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3D Printing of Microspheres for Tissue Engineering Scaffolds

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Microspheres have tremendous potential as a scaffold material for tissue engineering applications due to their capability of encapsulation and controlled release of factors that assist tissue regeneration in the desired fashion. Gradient scaffolds consisting of multiple types of microspheres can release different factors at different sites of the scaffold. Current microsphere scaffold production methods, however, cannot address the need for internal architectures to meet specific requirements in different scaffold regions, e.g., for mechanical properties or porosity. We combined 3D printing and microspheres to create scaffolds with defined internal architectures and tailored placing of materials, intended for bone/cartilage interfaces.
Poly(lactic-co-glycolic acid) microspheres were mixed with alginate to create a highly viscous suspension, which was manually expressed through a syringe needle to test feasibility. Subsequently, scaffolds were fabricated using a RepRap printer equipped with a syringe extruder.
The matrix of the printed material dried and hardened quickly through evaporation of water. This allowed to print a porous “green” body, which was then further stabilized by sintering. The amount of alginate played an important role on the suspension’s viscosity and drying time to fabricate a stable construct without sagging in unsupported areas.
This is the first demonstration of direct 3D printing of microsphere based scaffolds. This adds a high degree of freedom for the fabrication of such scaffolds with local definitions for mechanical properties, porosity, focal placement of phases, and controlled release of encapsulated factors.
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