Integrating printed EMG electrodes into smart textiles - BIOMAC Test case #5

BIOMAC, as an open ecosystem, focuses on the creation and validation of new supply and value chains where technologies that are being scaled-up and validated to TRL 7, accelerating their exploitation potential.
The BIOMAC OITB has been built to address 5 Test Cases (interTeCs) for the validation selected based on their complexity in order to involve different pilot lines as well as the supporting services and thus provide holistic feedback for the operation of the OITB as a whole.

1. About printed electronics

This technology involves printing electronic components directly onto a substrate, often using inkjet or screen printing techniques. Today, printed electronics find applications in diverse fields such as consumer electronics, healthcare, automotive, and wearable technology. For instance, they enable the production of low-cost, disposable sensors for medical diagnostics, flexible displays for smart packaging, and lightweight, energy-efficient antennas for IoT devices.

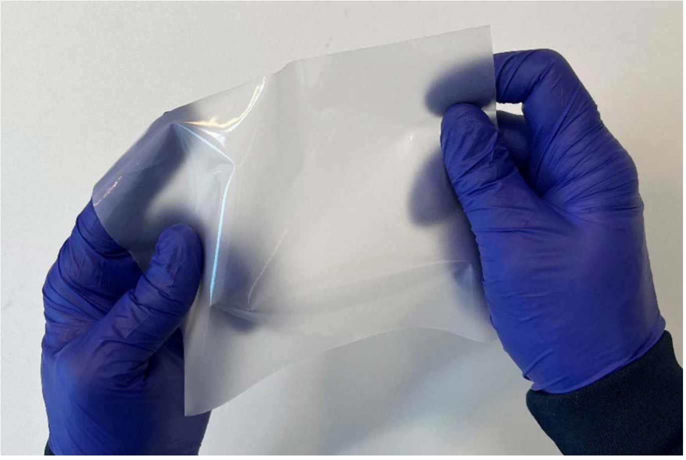
2. The concept

In this factsheet, we are presenting the work done in Biomac for the realization of new “Printed electronics” product. Such printed material can then be transferred or laminated onto a wearable textile. The material consist of conductive and nonconductive elements that form the electromyography (EMG) electrodes, which should be both mechanically robust and wash-resistant.

The prototypes developed are new designs of the original product “MLI ELBOW” developed by Precure, partner of BIOMAC. “MLI ELBOW” measures muscle strain in the forearm and can be used to prevent overexertion leading to musculoskeletal disorder in the elbow (tennis elbow). The original product has EMG electrodes made with silver textile, while the prototypes developed in BIOMAC use carbon-based electrodes made with a large content of biobased materials. This leads to a significant reduction in environmental impact.

Materials and process flow
Sawdust (woody residues) and Miscanthus (energy crop) were pretreated and then fractionated into cellulose, hemicellulose and lignin. Overall, fractionating sawdust and miscanthus into their constituent components allows for the efficient utilization of these biomass resources, making them an attractive option for sustainable material production and reducing reliance on fossil fuels. This process also helps to reduce waste generation and environmental impact associated with the disposal of agricultural residues.

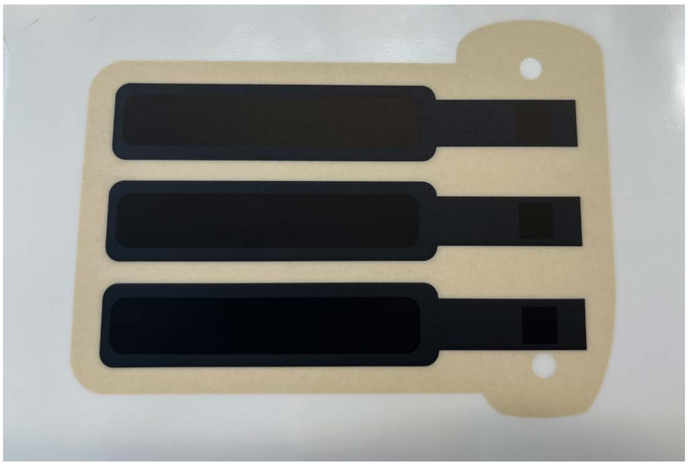
For the printed electronics application, the cellulose fraction was used, either for mechanical treatment into Cellulose NanoCrystals (CNC), or by enzymatic hydrolysis and fermentation into succinic acid and diols.



The succinic acid and diols were used, together with externally sourced biobased monomers and petrobased diisocyanates, to make PolyUrethane Dispersions (PUDs) that were subsequently used as a basis for both substrates and inks.

Polyurethane (PU) substrates were produced by film casting of PUDs, using a doctor blade. They were cast on top of transfer substrates that act as carriers in the subsequent processing of the films.

Figure 1: Part of a PU substrate



Two inks were developed. A conductive ink and a barrier ink. The conductive ink was formulated using PUD, CNC, carbon black and ethylene glycol (EG). The barrier ink was formulated using PUD, modified CNC, water, co-solvents and additives.

The substrates and inks were used for screen printing EMG electrodes that were integrated into textiles for the prototypes.

Figure 2: EMG electrodes screen printed with the conductive ink on a PU substrate with a screen printed cover of the barrier ink.

Figure 3

Figures 4a, 4b

Prototypes

Figure 3 shows pictures of an original “MLI ELBOW” product, while figures 4a and 4b show two prototypes produced with BIOMAC materials.

The prototypes show performance comparable to the original product and have the potential to reduce the environmental impact and production costs of the “MLI ELBOW” product, opening new horizons for a brand new family of products of biological origin.

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PARTNERS

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