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SPECIAL COLLECTION: APATITE: A COMMON MINERAL, UNCOMMONLY VERSATILE

Tracking the thermal decomposition of plasma-sprayed hydroxylapatite†

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Abstract

In modern orthopedics, plasma-sprayed hydroxylapatite coatings are applied routinely to metallic parts of hip and knee prostheses, as well as to dental root implants to render them osseoconductive, that is, able to assist the body in creating new bone by ingrowth of bone cells, blood capillaries, and soft tissue. In this work, hydroxylapatite coatings were deposited by atmospheric plasma spraying on titanium alloy substrates, and characterized by synchrotron radiation X-ray diffraction and solid-state nuclear magnetic resonance spectroscopy. The deposition parameters were varied using a statistical design of experiments methodology. Depending on the degree of heat input and heat transfer rates, (1) dehydroxylated hydroxylapatite phases such as oxy- and oxyhydroxylapatite, (2) thermal decomposition phases (tri- and tetracalcium phosphates, CaO), and (3) amorphous calcium phosphate were formed. Implications of this research are that oxyapatite appears to be unstable at ambient conditions, and that proper selection of intrinsic plasma-spray parameters is key to the chemical stability and mechanical performance of the coating.

Keywords: Hydroxylapatite, oxyhydroxylapatite, oxyapatite, amorphous calcium phosphate, plasma spraying, osseoconductive coatings, implants