THE SUMMARY OF Ph. D. DISSERTATION

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Title

Effects of chemical interaction with bio-organic matrix on crystallographic properties and preferential growth of hydroxyapatite nanocrystals

Abstract

The main mineral phase of natural vertebrate bones and teeth is hydroxyapatite [HAp: $Ca_{10}(PO_4)_6(OH)_2$], and hence HAp has been extensively studied for orthopedic and dental applications. However, a single phase HAp cannot meet the functional needs of bone implants due to its brittleness and insufficient mechanical toughness.

Natural bone is a composite material in which collagen fibers are effectively reinforced by an assembly of HAp nanocrystals. In order to prepare better nano-nano composite instead of nano-micro composite, which mimics the microstructure of natural vertebrate bone, the author prepared hydroxyapatite-based nanocomposites via a wet-mechanochemical route from $Ca(OH)_2$ and H_3PO_4 with silk fibroin (SF) or sodium hyaluronate (HYA), serving as an organic matrix. Moreover, chemical disintegration pretreatment of bio-organics was performed in an attempt to increase the nucleation sites for HAp. The effects of the mechanochemical stress and chemical disintegration pretreatment of bio-organics on the crystallographic properties and preferential alignment of HAp were examined.

In the presence of bio-organics, crystallinity of HAp was increased by the wet-mechanochemical processing. It was found that crystallite size and aspect ratio of mechanochemically synthesized HAp were close to those of swine trabecular bone. The increase in the crystallinity of HAp after milling can be explained in terms of promoted recrystallization by the significant chemical interaction between the mineral phase and the organic matrix.

Crystallinity of HAp in the HAp-SF nanocomposites was also increased by the preliminary disintegration of SF. Adsorption amounts of cations on SF were increased by the chemical disintegration of SF. The preferential *c*-axis alignment of HAp nanocrystals is oriented to the longitudinal direction of the aggregates. These nanocomposites are expected to be potential candidates for biocompatible materials after optimizing its formulation.