

## A new preparation technique of the resorbable silicon-substituted calcium phosphates

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**INTRODUCTION:** It is well established that trace elements such as magnesium, carbon (as carbonate) and fluorine (as fluoride) in calcium phosphate ceramics and coatings strongly influence both the biological response of implant materials, and affect the crystallographic, mechanical and chemical properties of manufactured ceramics and coatings. Since recently, silicon is also included into this list of trace elements: silicon-contained and/or silica-substituted calcium phosphates catch the attention of researchers and industrial manufacturers of bone grafts.<sup>1,2</sup> Precipitation is the standard preparation technique of silicon-substituted calcium phosphates which occurs by mixing of calcium- and phosphate-containing solutions at pH ~ 10 in presence of a silicon-containing compound, followed by aging, filtration, washing off, drying and sintering at 900 – 1200 °C. In this report we are going to present a simplified preparation technique of silicon-substituted calcium phosphates.

**METHODS:** Chemically pure solid calcium nitrate  $\text{Ca}(\text{NO}_3)_2 \cdot 6\text{H}_2\text{O}$ , solid ammonium dihydrogenphosphate  $\text{NH}_4\text{H}_2\text{PO}_4$ , liquid ammonium hydroxide (25% aqueous solution), and a very fine dry powder of silica-gel were used as initial chemicals. In order to prepare silicon-contained calcium phosphates, solid calcium nitrate was mixed with solid ammonium dihydrogenphosphate on the desired Ca/P molar ratios. Then, a necessary amount of solid silica-gel (the amount depended on the desired Si/P molar ratio) was added and the entire blend was mixed. Afterward, the mixture was placed into a alumina crucible and a small amount (to get approximately 1 : 1 of the liquid/solid ratio) of either pure deionized water or aqueous solution of ammonium hydroxide was added into the crucible. Finally, the crucible was placed into a furnace and the suspension was sintered at 1000 °C for 4 hours (ramp rate 3°C/min), followed by cooling down to ambient temperature. The resulting powder was analyzed by SEM, XRD, IR-spectroscopy and by chemical analysis.

**RESULTS:** The experimental results revealed that depending on the initially selected Ca/P and Si/P molar ratios of the initial reagents, the final

compounds might have either the structure and composition of a silicon-substituted hydroxyapatite, similar to that described by Gibson et al.<sup>2</sup>, or a triphase mixture of silicon-stabilized  $\alpha$ -tricalcium phosphate, hydroxyapatite and small amount of  $\beta$ -tricalcium phosphate similar to the product described by Langstaff et al.<sup>1</sup>. Dissolution experiments performed in slightly acidified (pH = 6.5) solutions of simulated body fluid revealed dissolution of both compounds.

**DISCUSSION & CONCLUSIONS:** Therefore, resorbable silicon-contained calcium phosphates might be easily prepared by a single stage which makes unnecessary the stages of aging, filtration, washing and drying. Presumably, the biological behavior of the simplify-prepared silicon-containing calcium phosphates should not be different from those prepared using the routine way (this needs to be verified). However, we believe that this simplified preparation technique of silicon-substituted calcium phosphates will reduce the production costs and make artificial bone grafts more affordable in the market.

**REFERENCES:** <sup>1</sup> S.D. Langstaff, M Sayer, T.J.N. Smith, S.M. Pugh (2001) *Biomaterials* **22**, 135 – 150. <sup>2</sup> I.R. Gibson, S.M. Best, W. Bonfield (2002) *J. Am. Ceram. Soc.*, **85**, 2771 – 2777.