FACULTY OF ENGINEERING AND ARCHITECTURE

DEPARTMENT OF MATERIALS, TEXTILES AND CHEMICAL ENGINEERING

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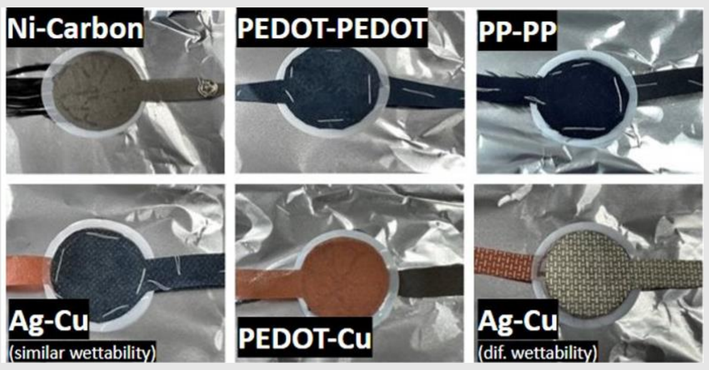
BALANCING COMFORT AND PROTECTION IN CLOTHING: COOL, DRY, AND SAFE IN HARSH ENVIRONMENTS

Clothing for personal protection can seriously compromise the comfort of a person and his physical and psychological states. New materials with smart moisture and heat management need to be integrated into clothing for better local and individual thermoregulation.
Textiles can be functionalized with passive and active cooling mechanisms, the latter having greater cooling power if they rely on an external power supply. Sweat removal is equally important as temperature for comfort, especially in cases where less permeable, protective outer layers must be worn over the body. This study includes developing textile systems for efficient sweat removal by utilizing the electroosmotic phenomenon.

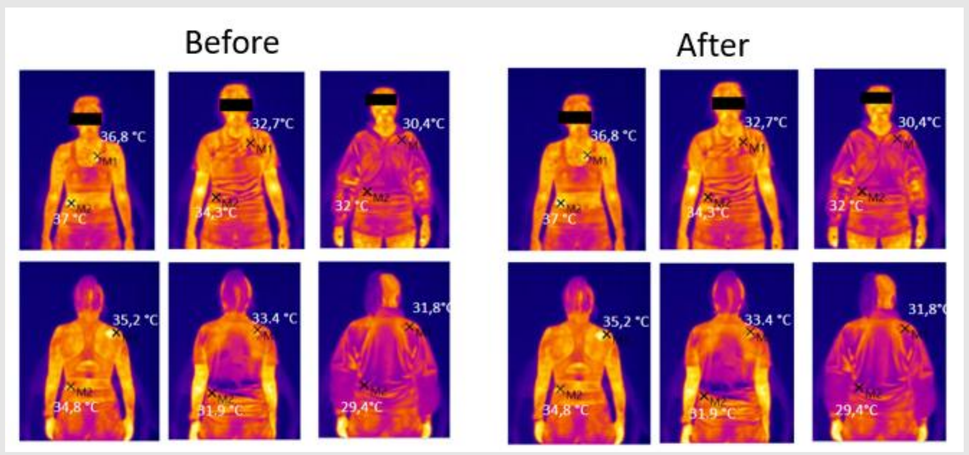
Research methods

- Development of textile systems for cooling/moisture management



- Performance tests on material level
- Integration in PPE clothing: prototypes

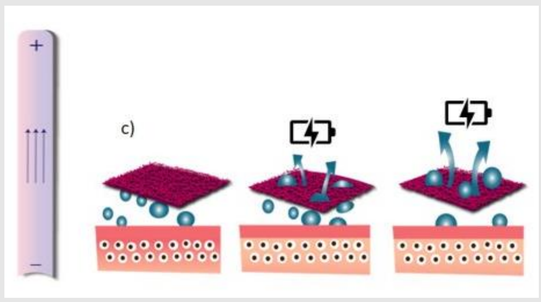
- Validation: Wear trials, objective measurements of comfort using physiological parameters and subjective comfort surveys



Cooling with textile electroosmotic pumps (EOPs) for active sweat transport

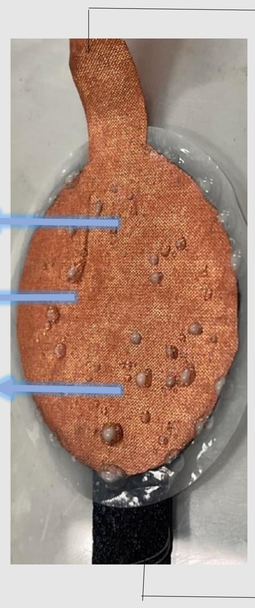
The EOP consists of textile electrodes, a microporous membrane between them, and a power supply for activation. Several conductive fabrics were selected and tried out as textile-based electrodes, varying in hydrophilicity, conductivity, and structure.

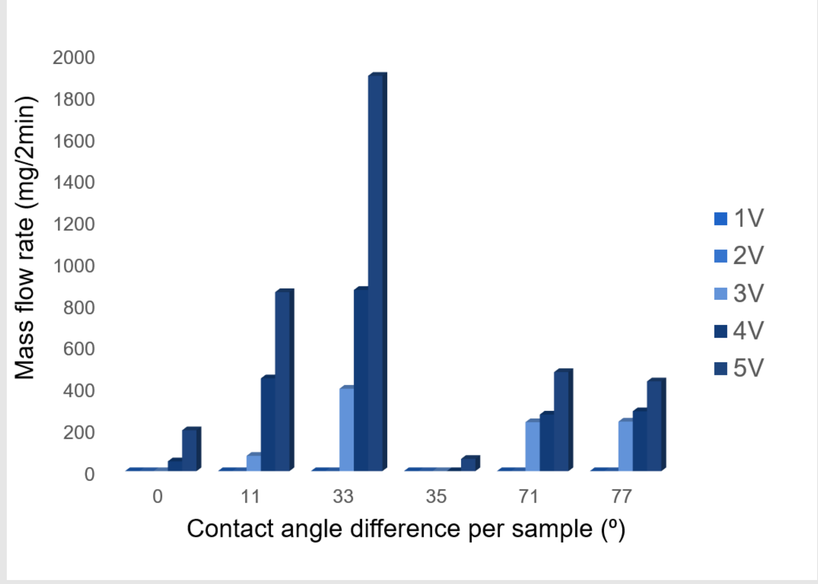
- **Active, 1 directional moisture transport**
- Low Voltage needed (portable battery)



Unidirectional water transport of tap water (against gravity)

2H2O → O2 + 4h + 4e- at the anode
2H2O + 2e- → H2 + 2OH at the cathode





The developed textile electroosmotic pumps (EOP) demonstrated active moisture transport using an electric potential of 3 to 5 Volts which can be supplied by a small battery. A water mass flux up to 986 mg/min was observed at 5 volts for the carbon-nickel combination. This low-powered pump is bendable, soft, and flexible. Further testing will include measurements of pump efficiency over time, washing resistance and use of artificial sweat as a testing liquid.

Some of the important challenges include:

- The evaluation of the cooling performance (power, duration…) in a specific scenario (physical activity, environmental parameters)
- Can the cooling textiles satisfy all protective and wearable requirements, specifically for the user case of Belgian Army Uniforms?

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