Sonochemical mineralization treatment of biomaterials: surface bioactivation, osseointregration and *in vivo* drug release

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The research presents the novel approach to surface functionalization of bone biomaterials aimed to enhancing their bioactivity and osseointegration. This approach presents the ultrasound-assisted oriented aggregation-based $CaCO_3$ crystal growth process, guided by substrate architecture (the implant structure) – so-called sonochemical mineralization approach, inspired by natural biomineralization processes occurring in living organisms. The technique developed allows to obtain homogeneous coatings based on porous $CaCO_3$ (vaterite) and is applicable for various substrates including highly porous nonwoven electrospun polymeric matrices and hydrogel networks.

The vaterite mineralization was applied for polymeric electrospun matrices and gellan gum hedrogel samples. Both for polymeric and hedrogel substrates, vaterite coating improved adhesion properties, which allowed to promote better cell adhesion, viability and proliferation. Implantation tests *in vivo* in white rats performed with vaterite-mineralized polymeric matrices, demonstrated the better osseointegration and recovering of bone defect, in comparison with non-mineralized matrices.

Along with bioactivation and improved osseointegration of biomaterials, the porous structure of vaterite provides the functionality of drug storage and delivery. Mineralized polymeric scaffolds with immobilized bioactive molecules demonstrated the modulation of the regeneration processes in tissues in course of the *in vivo* implantation. It was demonstrated, that scaffold with the tannic acid had the effect of moderation on the angiogenesis and decreased the tissue inflammation and hemorrhages caused by surgical intervention.

Thus, the developed approach demonstrated perspectives for bone implants designing with enhanced therapeutic functionality and osseointegration.

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