ABSTRACTS (MASTER THESIS)

Biomineralization by using cellulose nanofiber gel

**(Graduate School of Agriculture,
Laboratory of Active Bio-based Materials, RISH, Kyoto University)**

Akihiro Matsushita

Introduction

Biominerals are composites of bioorganic polymers such as polysaccharides or proteins and inorganic materials; examples include shells and bones. The process by which organisms create biominerals is called biomineralization. Biominerals can be imitated and used for artificial bones and teeth.

In this study, a strong hydrogel was prepared from cellulose nanofibers (CNFs) and used as a substrate for biomineralization. CNFs, which are the major constituent of plant cell walls, are the most abundant natural nanofibers on earth. Their widths range from 5 to 30 nm and they are highly crystalline materials. The resultant stable structure has outstanding mechanical properties, including a high Young's modulus and a low coefficient of thermal expansion. CNFs therefore have great potential for use as reinforcements in nanocomposites and have attracted a great deal of interest recently. The aim of this study was to imitate a biomineral structure by using a CNF gel and calcium phosphate, to produce a biomaterial for artificial bones.

Experimental

Cellulose was isolated from Japanese cypress wood powder by the Wise method and treatment with 6 wt% potassium hydroxide. A CNF suspension was prepared by grinding the cellulose with a grinder. A CNF/calcium phosphate composite was prepared by dipping the CNF gel (fiber content about 10 wt%, thickness about 500 μm) in 0.6 M diammonium hydrogen phosphate solution (1) and 1.0 M calcium nitrate solution (2). Immersion in (1) and (2) was regarded as one cycle, and 1 to 5 cycles were performed. A tensile test was conducted on a sample conditioned for 1 day in a humidity controller.

Results and discussion

Calcium phosphate was successfully deposited on the surface and inside of the CNF gel. The reaction on the gel surface progressed well, therefore a large amount of calcium phosphate adhered to the gel surface. X-ray diffraction analysis of the obtained composite showed peaks corresponding to hydroxyapatite and octacalcium phosphate. These are two of a number of calcium phosphate types, and are both present in natural and artificial bones. This method therefore has potential applications for use in materials such as artificial bone.

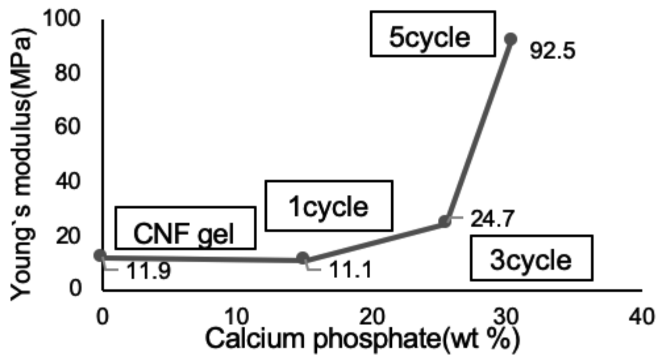

Figure 1. Relationship between Young's modulus and weight percentage of calcium phosphate

Figure 1 shows the changes in Young's modulus with increasing weight ratio of calcium phosphate to composite. This figure shows that the Young's modulus of the composites improved greatly when the weight percentage of calcium phosphate reached about 30%. This suggests that a calcium phosphate network was formed on the surface or inside of the CNF gel when the weight percentage was 30% or more.