A modelling strategy for customisation of drug-eluting medical devices

Project Description

Polymeric medical devices are increasingly being developed to provide mechanical and therapeutic functions in-vivo. Drug-eluting medical implants are active implants that induce healing effects, in addition to their regular task of support. This effect is achieved by controlled release of Active Pharmaceutical Ingredients (API) into the surrounding tissue. Devices include drug-eluting vascular stents; drug-eluting wound dressings; protein-eluting scaffolds for tissue regeneration and drug eluting bioresorbable polymer fixation devices for orthopaedic applications.

While the release mechanisms and diffusion kinetics of APIs in-vivo are in the main, well understood, accurate predictions of the properties of new formulations are not usually possible. The properties of the polymeric matrix play an important role and these in turn depend not only on the raw materials but also the processing conditions and in many cases the geometrical properties of the device. The influence of these parameters is usually less well-defined and there is a lack of comprehensive models which encapsulate the entire process from raw materials, through processing to post-production in-vivo performance. Availability of modelling tools for the prediction of drug release rates and mechanical properties would greatly accelerate the introduction of customised drug-eluting devices with properties tailored to the precise application. This involves the development of suitable modelling strategies to encapsulate the relationship between processing and the resulting matrix structure (which is almost black-box in nature) and between the structure and resulting properties (which is generally well defined).

The overall aim of the project is to investigate a suitable modeling strategy to encapsulate the processing-structure-property relationships of drug-eluting polymer devices such as swellable hydrogels and bioresorbable polymers. Such a model can then be explored through optimization techniques to identify the raw material, processing, and geometrical requirements of the device to achieve the desired drug release and mechanical properties. While such an all-encompassing model is obviously some way off, this project attempts to define a suitable strategy to achieve it and will be limited to one or two archetypal systems.

Profile of Student:

The ideal candidate will have a 1st class/2:1 Honours degree in Mechanical Engineering or related discipline with an interest in modelling and optimisation. The ideal candidate will have experience in modelling using MATLAB or similar software and/or experience in FEA modeling.