

EFFECT OF ION RELEASE ON APATITE-FORMING ABILITY OF CELLULOSE NANOFIBER-CALCIUM PHOSPHATE COMPOSITES

Takeshi Yabutsuka, Takuya Yoshioka, Shigeomi Takai

Graduate School of Energy Science, Kyoto University, Yoshida-honmachi, Sakyo-ku, Kyoto 606-8501, Japan

ABSTRACT

Cellulose nanofiber (CNF)-apatite nucleus (AN) composite and CNF-hydroxyapatite (HA) composite were fabricated by mixing AN or HA with CNF. In simulated body fluid, the CNF-AN composite showed HA formation within 1 day. The apatite-forming ability of the CNF-AN composite was considerably higher than that of the CNF-HA composite. It was suggested that such difference of apatite-forming ability was because of the solubility of AN and HA.

Keywords: Cellulose nanofiber, Apatite nucleus, Composite, Apatite-forming ability, Simulated body fluid, Ion release

INTRODUCTION

Cellulose nanofiber (CNF) is one of the plant-derived material with high mechanical strength, low thermal expansivity, light weight and biocompatibility. From these properties, CNF has been focused as the next-generation biomaterials [1]. If bioactivity, that is, apatite-forming ability in body environment, can be provided to CNF, it will be expected to develop novel advanced bone substitutes and scaffolds with suitable mechanical or biological properties such as flexibility, low elastic modulus and good bone-bonding ability in orthopaedic or dental application.

When the pH, the temperature, or the concentration of simulated body fluid (SBF) [2-5] with inorganic ion concentrations nearly equal to those of human blood plasma are increased, fine particles calcium phosphate were precipitated. Recently, we found that these fine particles are highly active to induce hydroxyapatite (HA) formation in the physiological SBF and named the particle apatite nucleus (AN) [6].

In order to provide apatite-forming ability to various types of bioinert materials, we focused the incorporation of AN inside or surface of the bioinert materials in a recent decade [7]. In the previous study, the AN was incorporated inside of the CNF matrix and high apatite-forming ability was provided to the CNF [8]. However, the mechanism of this high apatite-forming ability has not been clarified yet. In this study, we mixed AN or HA particles in CNF matrix and evaluated the difference of apatite-forming ability through SBF immersion test and solubility test of AN or HA particles in biomimetic environment.

METHODS

An aqueous solution of double concentration of SBF was prepared by dissolving 15.992 g NaCl, 0.700 g $NaHCO_3$, 0.448 g KCl, 0.456 g $K_2HPO_4 \cdot 3H_2O$, 0.610 g $MgCl_2 \cdot 6H_2O$, 0.556 g $CaCl_2$, 0.142 g Na_2SO_4 in 1 L distilled water. This solution was adjusted for pH 8.20 at 36.5 ºC by dissolving 1 M HCl and tris-buffer and, subsequently, held in an incubator at 36.5 ℃ for 1 day. By this treatment, AN was precipitated in the solution. The AN were filtered by suction, washed with distilled water and air-dried.

ISBN: 987-1-7752455-7-5