Proceedings of the 2nd World Congress on Mechanical, Chemical, and Material Engineering (MCM'16)
Budapest, Hungary – August 22 – 23, 2016
Paper No. MMME 122
DOI: 10.11159/mmme16.122

Hydroxyapatite Formation on Single Crystal of Calcium Carbonate under Hydrothermal Condition

Ill Yong Kim, Chikara Ohtsuki
Graduate school of Engineering, Nagoya University
B2-6(611) Furo-cho, Chikusa-ku, Nagoya, 464-8603 Japan
kim.ill-yong@apchem.nagoya-u.ac.jp; ohtsuki@apchem.nagoya-u.ac.jp

Extended Abstract

Hydroxyapatite (HAp, $Ca_{10}(PO_4)_6(OH)_2$) crystals as a main mineral in living bones are oriented among collagen fibers. To develop a novel artificial bone, fabrication of oriented HAp crystals is one of important prospects on processing of ceramic biomaterials. Hydrothermal processing is known as a typical processing for fabrication of well-grown HAp crystals with unique morphology [1-3]. On the hydrothermal processing, calcium carbonate is often used as a source of calcium ion to result in formation of non-stoichiometric HAp with carbonate of 4-8 mass%. However, the detailed process on formation of HAp from calcium carbonate under hydrothermal condition has been not clarified yet. To understand the formation of HAp crystals, we investigated the HAp-forming behavior on the surface of single crystal of calcite under hydrothermal condition, since single crystal provides uniform reaction on crystal face exposed to the surrounding fluid. In the present study, hydrothermal treatment was applied to either {104} or (100) plane of calcite, to observe effects the resultant morphology of the formed HAp.

Single crystal of optically clear natural calcite with {104} or (100) face was used as the starting material. The calcite specimens were placed in Teflon®-lined autoclaves with a phosphate solution. The sealed autoclave was heated at 160 °C. After heating, the samples were removed from the solution, washed, followed by drying. The surface and cross-section of the obtained specimens were observed under a scanning electron microscope (SEM). X-ray diffraction (XRD) and transmission electron microscopy was used to confirm the HAp formation and determine its orientation.

After the hydrothermal treatment, optically clear specimens became opaque. The XRD patterns showed formation of HAp on both the surfaces with {104} and (100) face. SEM observation on the cross-section of the specimens revealed that a layer consisting of needle-like and oriented HAp were formed on the surface of the specimen with {104} face while nano-sized crystals were observed on the (100) face. The thickness of the HAp layer reached approximately to 110 μm after the hydrothermal treatment for 24 h. The HAp formation on the surface of calcite proceeded through dissolution of calcite, and the subsequent reaction between calcium and phosphate ions. The (100) plane indicates lower dissolution than {104}. Hence HAp growth was prevented on the (100) plane of calcite. The difference of morphology and crystal growth of HAp was generated by reactivity of each crystal face of calcite.

References

[1] I. Y. Kim, K. Kikuta, and C. Ohtsuki, "Formation of Oriented Hydroxyapatite Rods by Hydrothermal Treatment of Calcite Single Crystal," *Kor. J. Mater. Res*., vol. 22, pp. 397-402. 2012.
[2] I. Y. Kim, K. Kikuta, and C. Ohtsuki, "Hydroxyapatite formation through dissolution-precipitation reaction: Effects of solubility of starting materials," *Ceram. Int.*, vol. 40, pp. 14385-14390, 2014.
[3] I. Y. Kim and C. Ohtsuki, "Hydroxyapatite formation from calcium carbonate single crystal under hydrothermal condition: Effects of processing temperature," *Ceram. Int.*, vol. 42, pp. 1886-1890, 2016.