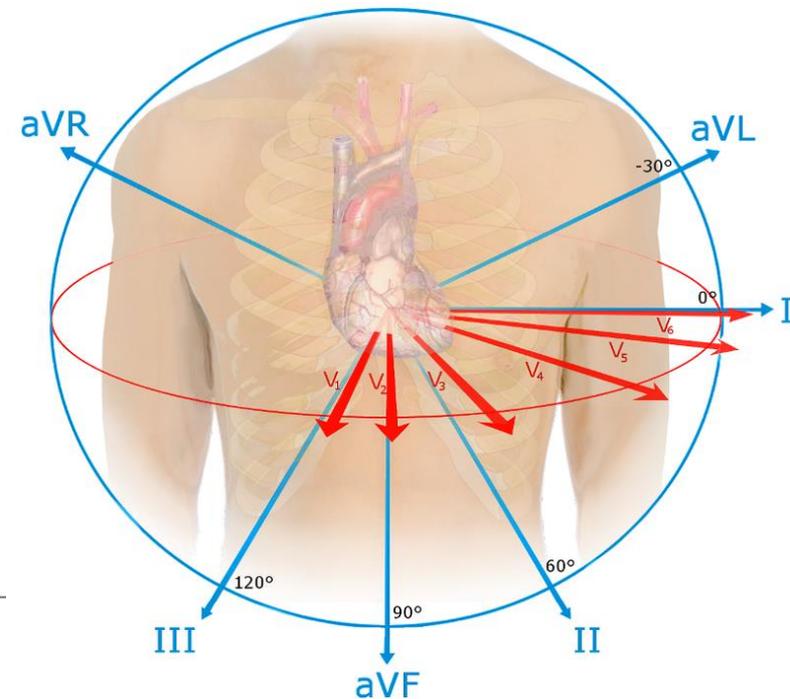
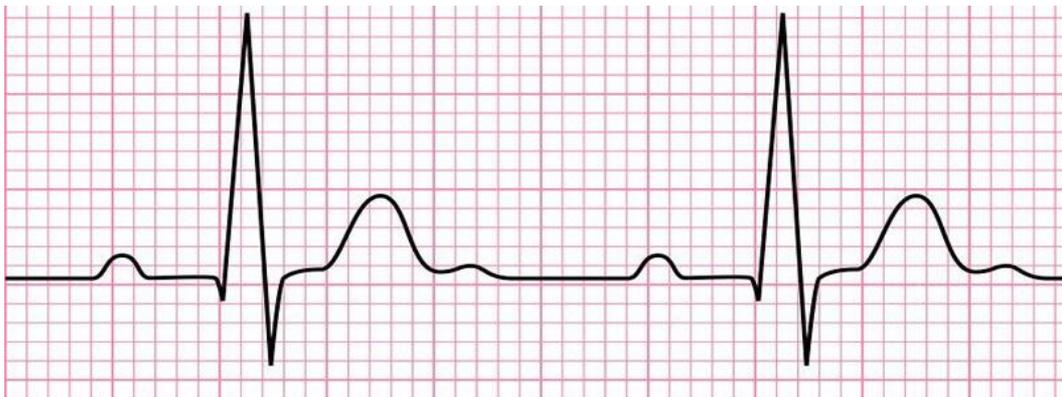
- > ambitious prevention programs
- > improving diagnosis, therapy and rehabilitation
- > enabling better coping with the effects of stroke

Consortium



Sensor Shirt Development for ECG measurement

- Detailed description of the heart beat
 - Clear breakdown of the 4 chambers
- Mobility and long term monitoring
 - No restriction on the users
- Intended use: Hospital and home patients

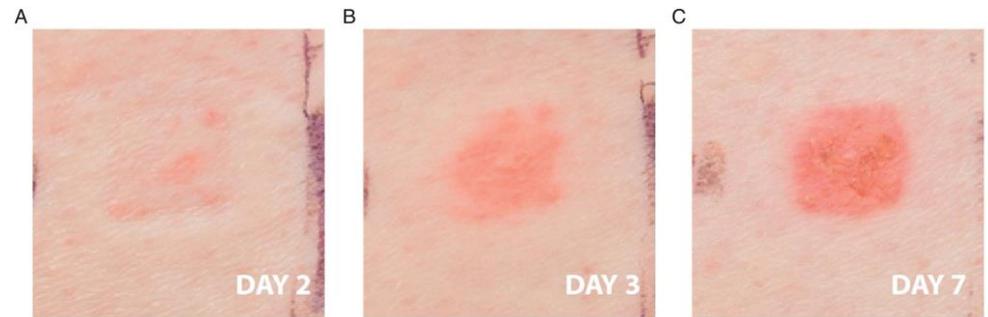


Problem with conventional electrodes

- Long term monitoring
- Problem with conventional electrodes



Suction electrode

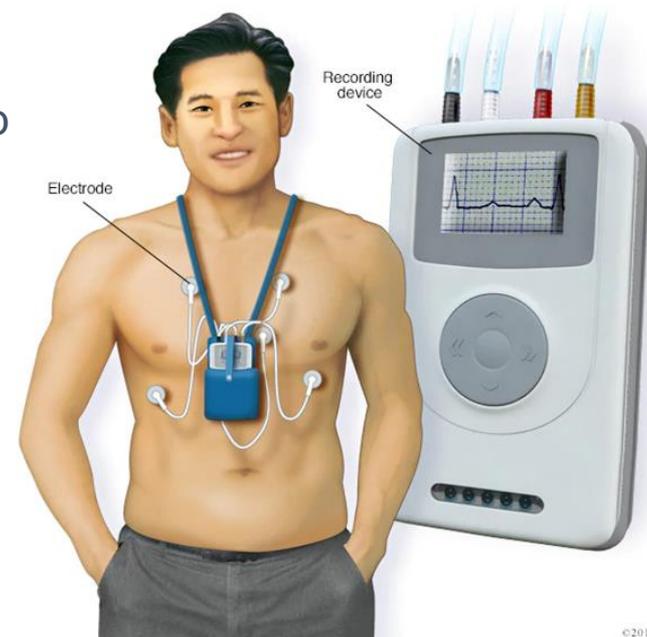


Wet electrode

Electrode development



- Dry electrode has reduced skin irritation
- Integration of electrical components into the textile structure
- Medical trials are being undertaken



Thank you and any questions?

 Bundesministerium
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Energie, Mobilität,
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 Bundesministerium
Bildung, Wissenschaft
und Forschung



Land  Wien



FFG
Promoting Innovation.

