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3D-Printing of bioceramics for bone regeneration applications

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The use of bioceramics like calcium phosphates or bioactive glasses for the regeneration of critical bone defects, as they can occur for example after serious injury or diseases is intensively researched worldwide. The advantages of the additive manufacturing technology make it possible to process these ceramics into customized patient-specific implants, so called scaffolds. In this work the process chain of powder-based inkjet-3D-printing is presented. This includes the production of bioceramic suspensions from bioglass, calcium phosphates and composites and spray dry granulation to obtain flowable granulates. 3D- printing is performed from CAD-modeling to postprocessing of the printed structures. Printed components are sintered and characterized with respect to mechanical properties and in vitro biocompatibility. After sintering the scaffolds show high porosity (about 70 %) and high surface roughness (Ra about 25 µm, Rz up to 200 µm) which is beneficial for the colonization of bone cells. The compressive strength was lower than 1 MPa for every scaffold, what makes them inappropriate for load bearing applications. In vitro tests using MG-63 stem cells showed an effective growth of cells on the outer and inner surface of the scaffolds and the formation of reinforcing secondary hydroxyapatite crystals.

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