FACULTY OF ELECTRICAL ENGINEERING
UNIVERSITY OF WEST BOHEMIA

RICE

Faculty of Electrical Engineering
University of West Bohemia
Pilsen, Czech Republic

Hlavní směry materiálového výzkumu na FEL

doc. Ing. ***Radek Polanský****, Ph.D.*

Inteligentní specializace regionu (ISR 2021)

Paralelní jednání krajských oborových inovačních platforem

Chytré textilie

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Smart textiles – target applications

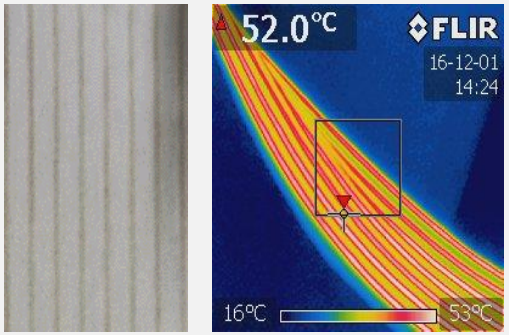
Protective clothing

- Smart protective suit and glove with integrated sensor system
- Boot with integrated inertial localization system.

Home and health care

- Smart bed sheet including evaluation electronics for patient monitoring (in 2 zones integrated presence sensors, motion detection & humidity sensors).

Well-being, IoT



Washable knitted heating textiles for well-being and automotive applications.

Printed and embroidered antennas for IoT applications.

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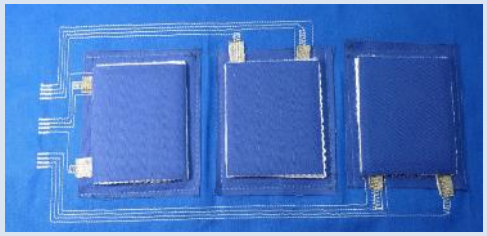
Home and health care applications

Smart leg sleeve

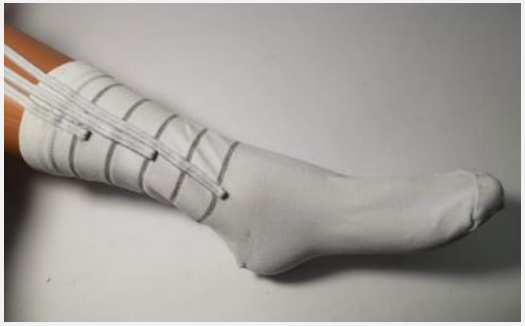


Textile pressure sensors

Smart leg sleeve with sensors

- Smart compression leg sleeve with integrated pressure sensors to increase the effectiveness of compression therapy of leg ulcers
- Continuous measurement at 3 points, IoT network, cloud server – web based front end application.

Leg edema measurement



Textile strain sensors knitted into socks.

Thread based on blending of stainless steel fibers with textile fibers developer in close collaboration with VUB Company.

- Monitoring of the edema throughout the day without any limitation in patients motion.
- Specially designed socks with the strain gauge effect.

Measurement of skin hydration

Textile based sensor system for continuous measurement of skin hydration.

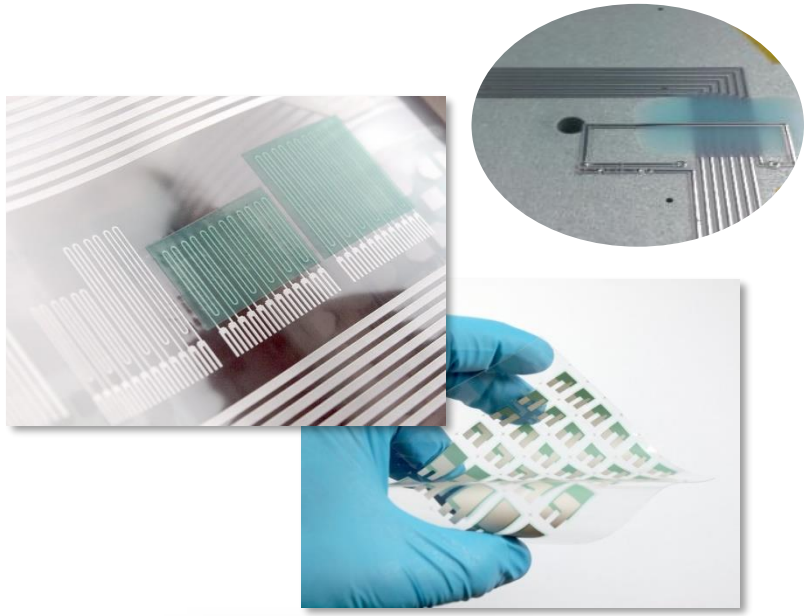
- System developed for continuous monitoring of skin hydration (e.g. eczema treatment).
- The sensor is printed on a textile substrate (capacitive measurement)

Tištěná elektronika & Senzory

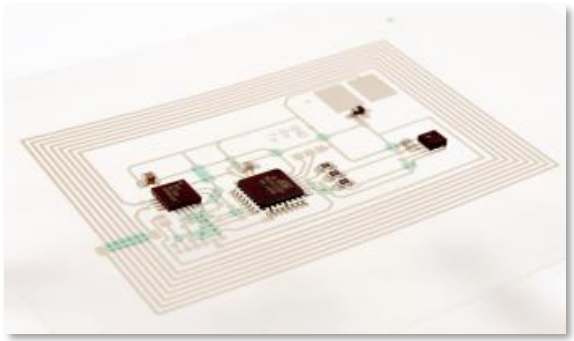
Printed electronics components

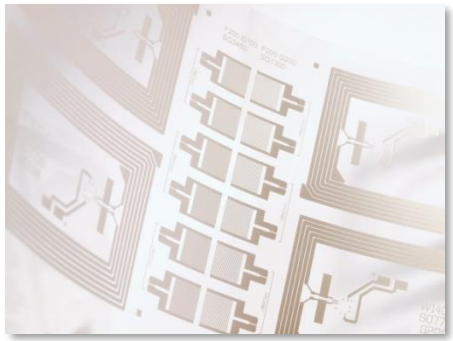
Printed electronics applications

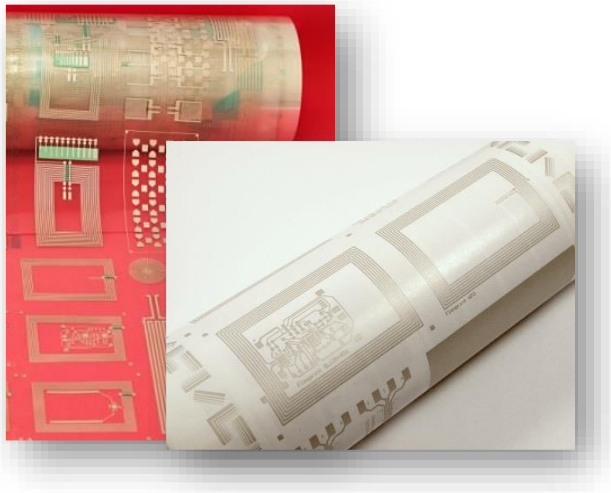
- **Components**
  - Passives – R, L, C
  - Active - transistors
  - Antennas – HF, UHF
  - Sensors – T, RH, chemical



- **System-on-Foil**
  - Hybrid T+RH labels
  - ID system on metal holograms



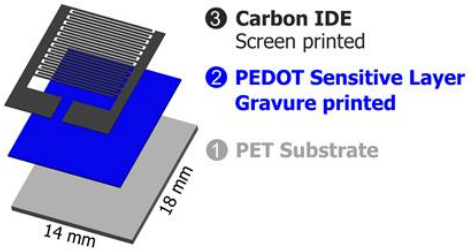


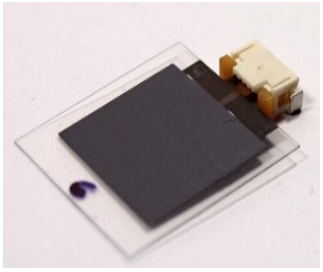


Printed sensors

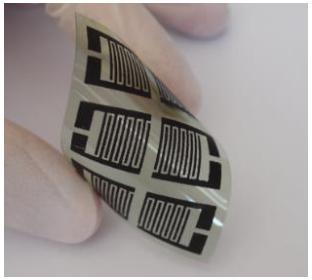
Developed printed sensors

- Low-cost fabrication (screen printing, airbrush, dispensing, Aerosol-Jet)
- **Planar flexible sensors** suitable for integration into smart labels and packages
- Chemoresistive and electrochemical principle
- **Organic materials – biodegradable sensors**

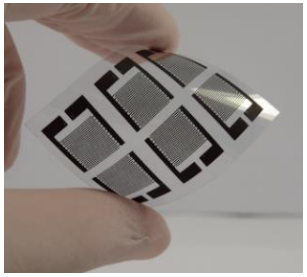




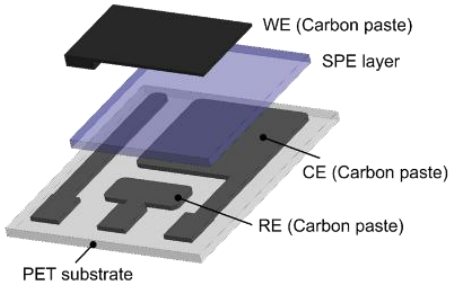
Temperature sensor
(Flexible NTC thermistor)

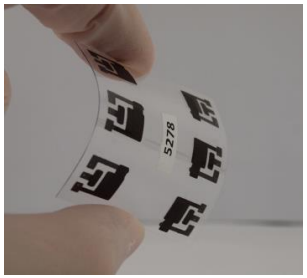


Ammonia sensor
(Chemoresitive)

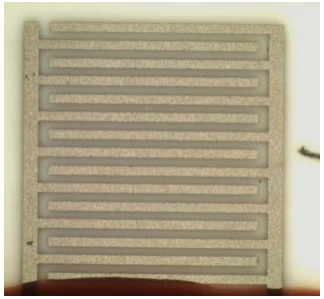


Humidity sensor
(Chemoresitive)

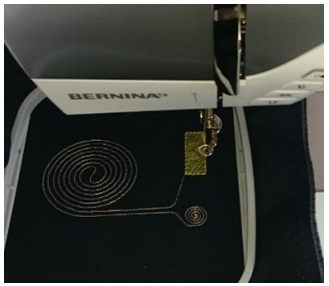




Nitrogen oxide sensor
(Electrochemical)



Ammonia sensor
(based on CNTs)



Embroidered
temperature sensor

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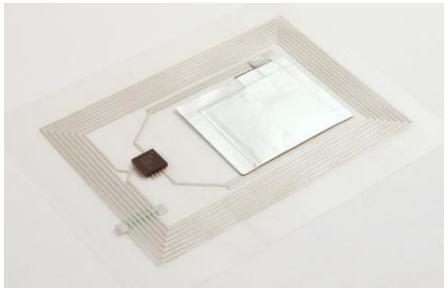
Printed electronics systems

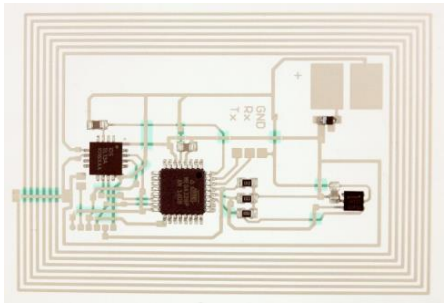
Hybrid system printed on foil

- **Flexible RFID sensor tags** for smart labels, smart packaging, logistics and IoT
- Including **data logging** and android application for **data visualization**
- Smart labels for:
  - **Temperature logging**
  - **Temperature and relative humidity logging**

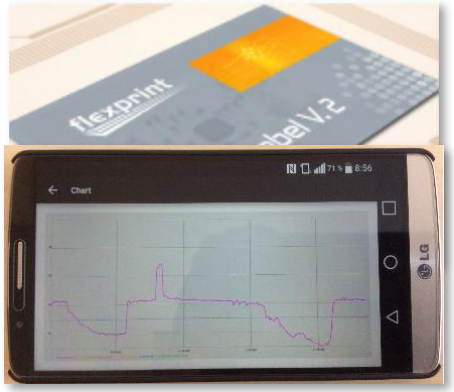


Smart label for temperature logging

Smart label android application



Smart label for temperature and relative humidity logging



Smart label android application with data history visualisation

Tištěné substráty pro výkonové moduly

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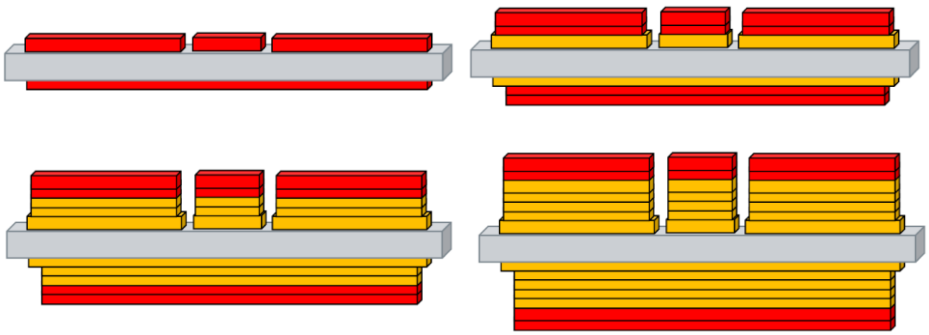
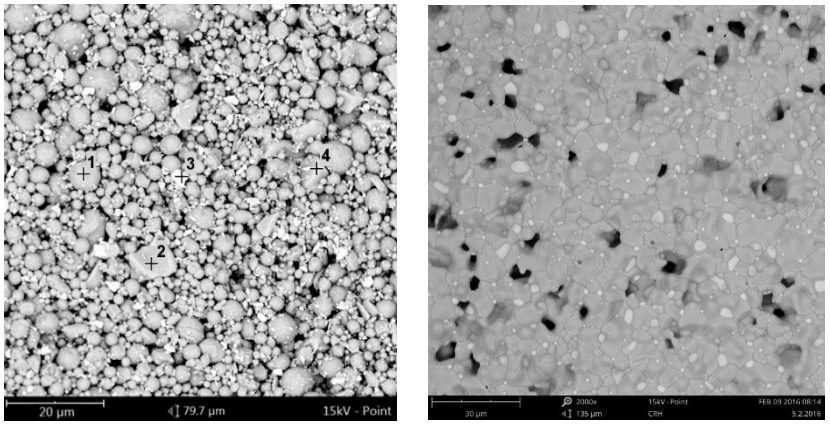
Thick Printed Copper Technology (TPC)

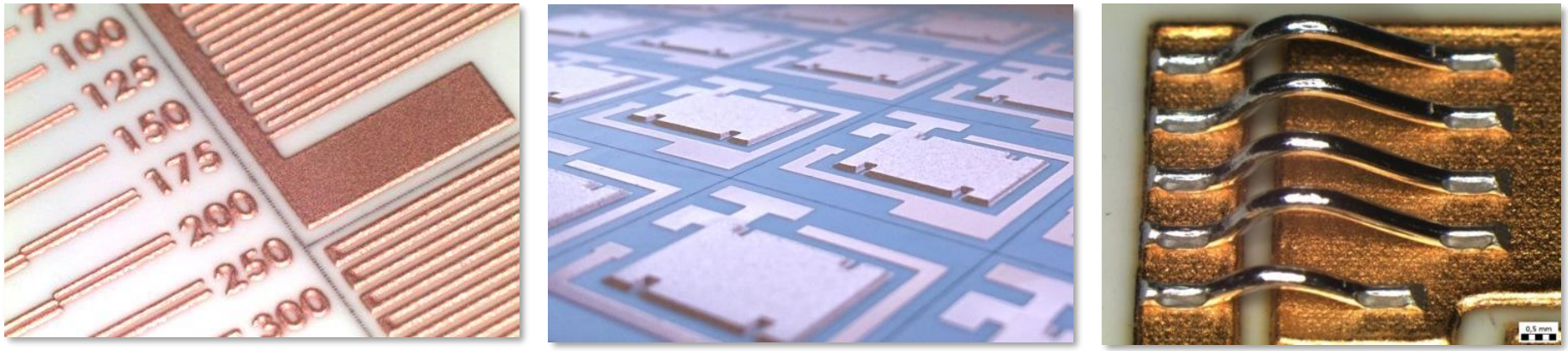
New opportunities for designers.



Sequentional printing and firing of Cu paste.



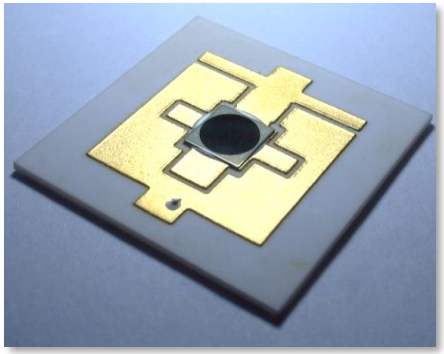
Cu paste before and after firing.



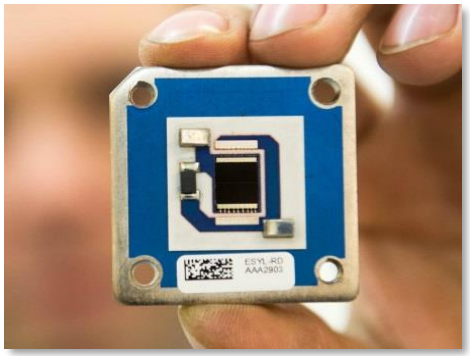
Examples of substrates made by TPC technology.

Examples of modules based on TPC

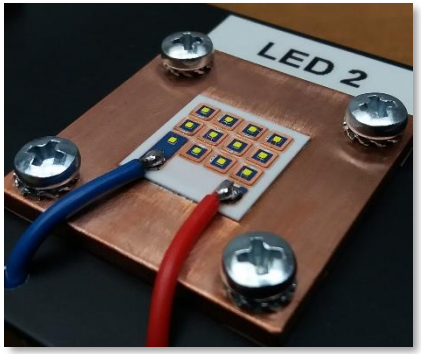
Examples of power modules based on developed TPC technology:



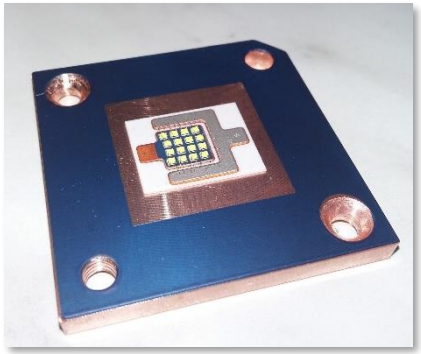
2 W CPV receiver.



15 W CPV receiver.



37 W LED module.



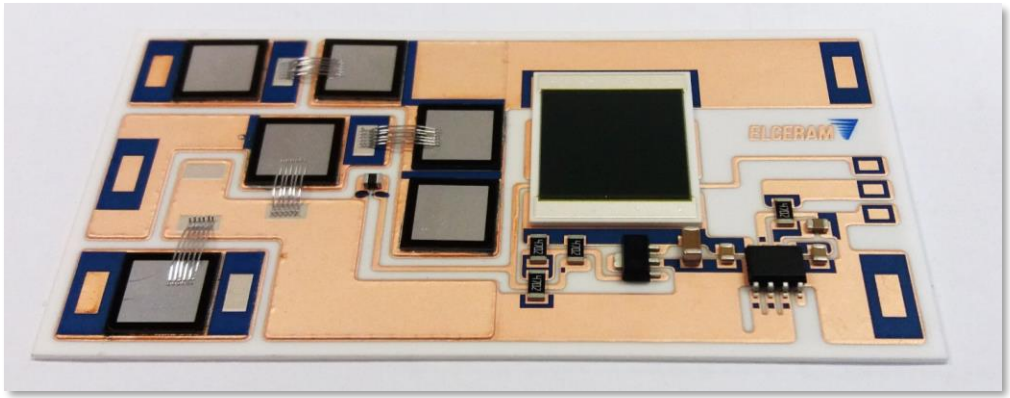
50 W LED module.

LED module for car headlight – blinker + daytime running lamp

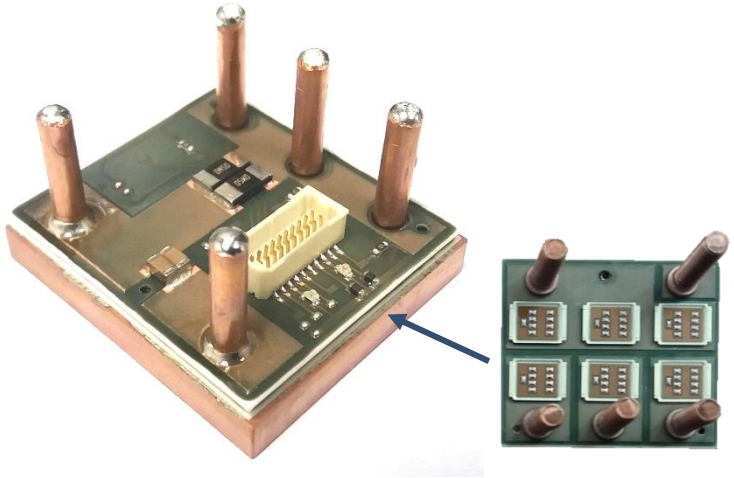
LED module for car headlight – High beam lamp

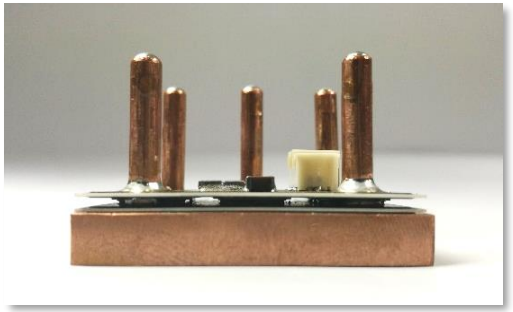
Examples of modules based on TPC

Examples of smart modules based on developed TPC technology:



Smart 3-phase rectifier with integrated temperature and current monitoring (max. current 100 A).





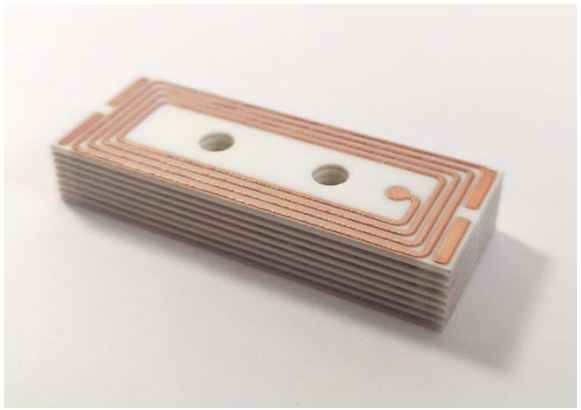
3-phase MOSFET regulator for BLDC motors (max. current 200 A, 36 V).

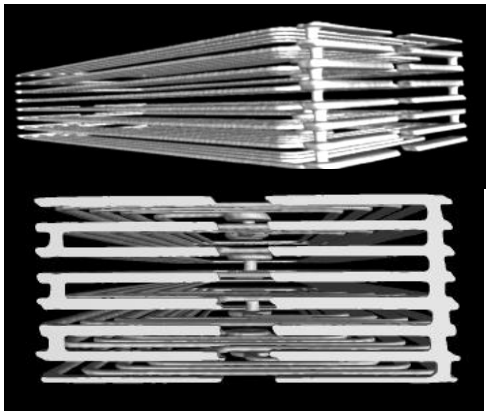
New posibilities of TPC technology

TPC stacking:

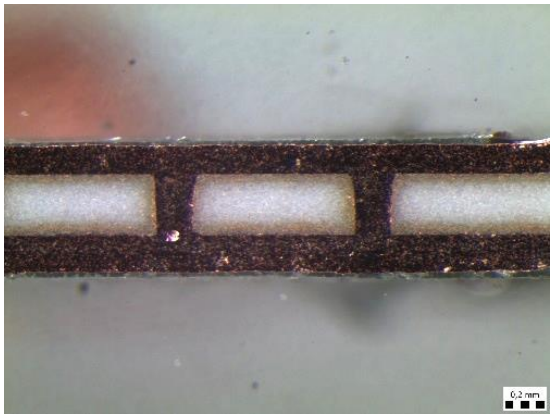
Tested stacking of individual TPC substrates using bridges made of sintered Cu paste:

- Direct connection using Cu paste
- Connection via Cu paste and Cu foil
- Connection via additional TPC substrate
- High resistance against temperature shock cycling (1000 cycles -40 °C / +125 °C, no delamination)
- High adhesion (average 37,9 N/mm^2)
- Application – magnetic sensor coils for fusion reactors (Tokamacs).





Stacking of substrates.

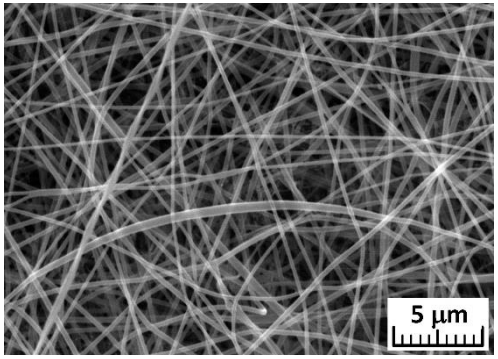


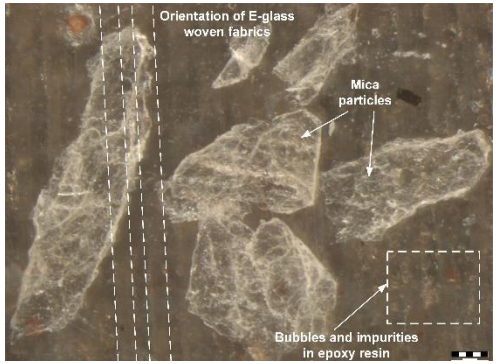
Cu plated vias.

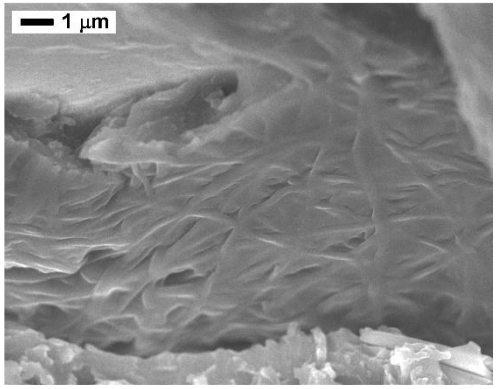
Polymerní kompozitní materiály (PMCs)

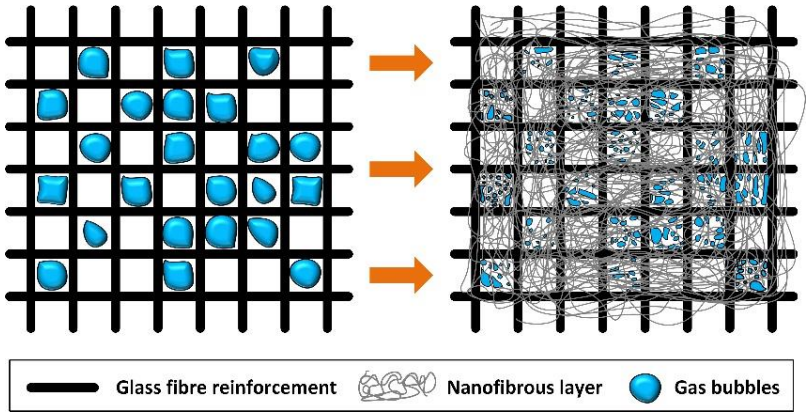
Electrospun Nanofibres in PMCs

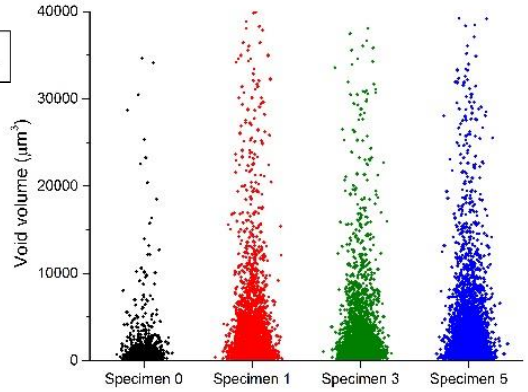
- Investigation the influence of electrospun nanofibres on the properties of glass-fibre-reinforced composites.
- Electrospun nanofibres can be made from variety of polymers or from inorganic materials.
- Electrospun nanofibres can serve as a tool for controlling the gas bubble size distribution in fibre/thermoset-matrix composites.





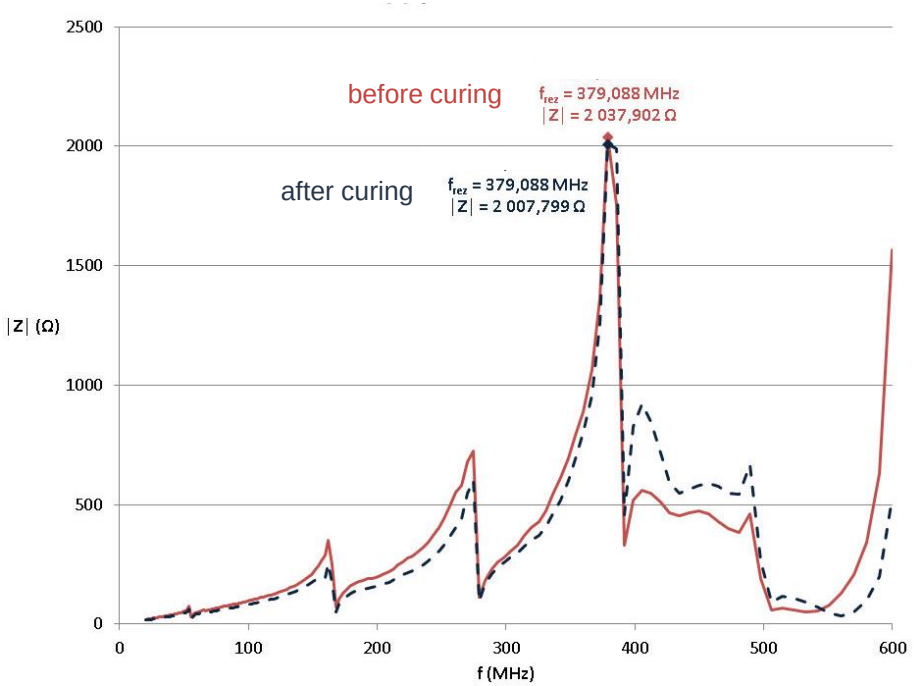






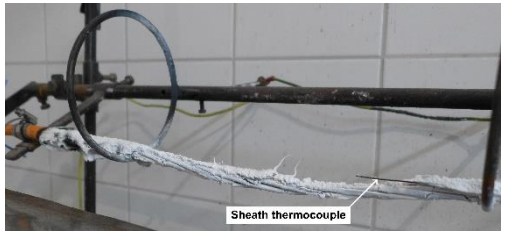
Smart PMCs

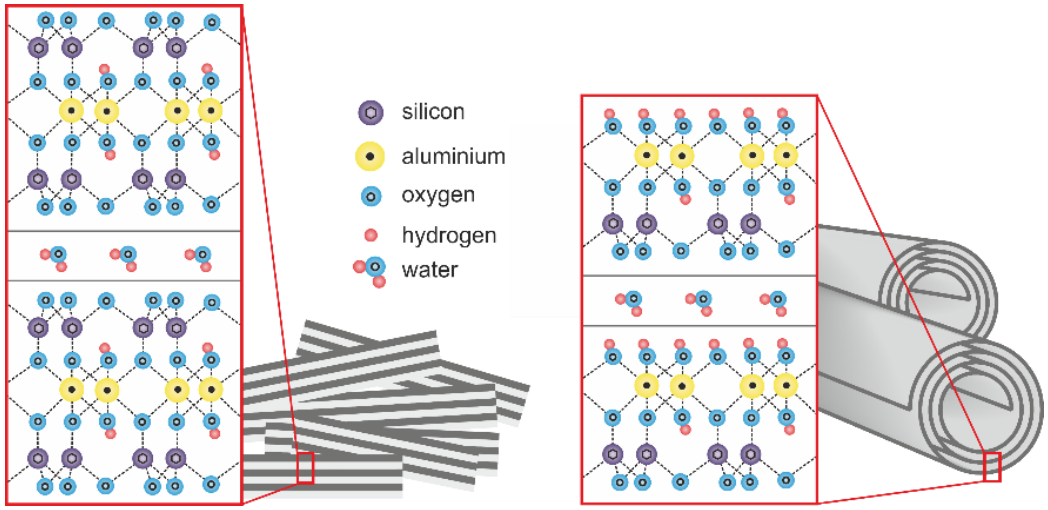
- Embroidered Conductive Metal-Polymer Fibers
- Contacting of „conductive ribbons“ to the embroidered antenna structures by resistance welding.
- Efficient and rapid embroidering of entire electronic assemblies (e.g., *temperature* and *vibration sensors*, *antennas*, *heating elements*) into the structure of composite materials.

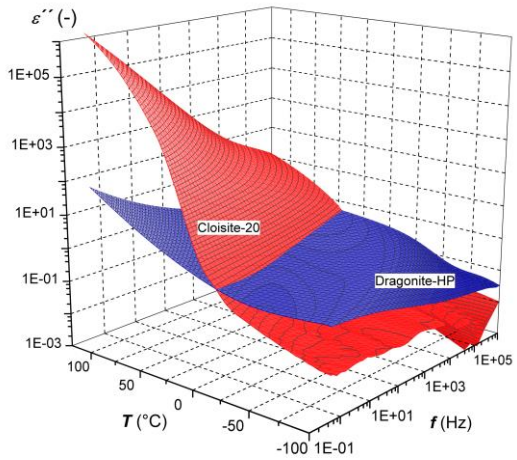


Halloysite Nanotubes in PMCs

- Investigation of application possibilities of aluminosilicates (halloysite nanotubes, organically modified montmorillonite) in electrical engineering.
- Influence analysis of the incorporation of aluminosilicates as additives in electrical insulating materials.
- Exploring the thermal, dielectric, structural and microstructural properties of tested clay minerals or composite structures.







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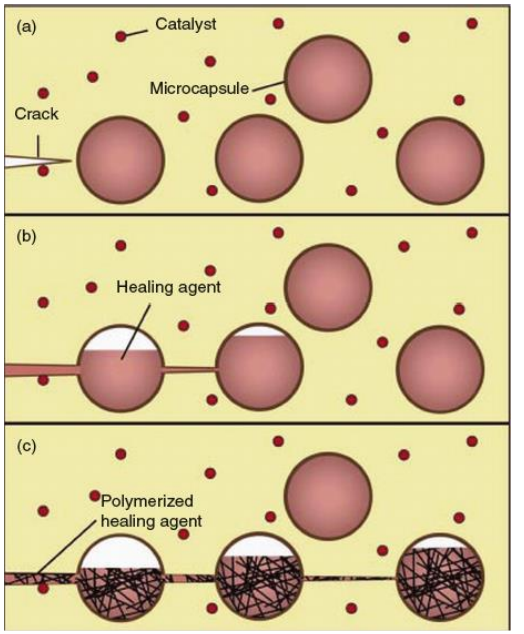
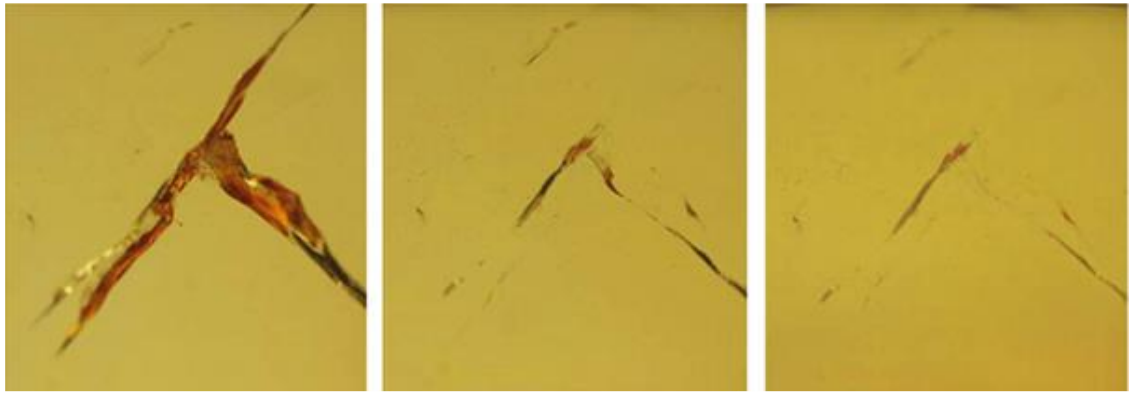
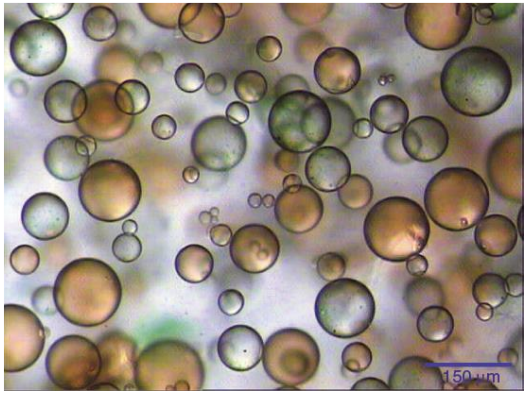
Self-healing Electrical Insulating Materials

- Investigation of application possibilities of self-healing materials in electrical engineering.
- Materials selection, design, and characterization of their respective properties.
- Application of phenomenological and structural methods of diagnostics.







Thank you for your attention

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