3D-Manufacturing of Novel Biomaterials (3D-BioMat)

The main goals of project are new material concepts and production value chains by combining novel biomaterials with the fast-developing 3D-additive manufacturing technologies. Key results in the project thrust areas are:

1) 3D printed UV curable and elastic composite

Shear thinning inks based on polyurethane and nanocellulose were 3D printed *via* Direct Ink Writing (DIW). The developed composites were found to be easy to produce and fast in and showed high flexibility, high porosity and swelling in neutral and slightly acidic pH, as well as slow degradation.

2) 3D-Scaffold of polyurethane for soft tissue engineering

With developed processing method such as stereolithography (SLA), high resolution 3D printed scaffolds with complex geometry were prepared using biocompatible, biodegradable and fast curing polyurethane resin. 3D printed scaffold containing poly(ε-caprolactone) (PCL) and polyethylene glycol (PEG) segments showed high applicability to be used in soft tissue engineering especially for skin tissue scaffold development due to high cell attachment and proliferation with no sign of cytotoxicity.

3) 3D printed all wood structures as porous carbon electrode for energy conversion and storage

All-wood structures of high carbon density have shown promise for applications in energy conversion and storage. In an ongoing research, fully bio-based structures with varying lignin concentration are 3D-printed via the DIW method. The rheology of the ink is controlled to achieve structures with high porosity, fidelity, and (gradient) mechanical properties, which are essential for the aimed application.

4) Lignin-based composite selective laser sintering

Mixtures of lignin-polymer powder were processed through selective laser sintering (SLS), where a laser is used as the power source to sinter powdered compounds. In this method, a solid structure is formed by binding the powder while a laser focuses on the areas defined by the predefined 3D model. The produced lignin-based structures of high lignin content display promising mechanical properties and thermal stability.

5) 3D printed sugar

3D printed sugar (sucrose) designs were created using Selective Laser Sintering (SLS) process, in order to be used in casting applications. The experiments were designed to understand the role of scan speed and energy density in sugar SLS process. All the tests were sintered at various scan speeds and power levels, and a pycnometry analysis was carried out to relate the average densities of the test samples to the respective energy densities.

6) 3D-printed nerve conduit for nerve regeneration:

3D-printed nerve conduits with precise and modified geometry was developed using SLA technique and conductive, photo crosslinkable, and biocompatible polyurethane/functionalized graphene nanocomposite. We are aiming to investigate the effect of using conductive and modified geometry conduits on healing of damaged peripheral nerves.

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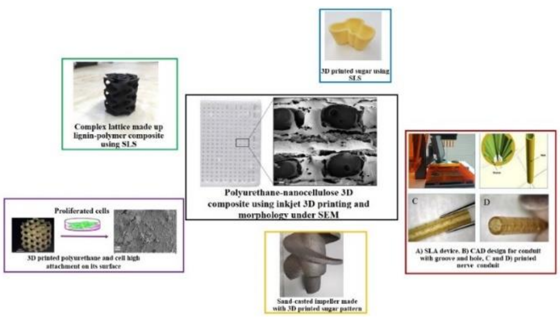

Figure 1. Different specimens' geometrical structures produced in 3D BioMat-project.