Waste-to-resource: eggshells as a source for next generation biomaterials for bone regeneration

Summary

The aim of this project is to covert egg shells and their constituents into bulk amorphous calcium phosphate for biomedical applications. The consolidation of the amorphous precursor may be carried out using powder technology and/or additive manufacturing technologies to produce micrometer sized interconnected porosity.

Research field:	Mechanical engineering
Supervisors:	Prashanth Konda Gokuldoss Jayaraj Jayamani
Availability:	This position is available.
Offered by:	School of Engineering Department of Mechanical and Industrial Engineering
Application deadline:	Applications are accepted between May 03, 2021 00:00 and May 31, 2021 23:59 (Europe/Zurich)

Description

Consolidation of amorphous calcium phosphate in to macroporous bone-like scaffolds. This involves:

- A detailed study on the crystallization kinetics using the combination of differential scanning calorimetry (DSC) and XRD to evaluate the activation energy for the crystallization process (up to 700 oC) of the ACP derived from eggshells. This information is critical for implementation of the subsequent tasks.
- Consolidation of ACP: The ACP will be consolidated into bulk form using spark plasma sintering (SPS), high pressure torsion (HPT) and selective laser sintering/melting (SLS/SLM) with selected process parameters (e.g temperature, pressure, environment) and with the knowledge gained from the crystalization kinetics. Structural (XRD) and microstructural (SEM) characterizatieeeon will be carried out of obtained specimens.
- Preparation of porous ACP: Depending on the consolidation results, the parameters used ITHfor obtaining amorphous structures will be utilized to produce porous samples using space-holder techniques (for SPS and HPT) and/or modified CAD data (for SLS/SLM) process. The goal will be to achieve the samples with 200-300 µm large interconnected porosity, which will be considered as the ideal sample in the present study. All the necessary characterizations like XRD, microscopy (including tomography), etc. will be carried out to ascertain the presence of pores and amorphous structure in the porous samples.
- Coating of porous structures with proteins from eggshell membrane: Dipping or vacuum infiltration technology will be used for coating of porous structures with proteins. The biocompatibility of all prepared materials will be further evaluated in detail.

Aim for ACP consolidated samples with density > 80% of theoretical density and 200-300 µm large interconnected porosity.

The applicants should fulfil the following requirements:

- Master's degree in Metallurgy / Materials Science or equivalent
- Experience in any / all of the following fields: alloy design, powder metallurgy, additive manufacturing, thermodynamics, materials characterization and testing
- High level of scientific integrity, rigor, and excellence with regard to experimental methodology, analysis of data, and scientific / technical reporting.
- Ability to work autonomously while being a good team player willing to perform and develop with the team.
- Creative and innovative mindset

- Required application documents: CV, motivation letter, degree certificates and passport copy

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