Recent Developments in Tissue Engineering using the 3D-Bioplotter™

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Statement of Purpose: The use of Rapid Prototyping techniques for Tissue Engineering purposes is seen as promising, as these processes not only allow the layer-by-layer construction of complex 3D objects, onto which cells can be seeded, but also make available methods with which scaffolds with cells incorporated into the constructs' material can be created. While most RP techniques can only use a limited range of materials or can only process one material at a time, the 3D-Bioplotter™ is based on a simple deposition method which allows for the widest range of processable materials by any singular commercial RP machine.

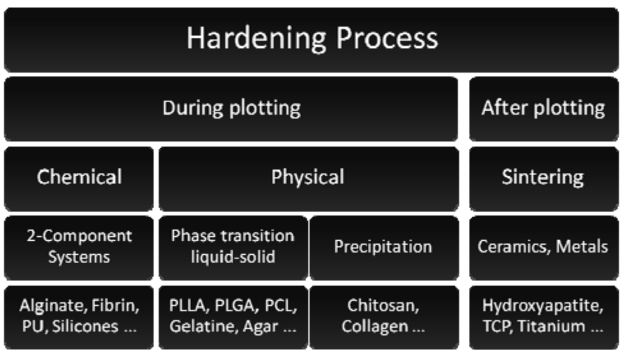

Figure 1. Materials processable with the 3D-Bioplotter™

The 3D-Bioplotter™ applies air pressure upon a heatable syringe, which is movable in three dimensions to extrude the plotting material onto a plotting medium or plotting surface. Parallel strands of the material are deposited on each layer, which change in direction by 45° or 90° per layer to create complex nets. The plotting material not also allows 2-component systems to be used to fabricate 3D objects, but also provides buoyancy for objects being constructed using soft materials during the hardening process. Since the 3rd generation of this machine, up to 5 materials can be processed into the same object, allowing layer by layer material changes as well as heterogeneous layers. Multi-material deposition using hydrogel biomaterials with incorporated cells provides Tissue Engineering with the perfect tool for Organ Printing purposes.

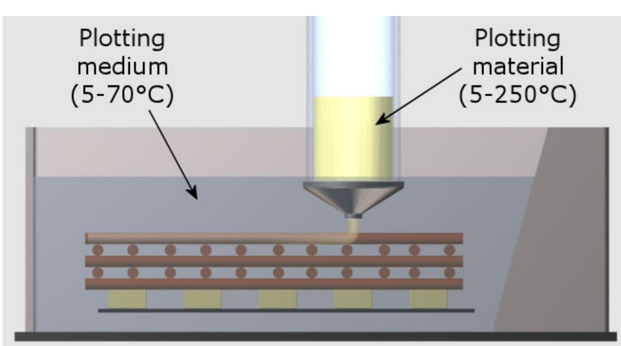

Figure 2. Illustration of the 3D-Bioplotter™ process

Most of the current research is based on the material flexibility of this process and scaffold fabrication using Ti_6Al_4V (1), PEOT/PBT (2), PCL (3), as well as TCP, PLGA and alginate (4) has been documented. The 3D-Bioplotter has also been used for the in vivo observation of scaffold vascularization (5) and bone regeneration (6).

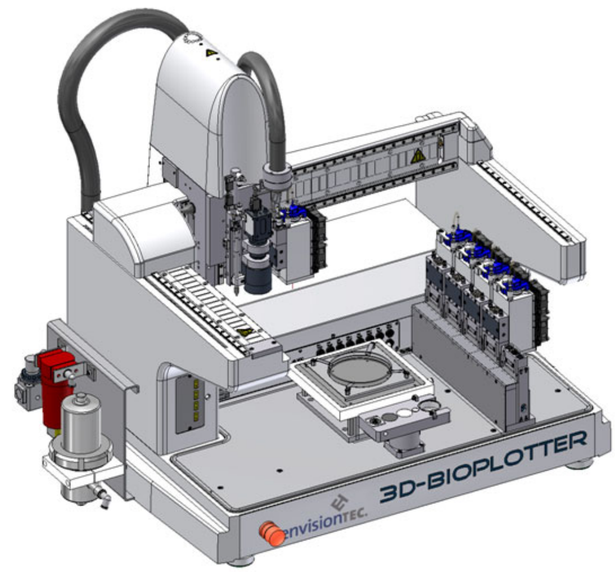

Figure 3. 4th generation 3D-Bioplotter

To satisfy the ever-increasing requirements of Tissue Engineering processes, a major step in the development of the 3D-Bioplotter has been taken. The 4th generation has a new built-in sterile filter as well as a camera for automated strand control. The resolution has been increased to 1 µm and a new sensor is used to measure the needle position in the z axis. The software user interface has been overhauled and a new algorithm allows the 3D-Bioplotter to better plot curved strands. The high-temperature head has been simplified for faster cleaning, while decreasing melting times to around 10 minutes.

Conclusions: Scaffolds fabricated using the 3D-Bioplotter™ have provided different research groups with excellent results in both in vitro and in vivo experiments. The 3D-Bioplotter is therefore becoming one of the major Biofabrication techniques due to multi-material dosage, high accuracy and the ability to construct full-scale scaffolds. The new 4th generation 3D-Bioplotter enhances the potential of this technology with greatly improved software and hardware, which meet the requirements for clinical trials as well as research on Organ Printing.

References:

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