

BIOFUNCTIONAL PROCESSING: SCAFFOLD DESIGN, FABRICATION AND SURFACE MODIFICATIONR.Mülhaupt, R.Landers & Y.Thomann*Institut für Makromolekulare Chemie der Universität Freiburg und Materialforschungszentrum, D.*

INTRODUCTION: Scaffolds play an important role in tissue engineering (TE). Scaffold architectures have to be designed and fabricated to scaffold has to fit the needs of individual patients. Novel rapid prototyping (RP) technologies meet these requirements by layer-by-layer construction combining computer-assisted design with biomedical diagnostics like computer tomography. In particular the ability of RP techniques to create a well defined shape, makes these techniques so attractive for the fabrication of 3D-scaffolds.^[INT6] Among the expanding number of But not all of the commercial RP techniques, very few are suitable for application in TE. are useful for this medical application. They have to meet several criterions, Stringent criteria must be met in biofunctional RP like like the production of scaffolds from non-toxic processing, biocompatible and biodegradable materials, avoidance of elevated temperatures and sterile and mild processing conditions and the absence of strong heat, which causes the denaturation of sensitive biomolecules like proteins.

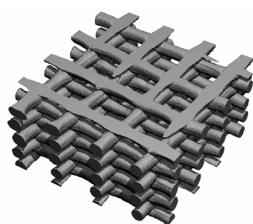


Fig. 1: μ computertomographic image of a PLGA-3D scaffold. Strand diameter is 200 μ m.

METHODS: A new 3D dispensing process (3D Bioplotting) has been introduced at the Freiburger Materialforschungszentrum recently¹. Key feature of this process is the 3D dispensing of strands of a viscous plotting material into a liquid medium. As a consequence of the buoyancy compensation, architectures can be fabricated mostly without requiring temporary support structures and especially processing of low viscous materials with low viscosities is facilitated² profit. The 3D Bioplotter can therefore process a remarkable wide variety of different materials including polymer melts, thermoset resins, polymer solutions, pastes with high filler content and hydrogel precursors³. More general is the approach A more viable general approach is based upon dispensing to dispense biomaterials continuously into a liquid medium with a matching density. This commercial RP process technique became known as became known as 3D Bio The curing after dispensing can be achieved by a

physical phase transition or a chemical reaction (i.e. between material and medium). Nevertheless, one main disadvantage of 3D Bioplotter scaffolds is the smooth surface of the strands, which is unfavourable during cell seeding.

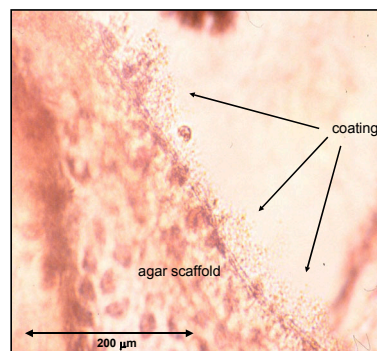


Fig. 2: 25 μ m thick calcium alginate/calcium hyaluronate coating on the surface of an agar scaffold.

RESULTS: Different attempts have been made to make the hydrogel (agarose) scaffold strand surface more rough and to change its chemical nature, which has been evaluated by observing the cell attachment. Most successful were precipitation reactions performed at the scaffold surface by using a loading technique. The hydrogel scaffolds were placed in an aqueous solution of reactant A, loaded, washed and dipped in an aqueous solution of reactant B. The molecules of A diffusing to the interface, start the reaction with B and the reaction product precipitates in a fur-like coating at the phase border. Suitable reaction types are especially the complex formation of polyelectrolytes with low molecular weight ions and the enzymatic gelation of fibrinogen with thrombin. Cell attachment is significantly enhanced by this type of surface modification.

CONCLUSION: Combination of modern processing technologies for biomaterials and suitable surface modification reactions provides scaffolds highly desirable for TE applications.

REFERENCES: ¹R.Landers, R.Mülhaupt (2000) *Macromol. Mater. Eng.* **282**: 17-21. ²R.Landers, A.Pfister, U.Hübner, et al, (2002) *J. Mat. Sci.* **37**: 1-10. ³R.Landers, U.Hübner, R.Schmelzeisen, et al (2002) *Biomaterials*, **23**: 4437- 4447.

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