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Abstract

Piezoelectric and bioactive composites: Functional materials for bone tissue engineering

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When deformed, piezoelectric biomaterials generate electricity, creating a microenvironment to electrically stimulate cells, which can restore essential functions in biological tissues. In previous studies, the beneficial effects of electrical stimulation have shown to significantly impacted bone formation, cartilage repair, and neurological tissue regeneration [1]–[4]. However, preparing piezoelectric and bioactive bone substitute materials remains a challenge in the field. Here, we report barium titanate composites in combination with established bone substitute materials, such as hydroxyapatite, or bioactive glass, as multi-functional bone substitute materials. By 3D printing, the piezoelectric composites are processed into porous and piezoelectric scaffolds, achieving piezoelectric constants d33 of 3-40 pC/N, which are in the range of native bone or above [5]. Especially with 45S5 bioactive glass, the materials show profound cytocompatibility and bioactive properties, inducing the formation of calcium phosphates on the scaffold surface. Piezoelectric composites based on barium titanate combined with modern manufacturing methods represent a promising approach to create bioactive and electrically stimulating implants. In the future, the electricity and bioactivity generated by such materials at the implant site may be harnessed without an external source or electrodes, thus acting as autonomous electroactive implants.

Author's statement

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