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Amorphous calcium phosphates synthesized by precipitation from calcium D-gluconate solutions

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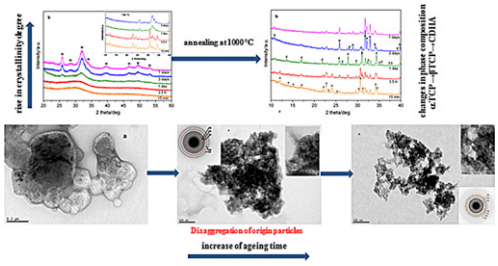
HIGHLIGHTS

- Preparation of calcium phosphates from non-toxic calcium D-gluconate solutions.
- Rise in crystallinity causes changes in phase composition after thermal treatment.
- β-TCP phase is formed via nanocrystalline hydroxyapatite-like precursor.
- α-TCP is created from phase with high content of amorphous matrix.
- Rise of particle dissagregation to well-ordered nanoclusters with aging time.

GRAPHICAL ABSTRACT



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ABSTRACT

The amorphous calcium phosphates were synthesized by the precipitation from non-toxic calcium D-gluconate precursor solutions. The low number of nanosized well-ordered calcium deficient hydroxyapatite clusters separated with amorphous calcium phosphate matrix was found at short aging times. The content of intramolecular water in aggregates decreased with an amount of well-ordered clusters and maturation time. The majority α-tricalcium phosphate phase and calcium deficient calcium phosphate were formed after annealing of samples with a high volume fraction of amorphous matrix and nanocrystalline apatite-like phase respectively. The very fine nanocrystalline calcium deficient hydroxyapatite was intermediate phase during thermal transformation to the final β-tricalcium phosphate. The rise of disaggregation of coarse particles to smaller well-ordered hydroxyapatite clusters with aging time was verified. The different amount and size of nanocrystalline clusters were responsible for the formation of various calcium phosphate phases after thermal treatment.

1. Introduction

The amorphous calcium orthophosphates (ACP) have a great biomedical importance due to their chemical and structural similarities to calcified mammalian tissues and they are one of the most frequent forms of calcium phosphate minerals in biological organisms. The ACP phase is an intermediate phase in the preparation calcium phosphates by precipitation [1,2]. The formation of ACP was affected by the presence of various organic additives to starting reactants [3–5] at different pH and they can be synthesized from organic precursors [6], ethanol solutions [7], mechanochemically [8] or e.g. thermal spray synthesis [9]. It has been showed that water addition to ethanol solution of reactant enhances the creation of ACP [10]. Results of EXAFS spectroscopy verified only short range ordering in ACP, which convert to long range with rise of crystallinity of ACP during maturation [11]. Two structurally

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