# Degradation Behavior of Porous Calcium Phosphates

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## Abstract

Concerning an ideal scaffold, evaluation of many factors, such as porosity, porous size and mechanical properties are needed so as to investigate degradation behavior in addition to chemistry and structure of materials used. In this study, the porous calcium phosphates were made on addition of a pore-former compound (PVA) by sinter processing. Mechanical properties, morphology, and weight change in in vitro testing were assessed. Experimental results indicated macropore sizes as large as hundreds of micrometers were generated and many micropores were also observed in the sintered body. After immersion in Hanks' solution, on the body surface there was a pitting appearance with immersion-induced micropores. The compressive strength of as-sintered bodies decreased steadily with addition of PVA. With increasing immersion time, the compressive strength and modulus of various porous bodies decreased and the weight loss increased. The biomedical uses of the present porous materials might limit to use as bone defect repair.

***Keywords*:** Tissue engineering, Porous scaffold, Mechanical property, Calcium phosphate

## Introduction

Tissue engineering is regarded as one of the bioscience for guiding body to regenerate or repair tissues, when organ and tissue lose or failure occurs [1-3]. The scaffold is a temporary supporting structure of tissue-engineered constructions and it needs to be selected carefully. The scaffold materials must be biocompatible and bioresorbable with controllable degradation rates to match tissue replacement [1-2,4-5]. Besides suitable surface chemistry, the scaffold architecture provides sufficient space and suitable mechanical properties for the tissues regeneration [1-2]. Hence, the use of biodegradable biomaterials as bone scaffolds has attracted a great deal of attention and a variety of fabrication methods have been proposed to produce porous scaffolds with interconnected pore networks [3-6]. Porous biodegradable synthetic materials, such as calcium phosphates, poly(lactic acid) (PLA), and poly(glycolic acid) (PGA), are currently tested as implants for the regeneration of damaged and diseased tissues [2-4,7].

The available synthetic biodegradable calcium phosphate ceramics for bone tissue regeneration include hydroxyapatite (HA), β-tricalcium phosphate (β-TCP), and calcium polyphosphate [3,4,6,7]. The biodegradation behavior of calcium polyphosphate materials in both in vitro and in vivo has been reported [6-10]. Utilizing solid freeform fabrication to build porous parts of calcium polyphosphate, Porter *et al.* [8] found a decline in mechanical strength in tris-buffered solution. Lee *et al.* [9] suggested that the composite graft of marrow-derived mesenchymal cells and porous calcium polyphosphate may be useful for the repair of bone defects.

Few studies on the variations in mechanical properties of porous calcium phosphates, when immersed in simulated body fluid have been exploited. In the present study, porous calcium phosphates were prepared by sintering mixtures of monocalcium phosphate monohydrate (MCPM, $Ca(H_2PO_4)_2 \cdot H_2O$) and polyvinyl alcohol (PVA). To impart porosity to the ceramic body, the PVA was burned out during firing, leaving free space in the resulting body. The degradation behavior of porous bodies was characterized by monitoring changes in compressive strength, compressive modulus as well as weight loss in simulated physiological solution.

## Materials and Methods

Commercially pure MCPM and PVA powders (Showa, Tokyo, Japan) were used. The as-received MCPM powder was directly mixed with PVA in a vacuum mixer (VM-112T, J.Morita, Saitama, Japan) for 5 minutes to ensure homogeneity. Four different types of porous bodies were prepared from mixtures of MCPM and PVA powders with different ratios (75/25, 67/33, 60/40, and 50/50 by weight). For simplicity, throughout this study the green body and the sintered body derived from the same mixture are designated with the same code. For example, the specimen code "67C33V" stands for both the mixture containing 67 wt% MCPM and 33 wt% PVA

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