Master Thesis Announcement

Characteristics of Porous Ti-6Al-4V Implant Fabricated by Electron Beam Melting (EBM) for Biomedical Applications

Background

Additive manufacturing (AM) is revolutionizing the field of material science and has great potential for production of materials intended in clinical use. The restoration of lost body functions in the musculoskeletal system includes among others, hip and knee joints, dental implants, ostosynthesis and major limb amputation prosthesis, whereof almost all materials used today is manufactured by conventional techniques.

There are several benefits using AM, where innovative designs and multifunctional constructs could be readily made, with integrated porous systems allowing biomechanical fixation as well as modifying the overall stiffness of the construct. This is especially important for high load applications where a mismatch between the elastic properties of the materials and the surrounding tissue will have a negative effect on the maintenance of the tissues and thus long-term function.

One of the most promising AM processes for bone anchored implants is Electron Beam Melting (EBM)[1], a technology which locally melts the powder bed by an electron beam in high vacuum. The mechanical properties of an EBM produced materials could be improved as compared to conventionally produced materials[2, 3], while further offering the ability to tailor the macro design, lattice structure and porosity, thereby also the elastic modulus of the resulting construct[4, 5].

The bone healing capacity to EBM produced Ti solid implants[6-8] and porous constructs[9-14] have been evaluated experimentally with promising results. Furthermore, clinical use has been evaluated[15, 16].

Initial bone healing around an implanted metallic material will highly depend on the surface properties, which will alter the subsequent cell communication, recruitment and activity[17, 18] and thus result in different kinetics of healing[19, 20] or rejection of the material. The surface oxide and the microtopography are among the most important surface properties for the healing.

From a sustainability aspect, it is highly important to understand the effect and limits of reusing powder in the EBM process.

Hypothesis

The hypothesis of this project is that a reuse of powder could have a beneficial effect on the biological potential of porous implants by inducing a thickening of the surface oxide and increasing the surface topography.

Aims

The aim of the current project is to evaluate the surface and geometrical effect from reused powder in the EBM process.

Work Description

Porous scaffold is produced by EBM in Arcam AB (GE additive), according to a standard process. Half of the scaffolds are produced with virgin powder while the remaining are produced with a powder that has been recycled.

Powder samples are taken prior to the build.

This project includes the following packages: 1) Literature study; 2) Powder characterization: the powder samples are evaluated in terms of surface chemistry and morphology by XPS and SEM; 3) Porous scaffold characterization: the scaffolds are evaluated in terms of surface chemistry, surface morphology and geometry by XPS, SEM and microCT; 4) Report and possibly drafting of a scientific manuscript.

Project partners

Emmy Yu Cao at the Department of Industry and Materials Science, Chalmers University of Technology
Anders Palmquist at the Department of Biomaterials, University of Gothenburg
Joakim Ålgårdh at Arcam AB (GE additive)

Qualification

We are looking for you who are studying towards a Master of Science degree in the field of material science, applied physics or mechanical engineering.

Start of the thesis work:

Time frame: The thesis covers 30 credits / 20 weeks or 60 credits/40 weeks

Contact: Prof. Emmy Yu Cao (yu.cao@chalmers.se); Supervisor and examiner
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