American Mineralogist, Volume 102, pages 2170–2179, 2017

SPECIAL COLLECTION: BIOMATERIALS—MINERALOGY MEETS MEDICINE

Calcium (Ti,Zr) hexaorthophosphate bioceramics for electrically stimulated biomedical implant devices: A position paper

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Abstract

Osseointegration of biomedical implants as well as healing of broken bones are supported by novel bioceramic materials that, owing to their engineered ionic conductivity, in the presence of an electric field provide accumulation of negative electrical charges close to the interface between an implant and living bone tissue, thus stimulating the rate of bone growth. In this position paper, the structure as well as the chemical, electrical, and biomedical properties of Ca (Ti,Zr) hexaorthophosphates are reviewed. In addition, based on evaluation of the material's properties, a conceptual configuration of a capacity-coupled bone growth stimulator will be presented. The advantage of the proposed novel device over already existing bone-growth stimulators is its provision of the intimate contact of a capacity-coupled electric field with the growing bone tissue as opposed to an externally applied inductively coupled electromagnetic field, which suffers substantial attenuation when transmitted through soft tissue covering the locus of bone growth. To achieve higher ionic conductivity in Ca (Ti,Zr) hexaorthophosphates, aliovalent doping with highly mobile Na or Li ions intercalated into the only partially occupied M1 sites appears to be a suitable route.

Keywords: Bioceramics, calcium hexaorthophosphate, plasma spraying, solubility, osseoconductivity, bone growth, bone growth stimulation, Biomaterials—Mineralogy Meets Medicine