LIFOMUL 3D - LIGNIN FORMULATIONS FOR MULTIMATERIAL 3D PRINTING OF MICRONEEDLE ELECTRODES

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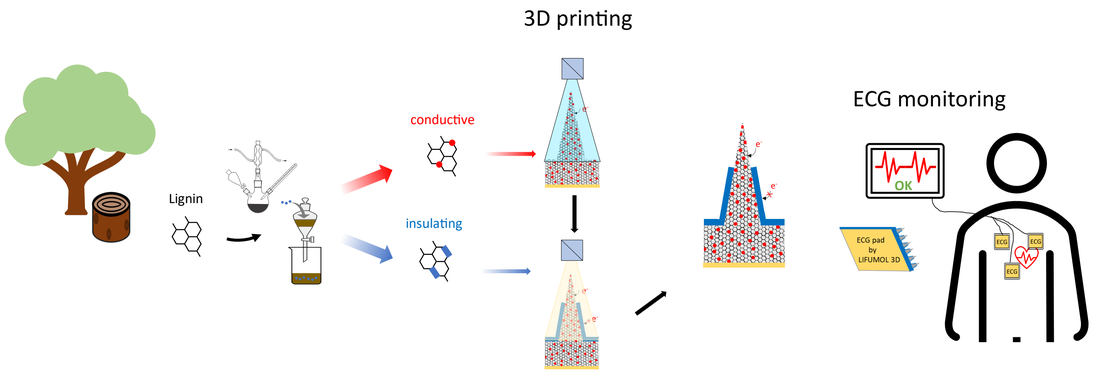
Impact

In LIFOMUL 3D, a multimaterial 3D-printer and lignin-based resins are currently developed toward product maturity. Together, they enable the manufacturing of microstructures for medical applications in an environmentally sustainable way. LIFOMUL 3D brings together the following five partners:

AIT Austrian Institute of Technology – Project coordinator | ALPIN3D® Engineering | 3D-Scan | Production | FH University of Applied Sciences TECHNIKUM WIEN | IN-VISION® Future built on light. | ipf Leibniz-Institut für Polymerforschung Dresden

Motivation

Metallized microneedle electrodes have been demonstrated as valid alternative to well-established wet electrodes for electrocardiography- (ECG) and electroencephalography- (EEG) measurements. The advantage of microneedles primarily lies in their drastically reduced skin-electrode impedance. Microneedle-based dry electrodes result in superior user comfort as well as signal quality and long-term stability, which is particularly relevant for specialty ECG and EEG applications such as long-time monitoring.

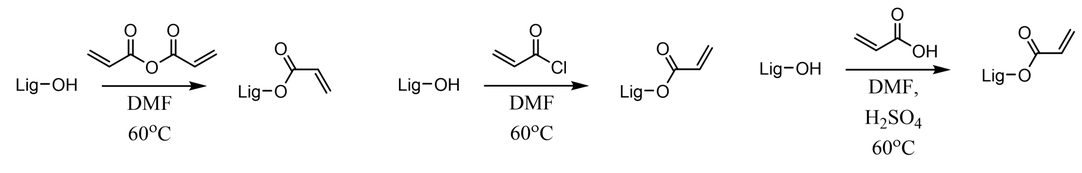


Approach

The LIFOMUL 3D project develops additive manufacturing to fabricate microneedle electrodes in an environmentally sustainable and economically viable fashion based on renewable materials. To this end, LIFOMUL 3D is implementing the printing of materials based on lignin via projection-microstereolithography (PμSL). The goal is to achieve sub-10 µm feature sizes, biocompatibility, and spatially controlled electrical conductivity.

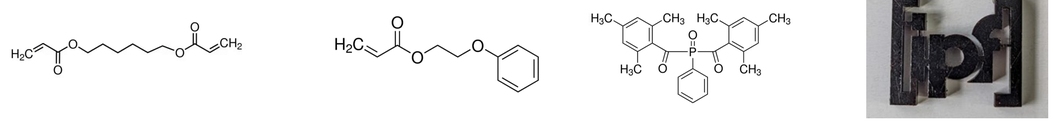
Formulation and printing of the lignin-based resins

Different pathways towards lignin modification



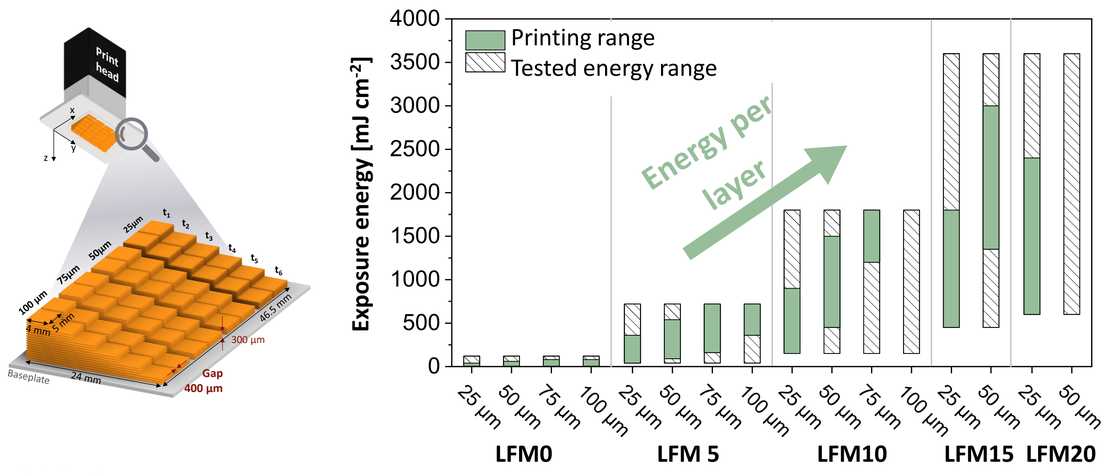
Acrylic anhydride | Acryloyl chloride | Acrylic acid

Composition of lignin-containing resins



HDDA (crosslinker) | EGPEA (monomer) | BAPO (photoinitiator) | IPF logo (15 wt% Lignin)

Step tests for rapid parameter screening of different lignin-based resins

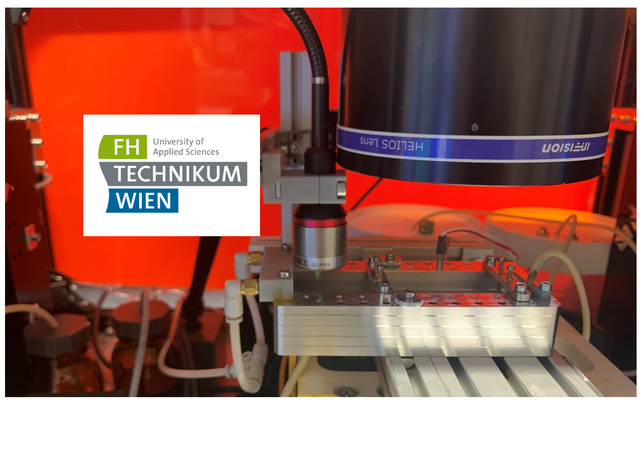


Publications
[1] M. Vigogne, C. Aeschbach, R. Bernhardt, A. Kaufmann, J. Thiele, *Step test for rapid screening of material and process parameters for resin development in DLP 3D printing,* manuscript submitted.
[2] M. Vigogne, A. Kaufmann, E. Grigoryev, C. Aeschbach, H. Lila, M. Schwidder, J. Thiele, *Expanding the usage of lignin in DLP 3D printing by optimized synthesis and processing parameters*, manuscript in preparation.

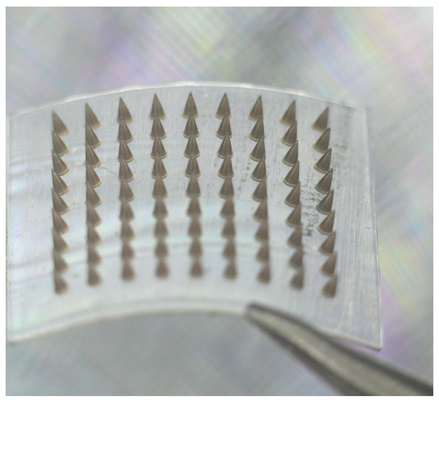
Development of the high resolution PμSL printer

A high-resolution PμSL system is developed and used as manufacturing platform, allowing for fabricating microneedles with up to 700 µm height. The system is designed to enable hybrid printing of two different materials (conductive and insulating) and incorporates a cleaning process of 3D-printed structures before switching from one material to the next one.

PμSL printer



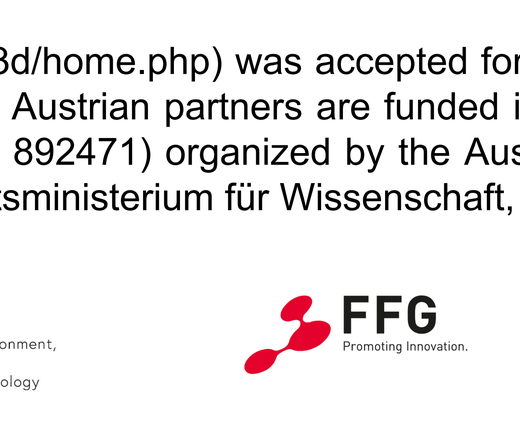
Hybrid printed microneedles

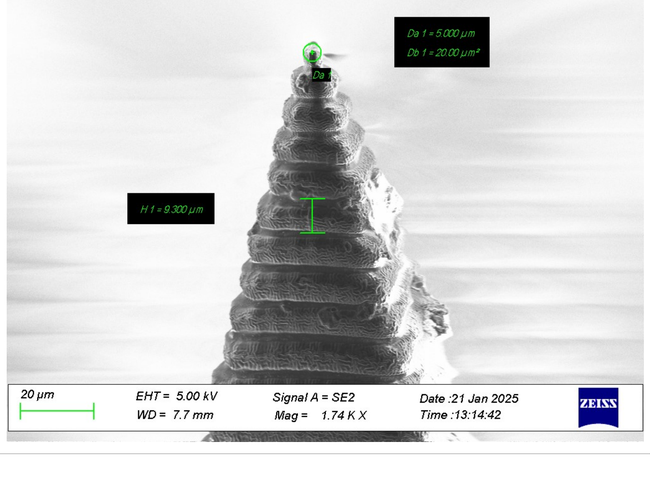


- Lignin part: 15 wt%
- Height: 550 µm
- Tip radius: 6 µm

High resolution printing of lignin-based microneedles

Lignin microneedles printed with the developed PμSL printer.





Project Funding

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