https://doi.org/10.2352/ISSN.2169-4451.2017.32.5

Materials and Fabrication Methods for Biofabrication

Jürgen Groll
Chair for Functional Materials in Medicine and Dentistry, University of Würzburg, Pleicherwall 2, 97070 Würzburg, Germany
Juergen.groll@fmz.uni-wuerzburg.de

Abstract

Within tissue engineering and regenerative medicine, Biofabrication is a young and dynamically evolving field of research [1]. It aims at the automated generation of hierarchical tissue-like structures from cells and materials through Bioprinting or Bioassembly. This approach has the potential to overcome a number of classical challenges relating to organization, personalized shape and mechanical integrity of generated constructs.

Although this has allowed achieving some remarkable successes, it has recently become evident that the lack of variety in printable hydrogel systems is one major drawback for the complete field [2]. In order to be suitable for Biofabrication, hydrogels have to comply with a number of prerequisites with regards to rheological behavior and especially stabilization of the printed structure instantly after printing, while at the same time allowing the cells to proliferate. Also fabrication techniques are often not ideal and need to be optimized for the printing of anatomical structures.

This lecture will briefly introduce the field and the major printing techniques, as well as the most important demands on materials and fabrication techniques. It will then introduce a new method for the rational design of thermoplast fibre constructs by the combination of melt electrospinning with automated movement of the collector (Melt electrospinning writing). This technique allows for the generation of highly regular fibrous constructs with pore sizes in cellular dimensions and fibre diameters down to submicrometer [3]. Printing of anatomical structures that would not be accessible otherwise will be demonstrated at one example.

The lecture will then focus on printable hydrogels. Thiol-ene cross-linking of poly(glycidyl-co-allylglycidylether) based 3D plotted hydrogels will be introduced [4] as alternative to the often used free radical polymerization to stabilize printed hydrogel structures with high resolution and reproducibility. Furthermore, a purely physically cross-linked system based on recombinant spider silk proteins will be introduced [5], in which beta-sheet interactions facilitate good printability and stability of the constructs.

References

[1] J. Groll, T. Boland, T. Blunk, J.A. Burdick, D.-W. Cho, P.D. Dalton, B. Derby, G. Forgacs, Q. Li, V.A. Mironov, L. Moroni, M. Nakamura, W. Shu, S. Takeuchi, G. Vozzi, T.B.F. Woodfield, T. Xu, J.J. Yoo, J. Malda: Biofabrication: Reappraising the definition of an evolving field. Biofabrication 2016, 8, 013001.

[2] T. Jüngst, W. Smolan, K. Schacht, T. Scheibel, J. Groll: Strategies and Molecular Design Criteria for 3D Printable Hydrogels. Chemical Reviews, 2016, 116 (3), 1496.

[3] G. Hochleitner, T. Jüngst, T. D. Brown, K. Hahn, C. Moseke, F. Jakob, P. D. Dalton, J. Groll: Additive Manufacturing of Scaffolds with Sub-micron Filaments via Melt Electrospinning Writing. Biofabrication 2015, 7, 035002.

[4] S. Stichler, T. Jungst, M. Schamel, I. Zilkowski, M. Kuhlmann, T. Böck, T. Blunk, J. Teßmar, J. Groll: Thiol-ene clickable poly(glycidol) hydrogels for biofabrication. Annals of Biomedical Engineering, published online: http://link.springer.com/article/10.1007/s10439-016-1633-3.

[5] K. Schacht, T. Jüngst, M. Schweinlin, A. Ewald, J. Groll, T. Scheibel: Biofabrication of Cell-loaded, 3D Recombinant Spider Silk Constructs. Angewandte Chemie International Edition 2015, 54 (9), 2816.