Open position for a 4-Year Full-time Scientific Collaborator (towards PhD degree in Medical Sciences - KULeuven)

Leuven BIOMAT Research Cluster, Department of Conservative Dentistry* and Department of Prosthetic Dentistry**, Catholic University of Leuven, Belgium.

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Title of the project:

3D NANO-SCALE MODELLING OF HARD TISSUE-BIOMATERIAL INTERFACES

Content:

The current research project is closely aligned with clinical problems associated with the application and utilization of synthetic materials in the **reconstruction of damaged and/or diseased calcified tissues**. Recent developments in Dentistry promote the use of so-called **minimal-invasive** restoration therapies. Such an approach can only be achieved when the biomaterial integrates with the hard tissue, for instance through bioactivity, inducing the tissue to respond and thus to adapt to the biomaterial (like oral implants inserted in jaw bone), or at least through adhesive procedures that bring both the biomaterial and hard tissue in intimate contact (like adhesive tooth restorations).

A complex biomechanical entity is then formed, of which the clinical performance (in particular within the hazardous oral environment) is mainly controlled by the **quality of the interface between the biomaterial and human hard tissue**. Similarly to the formation of biological hard tissues, the structural and mechanical complexity of phenomena at the interface is only fully appreciated at the **nano-scale level**. Moreover, novel findings are NOT expected to come from studies that disregard the complex **3D biomechanical and -chemical interplay** at the extracellular matrix.

Our goal is to develop **realistic multi-scale 3D models of hard tissue-biomaterial interfaces** (upto nano-level) that correlate morphological, chemical and mechanical data. These models will (1) allow a first insight in the 3D interface morphology, (2) contribute to our understanding of the underlying mechanisms of interaction between the biomaterial and human hard tissue, (3) help to identify potential chemical interactions, and (4) allow

evaluating local interfacial stress distribution upon different loading conditions of the interface. With this project, we focus on three different hard tissue-biomaterial interfaces (that are related to three important subfields of modern restorative dentistry):

- ADHESIVE-TOOTH INTERFACES within the field of adhesive dentistry
- ENDODONTIC SEALER-ROOT CANAL DENTIN INTERFACES within the field of endodontics
- TITANIUM IMPLANT-BONE INTERFACES within the field of implant dentistry

***In vitro* and *ex vivo* interfaces** between enamel, dentin and bone with respectively restorative/endodontic biomaterials and implant materials will be prepared according to current clinical standards and upon ensuing expertise of the BIOMAT research cluster. Initial **micro-/nano-scale morphological models** and subsequently derived **finite element models** will be developed based on an existing collaboration with the KULeuven MTM and BIOMECH research groups, as well as upon using cutting-edge Flemish technology (high-resolution X-ray Computer Tomography, SkyScan; Image processing software, Materialise, Leuven).

In addition, ultra- and semi-thin sections for transmission electron microscopy will be prepared using **conventional ultra-microtomy** [BIOMAT] and a new **focused-ion-beam milling** device [MTM]. A combination of ultrahigh resolution electron tomography and chemical microanalysis will be carried out on the ultra-microtome and FIB sections at the new KULeuven Core Facility for Analytical Electron Microscopy [CME].

With this innovative research methodology, we aim to answer primary research questions such as:

- What are the major mechanisms involved in the **pathogenesis of hard tissue-biomaterial interface failure** (for instance due to enzymatic breakdown or due to mechanical fatigue), and how can this degradation process be retarded or even arrested?
- What are the effects of **early loading of bone-implant interfaces** on the adaptation of bone to titanium?

Self-evidently, other secondary research questions with regard to the respective interfaces dealt with will be handled as well.

3D nano-imaging and modeling are nowadays applied in diverse medical and material science fields, and have led to multiple new scientific breakthroughs. The application on tooth/bone-biomaterial interfaces is rather unique. With this project, we wish to make the step

from 2D to 3D imaging/analysis of hard tissue-biomaterial interfaces, as well as **from micro- to nano-scale level**.

The BIOMAT research expertise, supported by the scientific and technical expertise from existing research collaborations with material scientists, biomechanical engineers, and electron microscopists, along with the research equipment available at KULeuven, altogether form the structure needed to succesfully run this project and to provide data that can serve as a good basis for future applied research in the research domains involved.

Requirements

The candidate should be a holder of a university degree and should have a particular interest in cell biology, more specifically with regard to the interfacial interaction of cells with biomaterials (e.g. biologist, bio-engineer, bio-medical scientist, …). At least a "distinction" degree is a minimal request for acceptance. The candidate is strongly encouraged to conduct the project towards a PhD degree (4 years).

Date of entrance: January 1, 2007

Date of project end: December 31, 2011

Salaried position, according to the KULeuven salary rates for doctoral students

Selection method:

An application requires a written solicitation, extended CV, and contact information for three references. The selection will be based on the comparison of the submitted applications, possibly including an interview with the pre-selected candidates.

Solicitation, CV and three references to be send before the 15th of September 2006 to:

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Further information with regard to the Catholic University of Leuven, and 'living in Leuven' can be found on 'http://www.kuleuven.ac.be/english/', with regard to the PhD program of the Faculty of Medicine on 'http://med.kuleuven.be/phd/index_en.html', and with regard to the BIOMAT Research Group on 'http://med.kuleuven.be/biomat/.