Synthesis of $CaSiO_3$ through mechanochemical process and in-vitro bioactivity studies

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I need a co researcher from medical background for the in-vitro test

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Introduction

$CaSiO_3$, wollastonite is a biomaterial with excellent bioactivity and biocompatibility. It is commonly used as bone repair material (artificial bone) and dental root (Hazar, 2007). A common feature of all bioactive materials is that they can bind to living bone through a hydroxyapatite layer when in contact with simulated body fluids. Currently many research works has been carried out to produce $CaSiO_3$ via chemical precipitation method and it has been reported that $CaSiO_3$ is difficult to be densified in conventional sintering method by which the relative density is below 90%, bending strength below 100MPa, and fracture toughness (K_{IC}) below 1MPa (Hazar, 2008) . Besides that there is a crucial need to prepare homogeneous powder as MSiO$_3$ powders which exhibits low sinteribility. Moreover, this process consumes chemicals in order to precipitate $CaSiO_3$. In order to overcome these drawbacks there is a need to produce fine $CaSiO_3$ powder which has homogeneous particle size with narrow distribution. Mechanochemical process is an alternative process route to prepare $CaSiO_3$ powder. This process exhibits several advantages such as lower sintering temperature, homogeneous particle size with narrow particle size distribution and formation of $CaSiO_3$ at ambient temperature by using oxide materials which is inert (Palaniandy et al., 2008a). This process route is much cheaper and environmentally friendly compare to the chemical precipitation (Palaniandy and Jamil, 2008). The availability of local calcium carbonate and silica resources in Malaysia is an advantage criterion of this project as there is a huge possibility and opportunity to value add these resources to biomaterials.

References

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Objective

The main objective of this research work is to produce $CaSiO_3$ powder via mechanochemical process and to study the sintering behavior of $CaSiO_3$ powders. Besides that biocompatibility of $CaSiO_3$ powders will be evaluated from behavior of HAp formation in SBF solution.

Methodology

High purity CaO and SiO_2 will be ground in planetary mill by varying the mill rotational speed and milling time and this process will be continued till the formation of $CaSiO_3$ phase. The feed and mill sample will be characterized for chemical composition, phase analysis, particle size and its distribution and specific surface area. The milled $CaSiO_3$ will be calcined and sintered (compact disks) prior to in-vitro test.

In order to evaluate the bioactivity of the $CaSiO_3$ materials, the compact disks were put into the SBF. The ion concentrations of the SBF solution were adjusted to be similar to those in human blood plasma. The soaking process will be continued up to 30 days and the surface of the disks will be evaluated for phase analysis and morphology.

This part will be carried out by the co-researcher in medical school

Expected outcome from this work

- Development of new processing route to synthesis $CaSiO_3$ which can overcome the above mentioned limitations such as poor mechanical properties and sinteribility.
- Development of biomaterial with excellent bioactivity and biocompatibility which can be use for bone repair material (artificial bone) and dental root.
- Possibility of value adding the local resources in Malaysia that can be used as the raw material in biomaterial.