



EUROPEAN UNION  
European Structural and Investment Funds  
Operational Programme Research,  
Development and Education



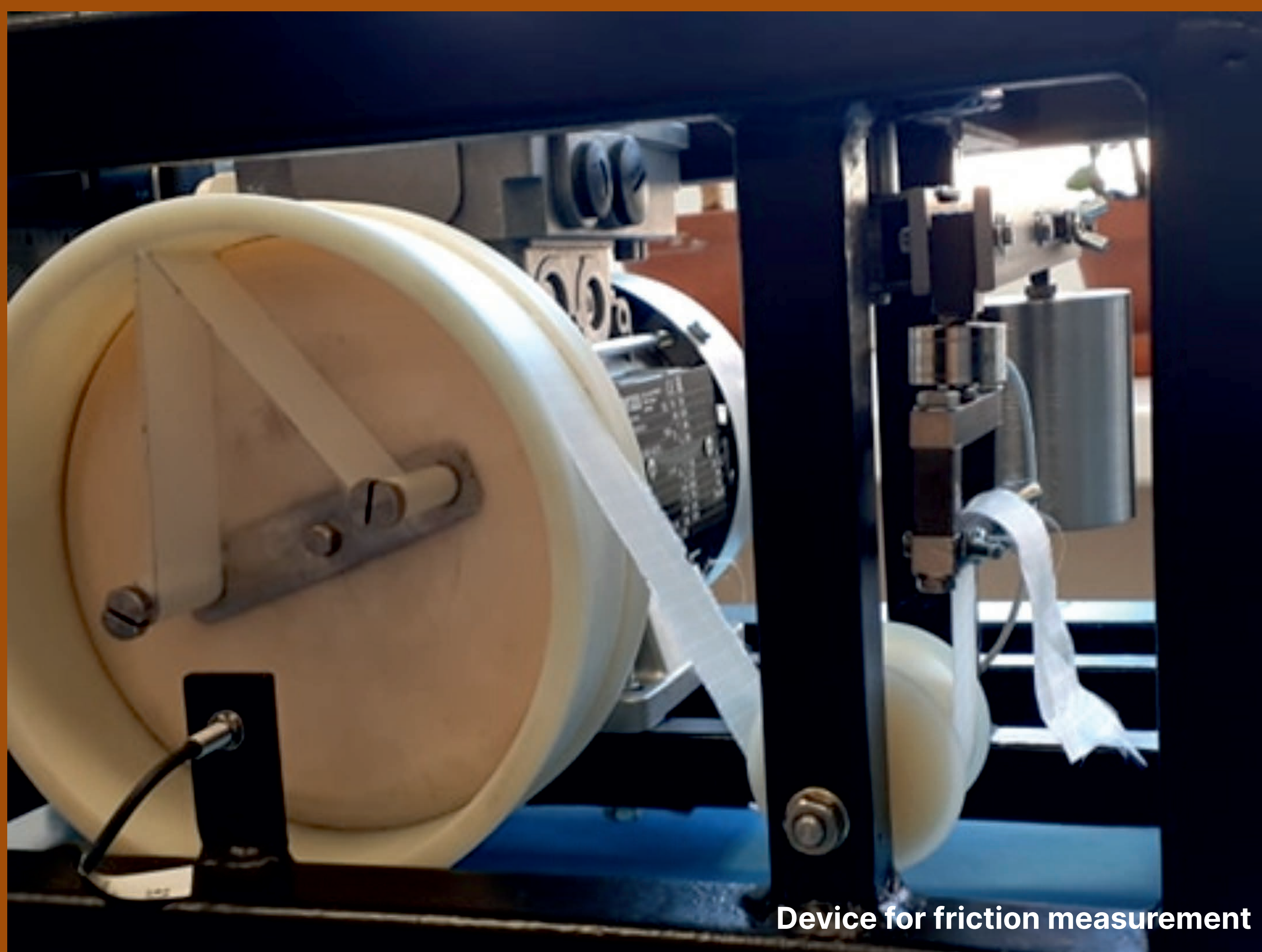
TECHNICAL  
UNIVERSITY  
OF LIBEREC



# HY HI

## RESEARCH PROGRAMME 1 FLEXIBLE HIERARCHICAL STRUCTURES

RESEARCH ACTIVITY 1:  
ACTIVATION OF FIBROUS SURFACES AND MEMBRANES



Device for friction measurement

### OBJECTIVES

- Development of new types of membranes for barrier textiles: optimization of construction conditions of coating, electro-spinning and electro-spraying for the creation of membranes with controlled porosity and functional properties.
- Activation of fibrous surfaces for sorption and adhesion systems: activation of fibrous surfaces. Use of metal oxide particles and functionalized carbon particles.
- Designing hybrid composite fiber systems: innovation of fiber structures with a focus on the use of wastes.

### RESULTS AND OUTPUTS

- Fillers from organic and inorganic materials improving the dynamic mechanical properties of composites.
- New methods of preparation and use of carbon structures and nanoparticles of metal oxides with photocatalytic and antimicrobial effects.
- Prototype of a line for evaluation of heat propagation in extreme climatic conditions.
- Systems for improving the thermal insulation of textiles containing aerogels.
- New methods of creating super-hydrophobic surfaces with self-cleaning and photocatalytic effect.
- Prototype for measuring friction, life to failure and thermal effects.
- An adaptive neuro-fuzzy inference system model for microplastic release predictions.
- New technologies of using materials with phase changes and hydrophobic coating.
- 65 publications indexed in SCOPUS and 4 international patent applications.



TiO<sub>2</sub> nanoflowers on the surface of PES fibersknitted fabric



EUROPEAN UNION  
European Structural and Investment Funds  
Operational Programme Research,  
Development and Education



TECHNICAL  
UNIVERSITY  
OF LIBEREC

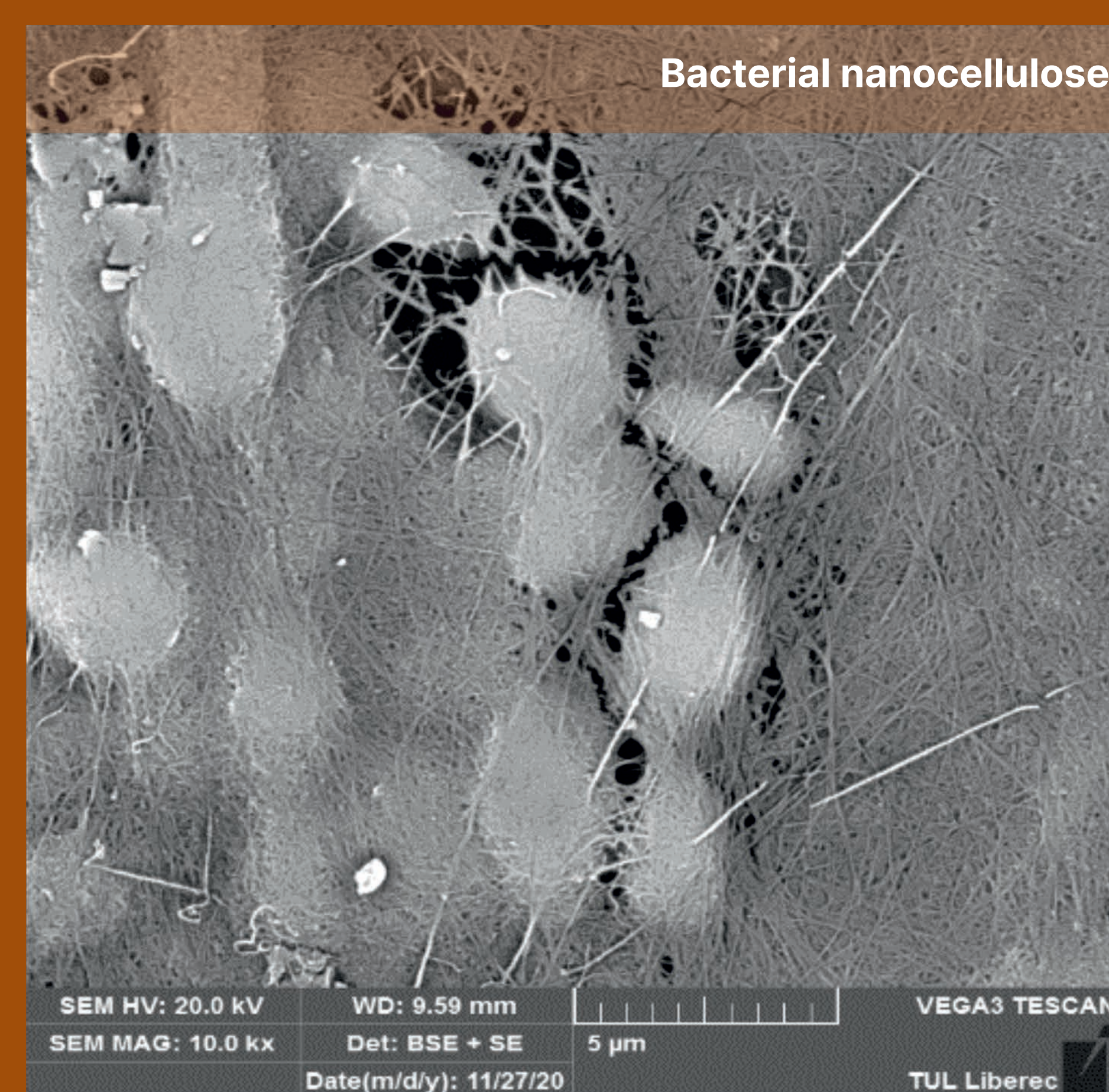


# HY RESEARCH PROGRAMME 1 HI FLEXIBLE HIERARCHICAL STRUCTURES

## RESEARCH ACTIVITY 2: FIBROUS STRUCTURES WITH SPECIAL EFFECTS

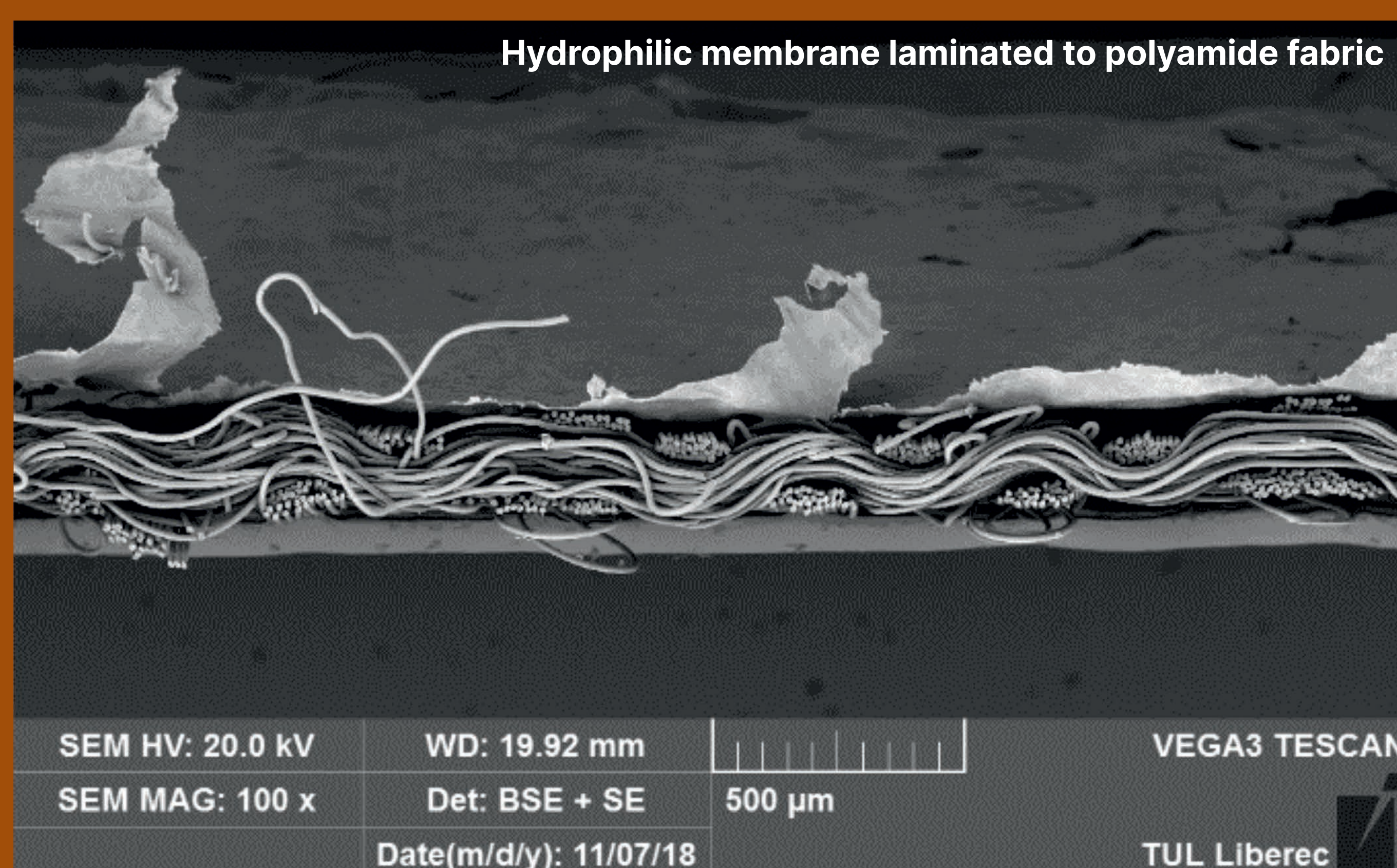
### OBJECTIVES

- Combined non-flammable treatments from waste raw materials: the development of systems ensuring the reduction of the flammability of textiles while maintaining the quality of the environment.
- Textiles limiting the absorption and emission of high-frequency radiation: the use of coated textiles to ensure increased reflectivity in the IR region. Construction of products with increased thermal insulation ability and barriers against parasitic electromagnetic radiation.
- Products with high added value using nanoparticles: development of new particle systems for multifunctional barrier structures. Use of nanocellulose particles and bacterial cellulose.



### RESULTS AND OUTPUTS

- Water droplet capture system in the air and residual aerosol analyzer.
- Treatment of textiles protecting against a wide range of bacteria and viruses containing complexly bound metal ions.
- The original device for measuring the effect of IR radiation on the speed of flame propagation.
- New methods of nanocellulose separation from the reaction medium using osmosis.
- New methods of testing composting and biodegradation of fibrous materials.
- A complex photocatalytic system for air purifiers with an optimal ratio of porosity, breathability and service life.
- Geopolymers containing inorganic fibers with high flexibility and water vapor permeability.
- 25 publications indexed in SCOPUS.





EUROPEAN UNION  
European Structural and Investment Funds  
Operational Programme Research,  
Development and Education



TECHNICAL  
UNIVERSITY  
OF LIBEREC



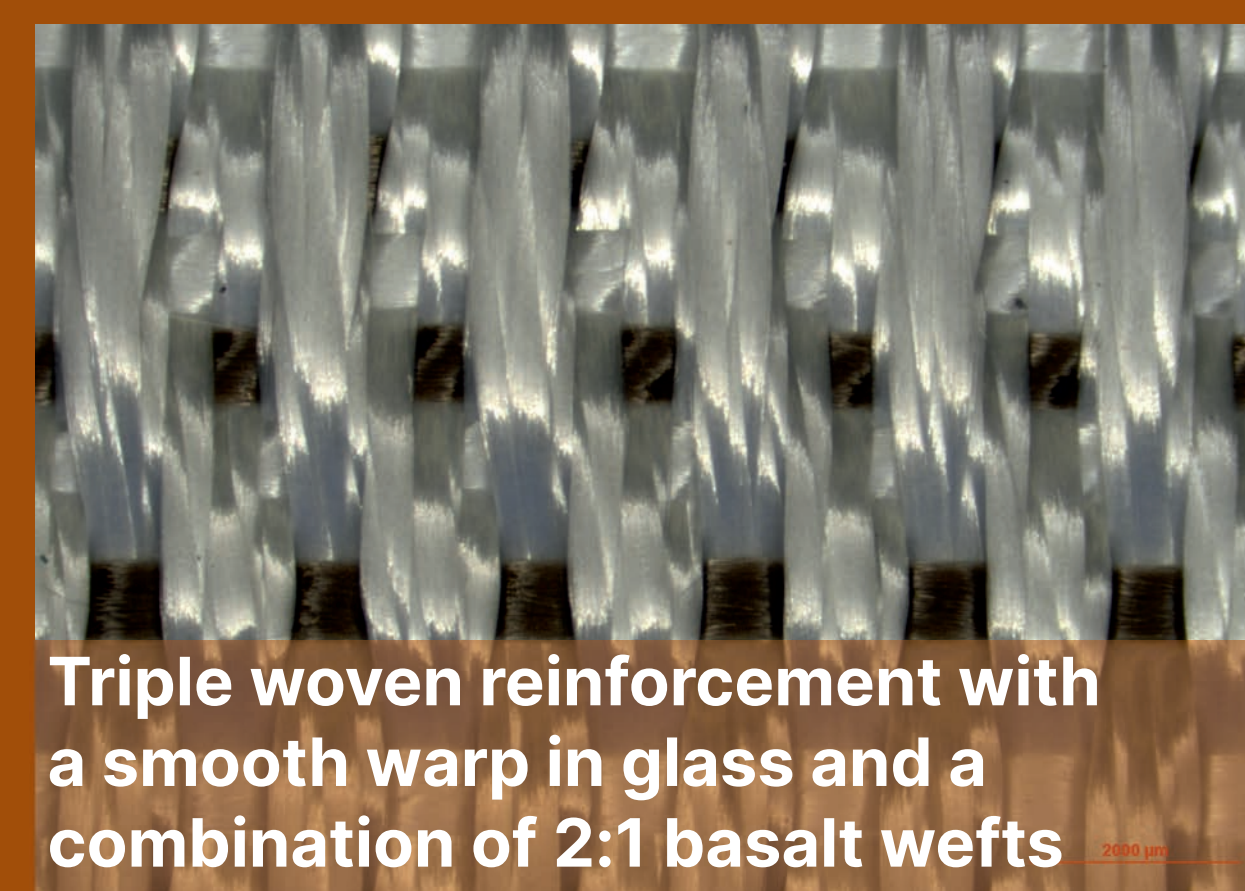
# HY HI

## RESEARCH PROGRAMME 1 FLEXIBLE HIERARCHICAL STRUCTURES

### RESEARCH ACTIVITY 3: HIGH FUNCTIONAL 2D AND 3D WOVEN AND KNITTED STRUCTURES

## OBJECTIVES

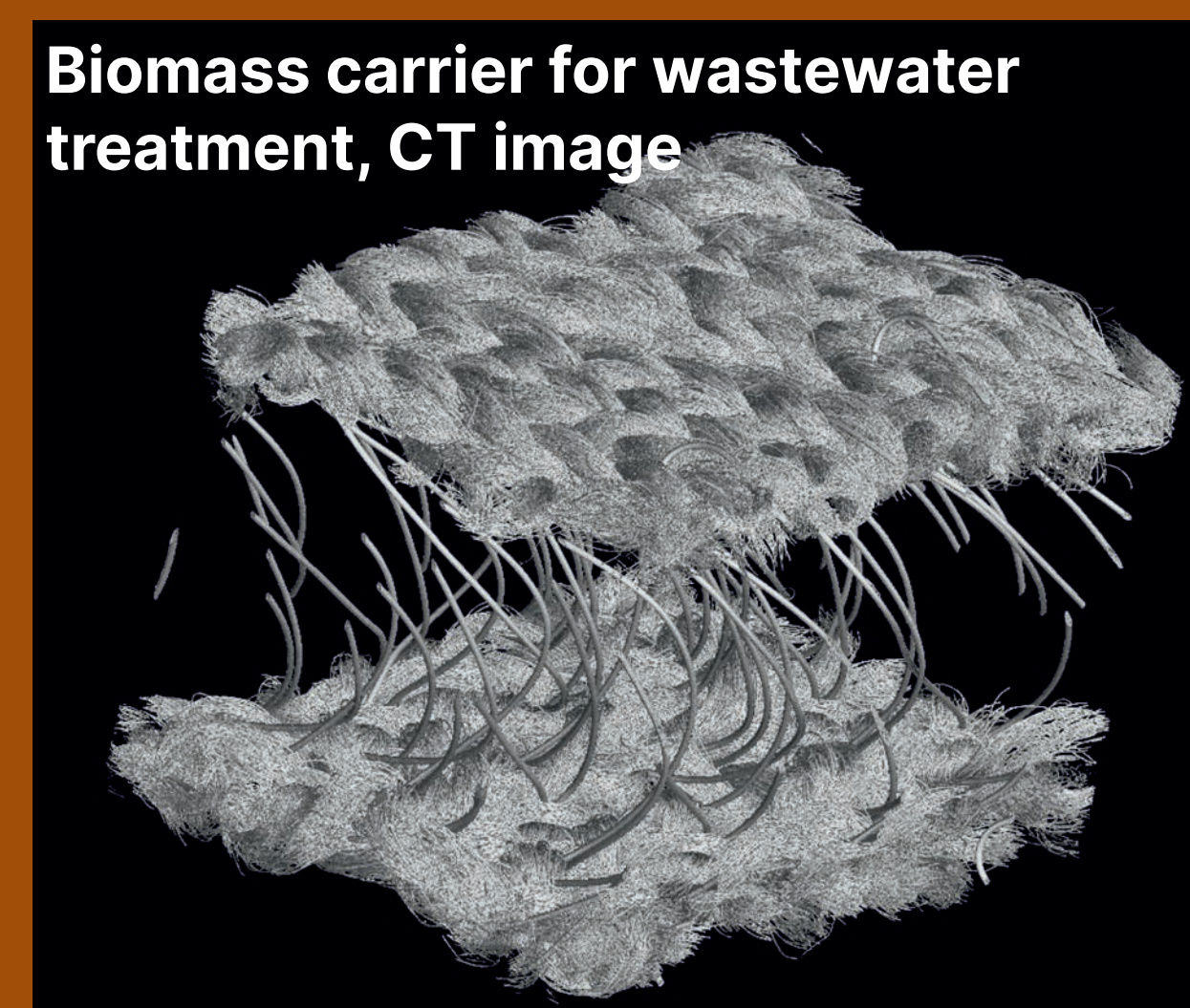
- Development of 2D and 3D textile structures of composite reinforcements, depending on the arrangement of pattern elements in the surface of the fabric, material composition and finalization of the fabrics structures in terms of the desired comfort of the textiles.
- Designing products with high added value, modification and development of technologies for the processing of new structures, use of optical fibers and materials with shape memory for technical products.
- Construction and technological solution of biomass carriers for wastewater treatment using micro and nanomaterials.



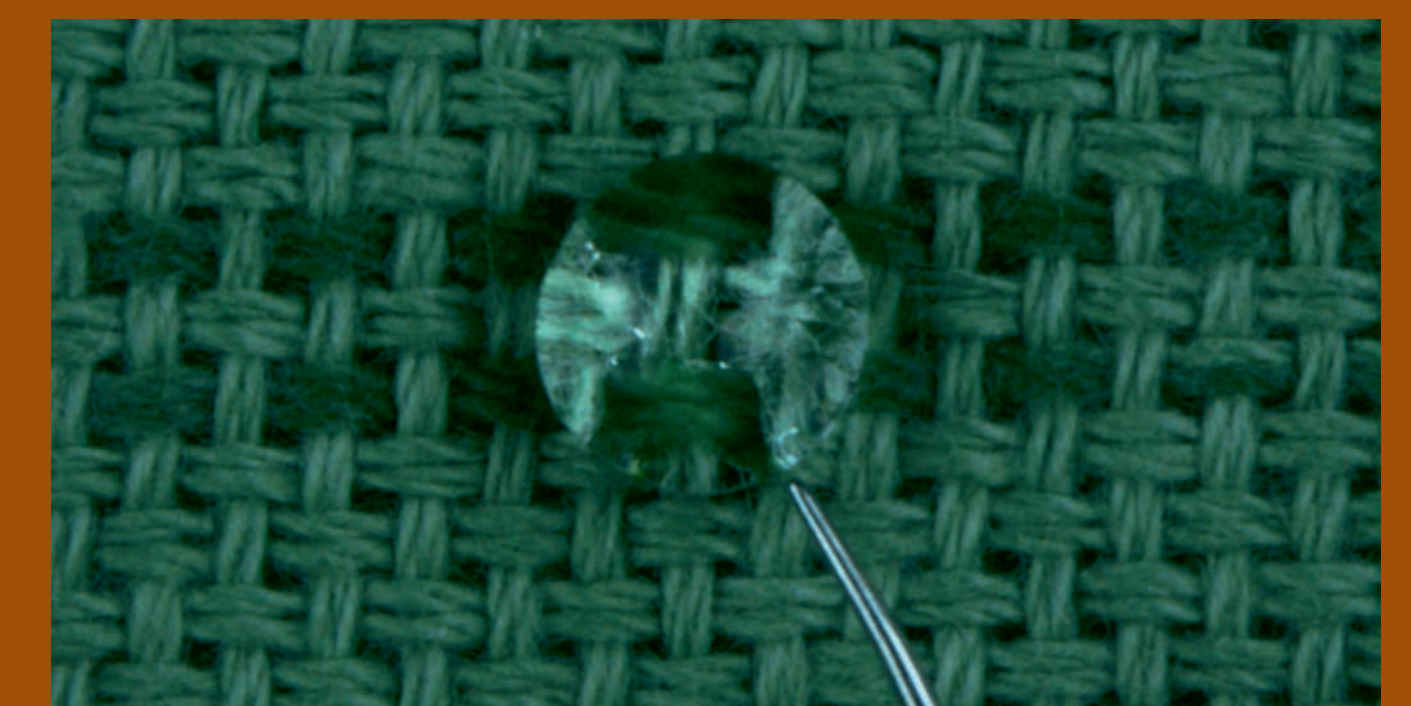
Triple woven reinforcement with a smooth warp in glass and a combination of 2:1 basalt wefts



Wetting the surface of a 100% cotton fabric with a pattern created by the combination of hydrophobic and hydrophilic woven and effect threads in the fabric (top: hydrophobic woven pattern + hydrophilic pattern, bottom: both hydrophobic)

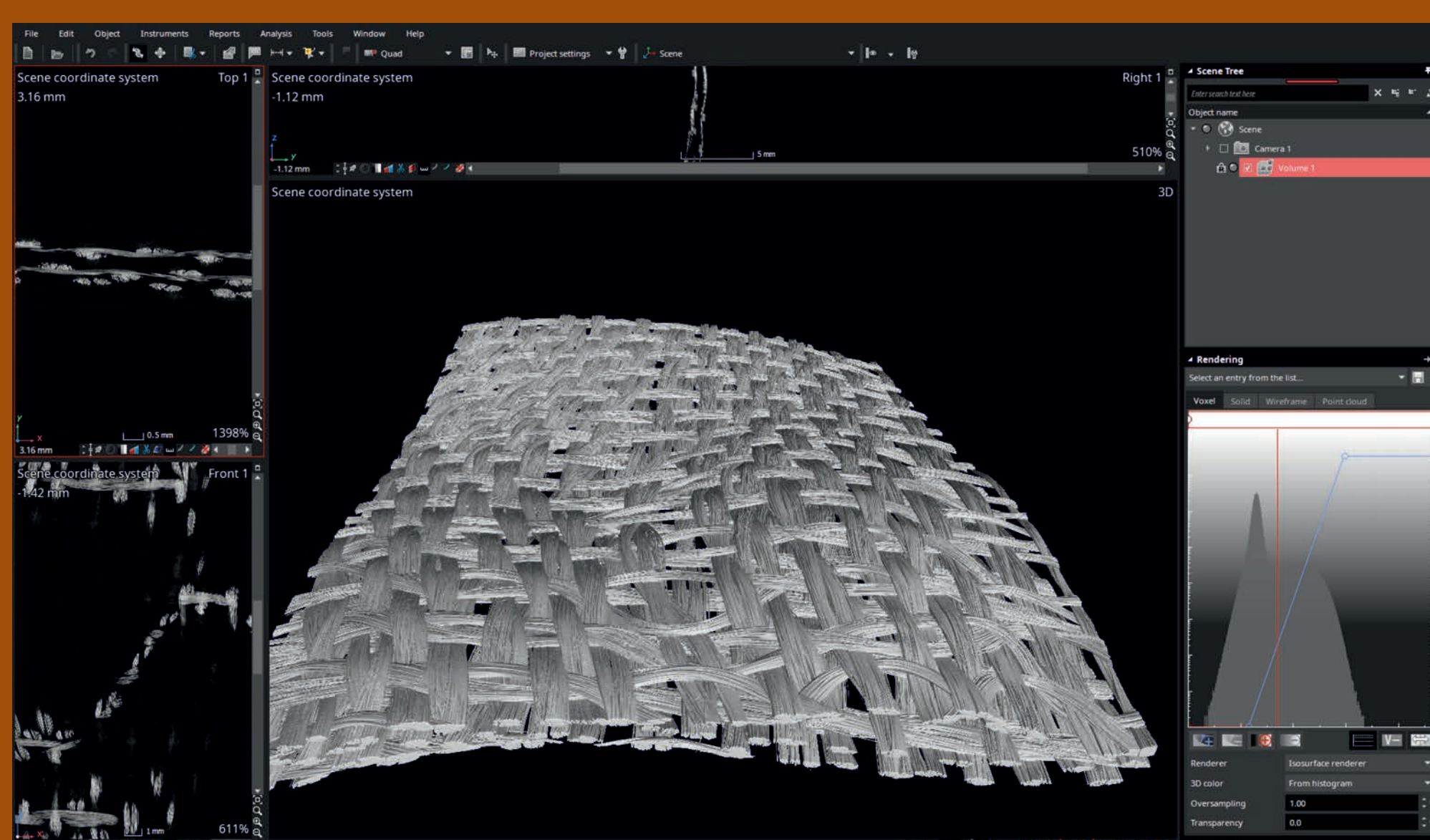


Biomass carrier for wastewater treatment, CT image

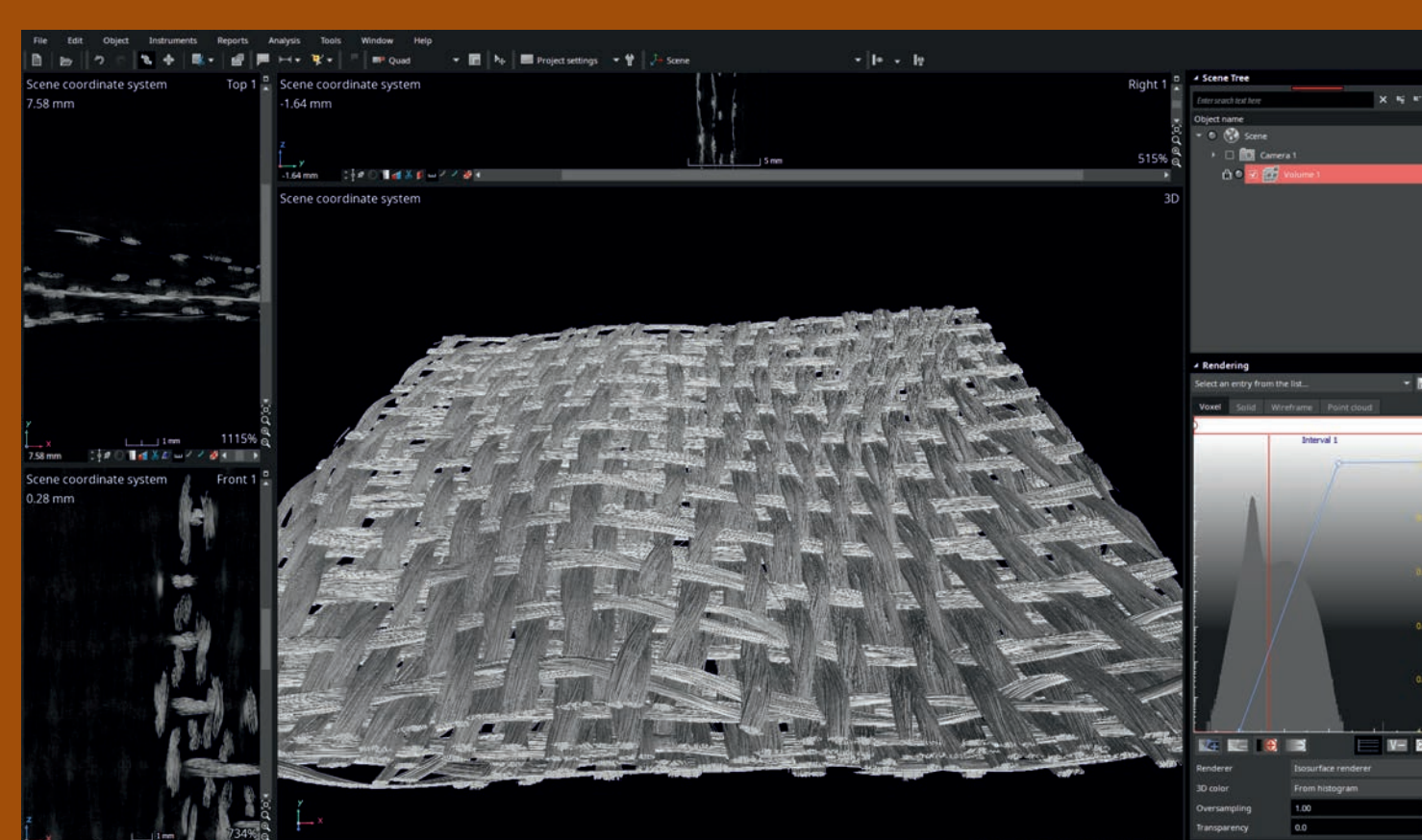


## RESULTS AND OUTPUTS

- 2D and 3D hybrid woven structures containing basalt and glass fibers made by bonding techniques of single and multiple weave fabrics for composite reinforcement.
- Construction and technical solution of a 3D biomass carrier for wastewater treatment using spacer textiles.
- Cotton fabrics with controlled moisture distribution using local hydrophobization.
- Modelling of the fabric structure and prediction of the mechanical properties of technical textiles, computer-oriented methods for the design of the fabrics.
- 7 publications indexed in SCOPUS.



3D reconstruction of CT images of 3D multilayers woven reinforcement (3-layers and 2-layers woven fabric)





EUROPEAN UNION  
European Structural and Investment Funds  
Operational Programme Research,  
Development and Education



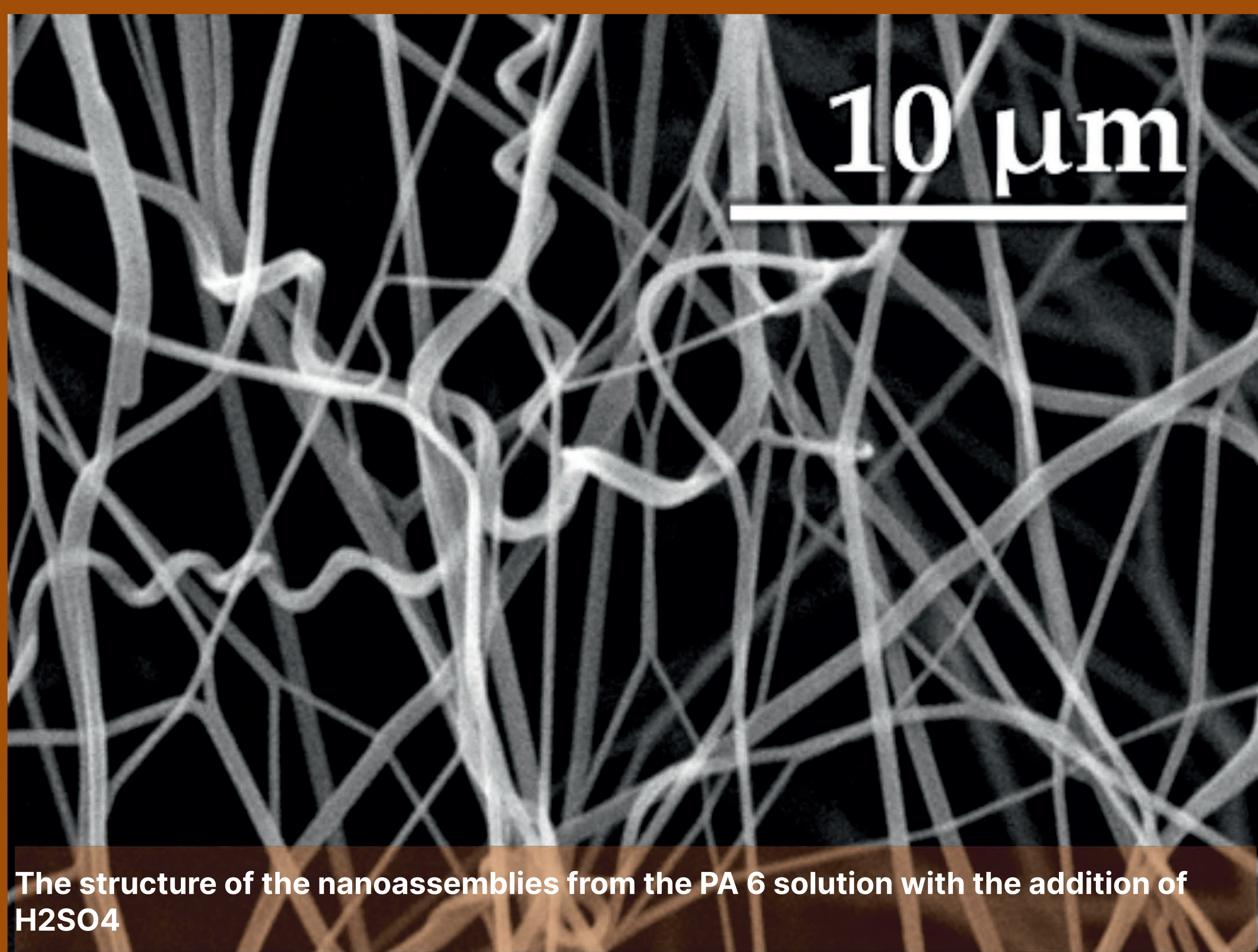
TECHNICAL  
UNIVERSITY  
OF LIBEREC



**HY**  
**HI**

# RESEARCH PROGRAMME 1 FLEXIBLE HIERARCHICAL STRUCTURES

## RESEARCH ACTIVITY 4: TEXTILE FIBROUS STRUCTURES WITH SPECIAL EFFECTS



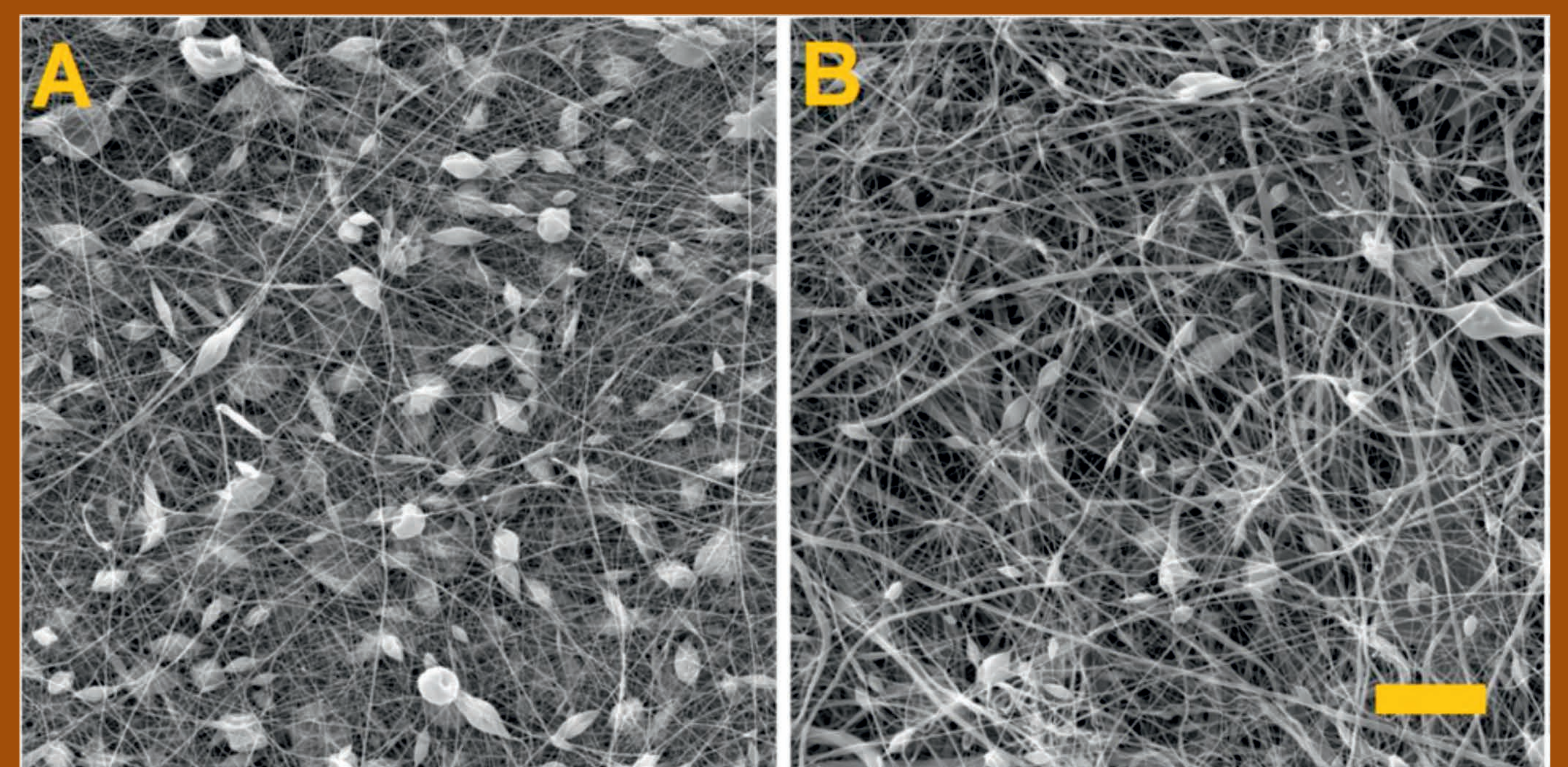
The structure of the nanoassemblies from the PA 6 solution with the addition of H<sub>2</sub>SO<sub>4</sub>

## OBJECTIVES

- Development of modified non-woven materials (including admixtures of nanofibres) for hygiene, healthcare and industrial applications, evaluation of the morphology of segments of the structure of non-woven and nanofibrous materials. Simulation of mechanical properties of non-woven and nanofibrous materials.
- Preparation of fiber structures from microfibers and submicron fibers for filter materials and industrial sorbents.
- Research and development of Rotis and Struto non-woven fabrics with reduced flammability.

## RESULTS AND OUTPUTS

- Test equipment for determining the amount of liquid in non-woven super absorbents.
- Low-flammability non-woven fabrics from a mixture of flammable and nonflammable fibers.
- Prototype and optimization of the technology of the production of assemblies from a combination of micro and nanofibers.
- Electrostatic spinning of nanoassemblies using alternating current and additives to the spinning bath.
- FEM model for the simulation of mechanical properties of non-woven fabrics
- Optimized nanofibrous layers produced by needle and needleless electrospinning of polycaprolactone and polyvinyl butyral. 7 publications indexed in SCOPUS.



Needle (A) and needleless (B) electrospinning of polycaprolactone (20 μm scale)



EUROPEAN UNION  
European Structural and Investment Funds  
Operational Programme Research,  
Development and Education



TECHNICAL  
UNIVERSITY  
OF LIBEREC



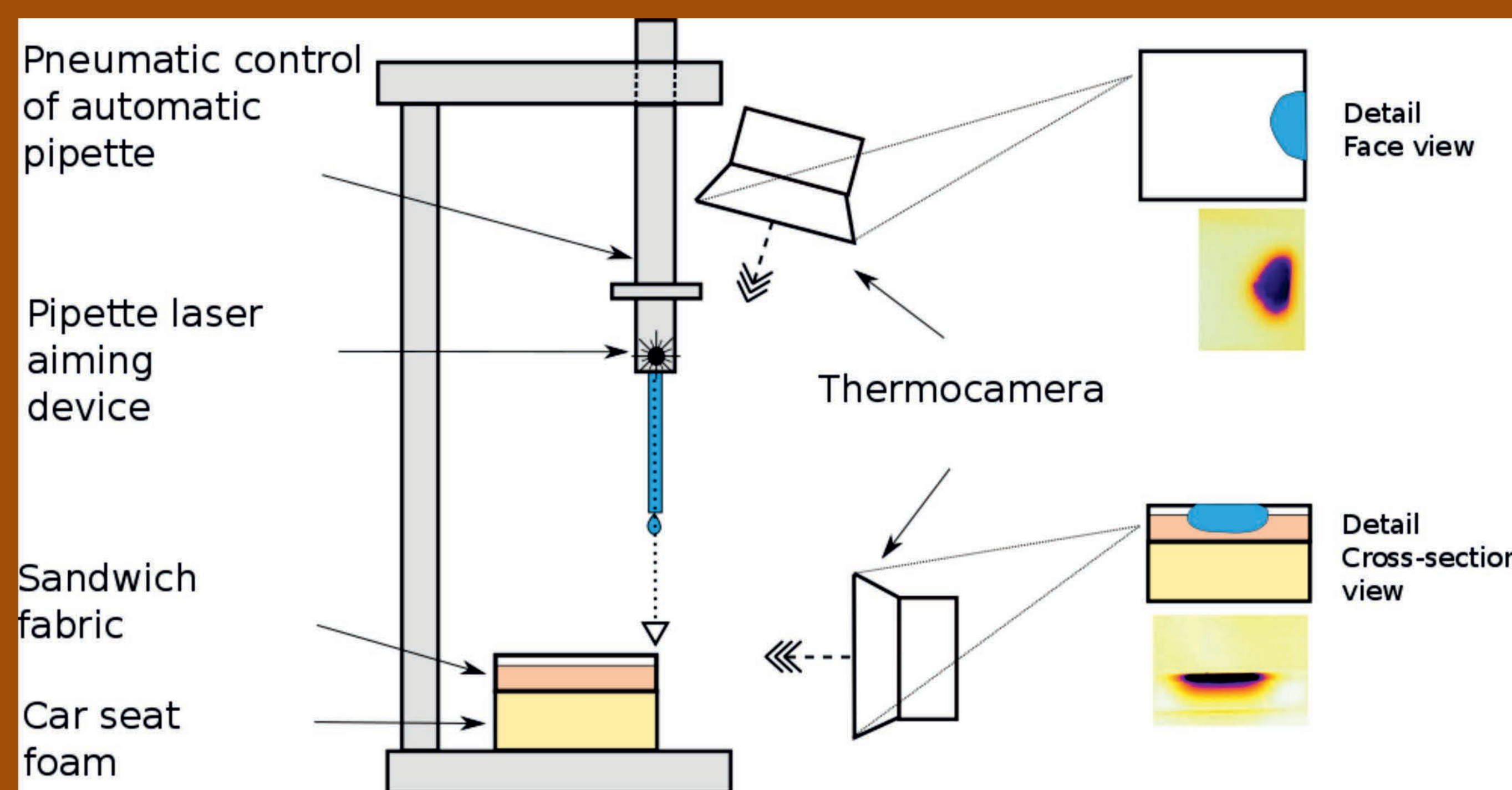
# HY #i

## RESEARCH PROGRAMME 1 FLEXIBLE HIERARCHICAL STRUCTURES

### RESEARCH ACTIVITY 4: SMART MATERIALS AND APPLICATION IN THE QUALITY OF THE INDOOR ENVIRONMENT

## OBJECTIVES

- Comprehensive research on temperature and moisture transport in the human/textile sandwich structure/environment system.
- Evaluation of the physiological comfort of fabrics in sandwich structures. Construction of Smart structures and modeling of properties of fiber materials.



Device for measuring the transport of liquid through automotive cars seats covers

- Construction of a system for testing car seats. Designing components of sophisticated car seats and professional clothing for the military, police and paramedics. Development of materials with the ability to absorb selected gases.

## RESULTS AND OUTPUTS

- Methodology for evaluating the breathability of fabrics and the permeability of fabrics for water vapor with regard to the parameters of their structure.
- Prototype of portable measuring device H2 for evaluation of vapor permeability of car seats.
- Construction of professional protective clothing, with an aerogel insulating layer.
- Prototype of "Smart Professional Clothing (SPO)" monitoring indoor and outdoor environmental conditions with LED lighting
- Test equipment for determining the vibration isolation properties of car seats.
- Measuring system of moisture management in the car seat cover using thermal imaging.
- 17 publications indexed in SCOPUS and 4 international patent applications.



Testing device for biaxial loading of car seats