HyPELignum - Exploring wooden materials in hybrid printed electronics: a holistic approach towards functional electronics with net zero carbon emissions

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Tasks

A air quality sensor system is developed by the use of an array (6 channels) of chemiresistive polymer-sensors. Interdigitated electrodes monolithically integrated onto the µchip, are modified using eco-friendly and solution processable conductive polymers. Real-time implementation of machine learning and artificial intelligence analytics of multi-variant sensor inputs complemented with edge computing solutions using Infineon's microchip and controller infrastructure is finally merged with IoT-protocols for unprecedented end-user experience and customer value.

i) Optimization of polymer solutions for applicability in an ink-jet printing process and adaptation of the process to match the preconditions for sensitive sensors and eco-friendly formulations.
ii) Implementation and testing of the printed polymer sensors on the HyPELignum furniture samples with a long-term study as technology demonstration under real-life conditions.

Project description

The ambition of the HYPELIGNUM project is to propose and demonstrate a lifecycle approach for the manufacturing of electronics with net zero carbon emissions from sourcing of raw materials until the end-of life of devices. The polymer-based IoT sensors implemented by DPU will monitor air-quality in real time at spot and propose action to the users (e.g. CO values, toxic compound presence, ventilation needed) or integrate into smart buildings and thereby decrease risks of exposure to harmful conditions and increase health of the user.

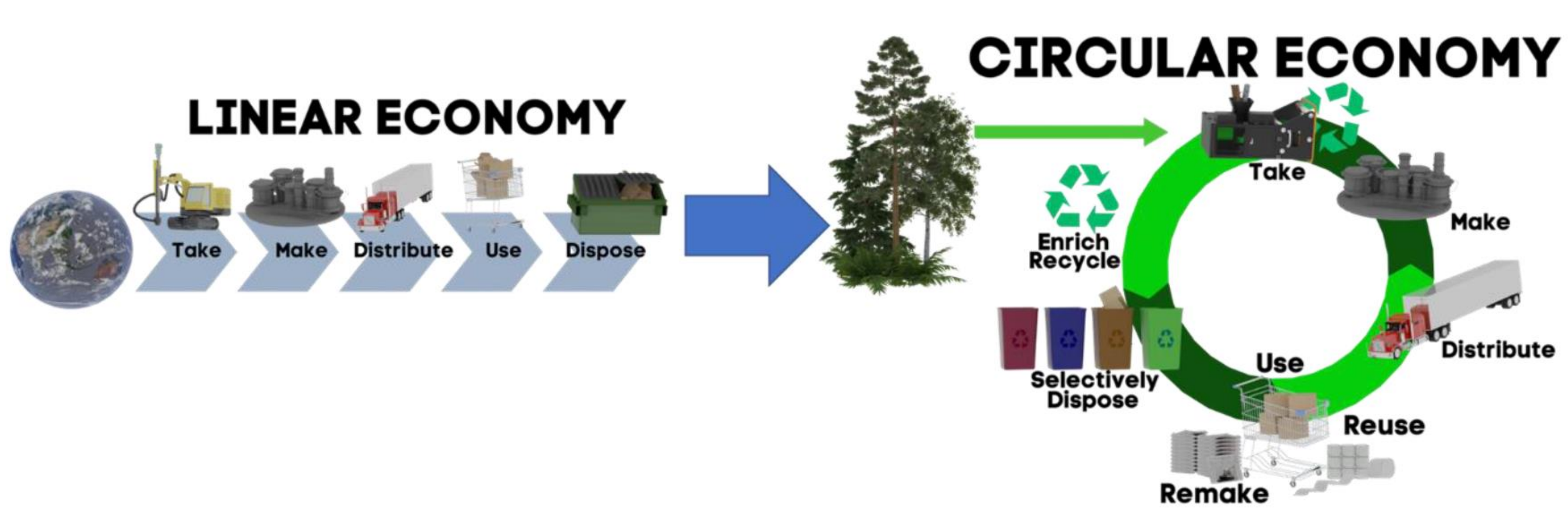

Figure 1: The main aim of the HyPELignum project is to develop smart furniture that is suitable for circular economy. From the wood materials to the electronic components a complete solution is researched enabling the efficient reuse, recycling and disassembly after a first lifespan.

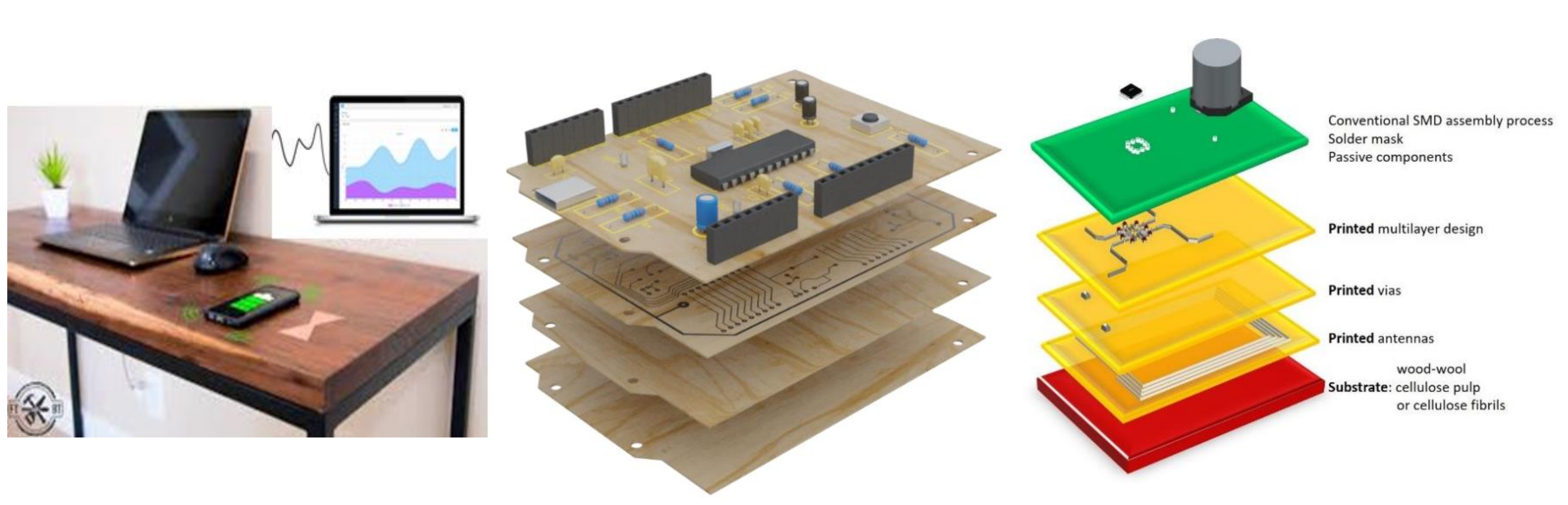

Figure 2: The wooden base materials is impregnated with a primer layer which is biodegradable and hence can be separated from the surface after its lifespan. The primer layer consists of the electronic and smart components enabling sensor implementation and environmental monitoring.

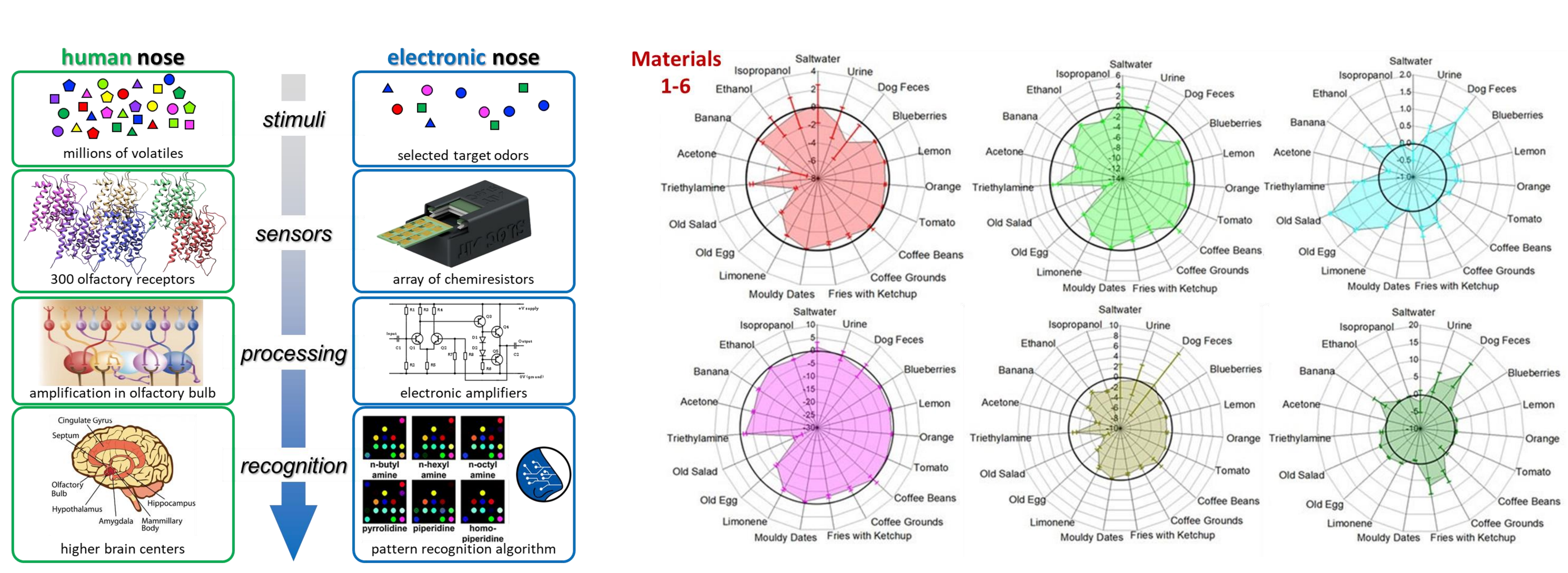

Figure 3: The smart smell sensors applied in the project are based on a biomimetic approach of the electronic nose, where, similar to the human nose, an array of sensor units is utilized to enable the discrimination of many different volatile organic compounds (left). Each polymer composite exhibits a unique fingerprint for different smell components (right) and the engineering of complementary polymer composite sensors remains a main task also in the HyPELignum project.

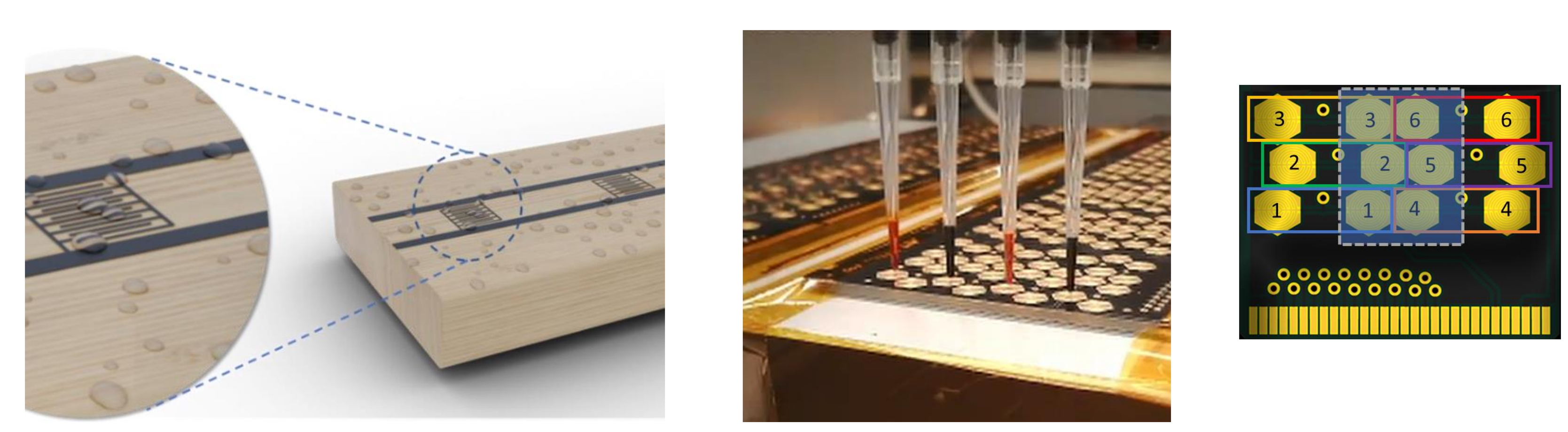

Figure 4: The surface of such smart furniture (left) will contained interdigitated electrode spots, where the DPU in collaboration with Profactor prints a variety of polymer composites (middle) on different channels to create a smart sensor array (right) module in direct vicinity of the implemented Infineon microchips for on-board analytics and edge computing.

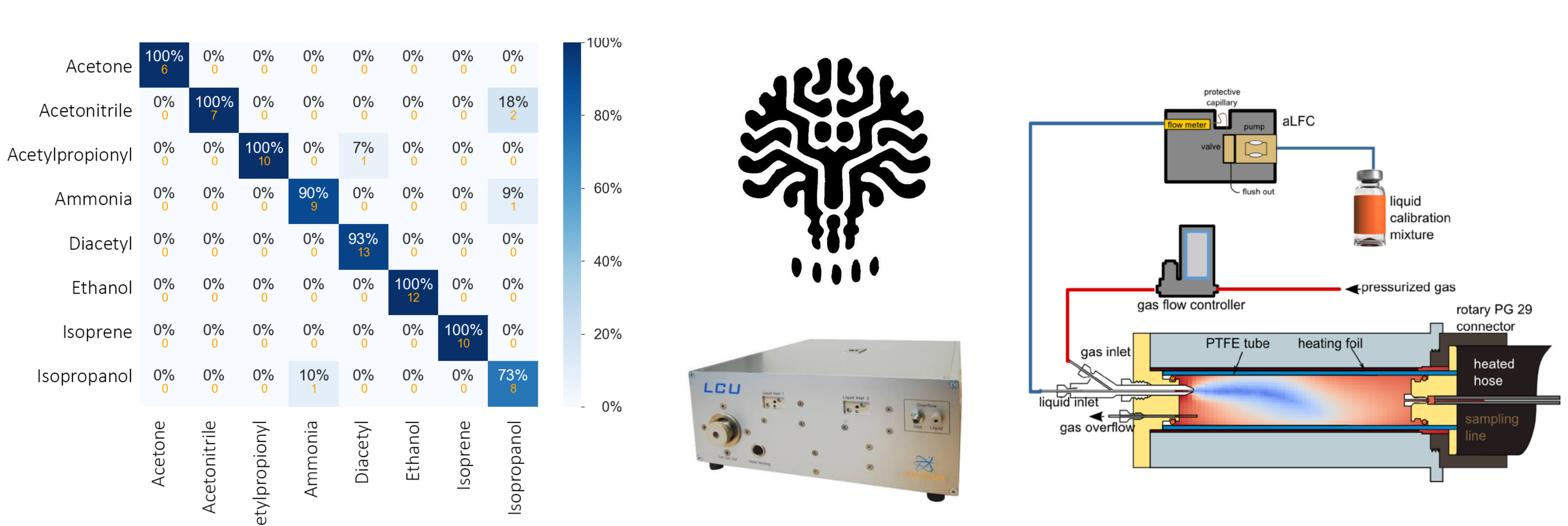

Figure 5: Calibration measurements of the HyPELignum developed smell sensors enable the qualitative discrimination of a wide variety of organic compounds utilizing artificial intelligence training and classification methods (left and middle). Calibrations of the sensors for quantitative predictions is performed with a liquid calibration unit, where the sensors are exposed to complex gas phase mixtures with defined concentrations for the creation of calibration curves.

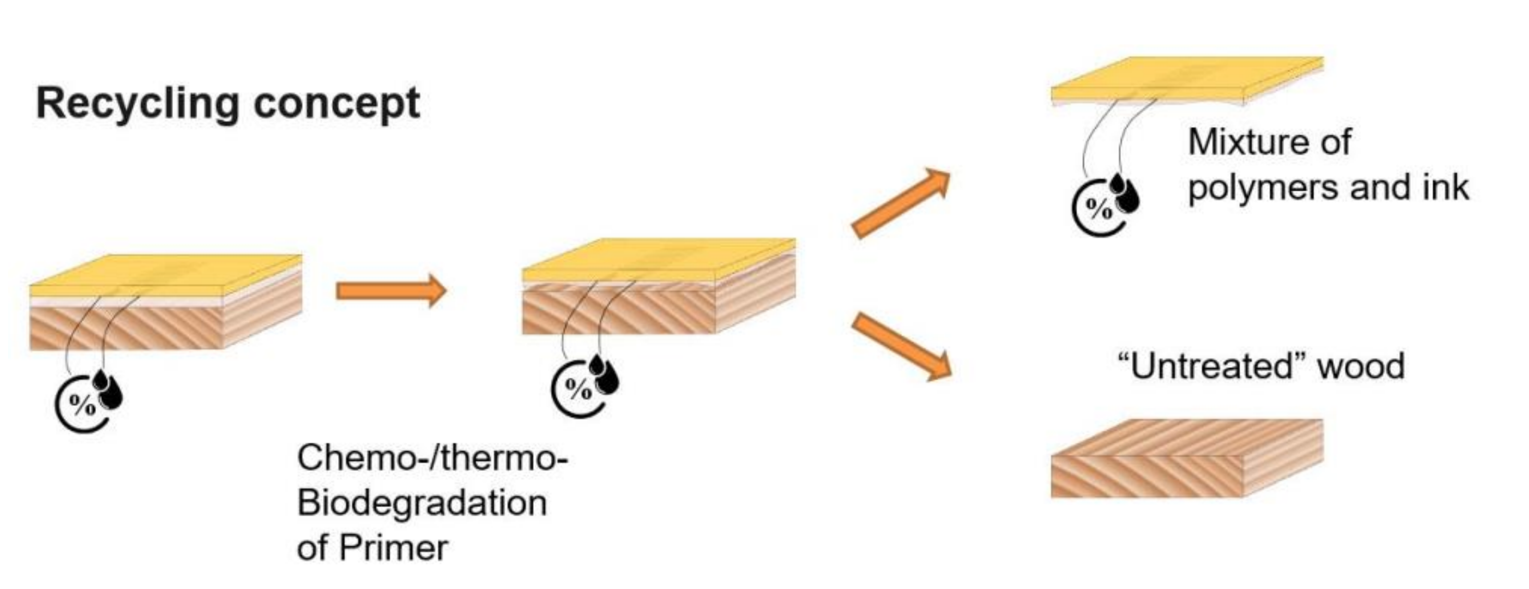

Figure 5: The main concept of the HyPELignum researched material is their complex functionality as well as the energy-efficient disassembly for recycling and reusability. The polymer ink solutions developed at DPU therefore fulfil the criteria stated by a circular economy approach.

The DPU based the research in the HyPELfgnum project on the research formerly performed at the Austrian Institute of Technology (AIT) at the Biosensor Technology group around Ass.-Prof. Dr. Ciril Reiner-Rozman. In several previous and parallel funded research projects the group including Ass.-Prof. Dr. Johannes Bintinger, MsC Vivien Madi, Dr. Patrik Aspermair, MsC Bernhard Pichler and MsC Thomas Hegedüs and their team have demonstrated the applicability of polymer based sensor systems for distinguishing a wide variety of real-life samples based on their smell fingerprints and have optimized the sensors for waste management application (EFRE – SMELL project), adapted environmental stabilization of the materials (FFG – Opossum project), their application for human smell emission identification (FFG – Track project), implementation of graphene-based sensors (EFRE – SMELL-Heroes project) among others.