Microstructure of Hydroxyapatite from Waste Eggshell Synthesized under Different Temperature

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Introduction

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References
Introduction

BONE

Support

Protection

Movement

Blood Cell Production
Introduction

Bone structure

approximately 60-70% is bone mineral

Calcium phosphate

Hydroxyapatite
Introduction

Broken bone
loss bone

Accident

Porous/Brittle bone
Introduction

Bone replacement material

Bioinert

Bioactive

Bioresorbable
Introduction

Bioactive Hydroxyapatite

Applications

Human bone contains 60%-70%
Introduction

Hydroxyapatite synthesizing

Calcium phosphate

Calcium ions

Phosphate ions

Sea shell

Coral reef

Bovine bone

Eggshell
Introduction

Why the eggshell can be used for synthesizing hydroxyapatite?

Calcium 95%

\( \text{CaCO}_3 \) 94%

\( \text{Ca(PO}_4\text{)}_2 \) 1%

Magnesium 1%

Organic 4%

Membrane

Collagen 35%

Glucosamine 10%

Chondroitin 9%

Hyaluronic acid 5-10%
Introduction

Some method to synthesis the hydroxyapatite

- **Solid state**
  - Very low cost
  - Lack of purity
  - Large particle

- **Sol gel**
  - Small particle
  - 20 – 50 nm
  - High cost of precursors
  - Easy to control

- **Wet chemical**
  - Small particle
  - Low cost

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Objectives

- To synthesis hydroxyapatite from waste eggshells.
- To study the effect of hydroxyapatite synthesizing under different temperature.
- To study the temperature effect on hydroxyapatite from waste eggshell.
Experimental details

Chemical precursors

Chicken eggshell

DI-AMMONIUM HYDROGEN ORTHOPHOSPHATE

\((\text{NH}_4)_2\text{HPO}_4 = 132.06\)

B/NO.1409179686

500g NET

Ajax Finechem Pty Ltd
Hydroxyapatite synthesizing

Heat at 1300°C

\[ CaCO_3 \rightarrow CaO + CO_2 \]

CaO + DI water + Ca(OH)_2 Solution → Di-ammonium hydrogen orthophosphate + Di water + PO_4^{3-} Solution

Stir 30 min

Keep at 200 - 700°C for 4 H
Dried at 80°C for 48 H

Hydroxyapatite
Experimental details

Sample characterization

All of sample

Furnace

Heat at 200-800°C

XRD

FESEM

FTIR
**Results & Discussions**

**Hydroxyapatite synthesizing**

\[
10\text{Ca(OH)}_2 + 6(\text{NH}_4)_2\text{HPO}_4 \xrightarrow{\text{Heat}} \text{Ca}_{10}(\text{PO}_4)_6(\text{OH})_2 + 12\text{NH}_3 + 18\text{H}_2\text{O}
\]

**Hydroxyapatite decomposition**

\[
\text{Ca}_{10}(\text{PO}_4)_6(\text{OH})_2 \xrightarrow{\text{Heat}} \text{CaO} + 3\text{Ca}_3(\text{PO}_4)_2 + \text{H}_2\text{O}
\]

<table>
<thead>
<tr>
<th>Wave number (cm(^{-1}))</th>
<th>Function Group</th>
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<tbody>
<tr>
<td>562 - 1095</td>
<td>(PO(_4)^{3-})</td>
</tr>
<tr>
<td>631</td>
<td>(OH(^-))</td>
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**Figure 1.** XRD patterns of hydroxyapatite were synthesized at various temperature.

**Figure 2.** FTIR spectra of hydroxyapatite were synthesized at various temperature.
Results & Discussions

FESEM images of hydroxyapatite various synthesizing temperature.

Figure 3. The FESEM images of sample powder were synthesized at various temperature.

[Images showing FESEM images at 200°C, 600°C, and 700°C]
Results & Discussions

Temperature effect of Hydroxyapatite from chicken egg shell

Figure 4. XRD patterns of hydroxyapatite were heated at various temperature.

\[ D = \frac{0.9 \lambda}{\beta \cos \theta} \]

Figure 5. The crystal size of hydroxyapatite were heated at various temperature.
Conclusions

- Hydroxyapatite can be synthesized from waste eggshells by reaction of Ca(OH)$_2$ and (NH$_4$)$_2$(HPO)$_4$.

- Hydroxyapatite transform to tri-calcium phosphate (Ca$_3$(PO$_4$)$_2$) at 700°C of synthesizing temperature.

- The particle size of hydroxyapatite synthesized from waste eggshells is around 50 nm.

- The crystalline size of hydroxyapatite increase with increasing the heating temperature and hydroxyapatite transform to Ca$_3$(PO$_4$)$_2$ after heat over 700°C.


Thank you!