Mathematical modelling of biodegradable magnesium implants for bone repair

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Magnesium and its alloys has many properties that makes it an ideal material for use as implants for bone repair. The stiffness of the magnesium is close to that of bone, meaning that the bone experiences compatible forces promoting stronger regrowth. Furthermore, Magnesium is biodegradable allowing bone regrowth into the space occupied by the implant as the implant corrodes and recedes, avoiding the need for further surgery to remove the implant once the bone has healed.

The PhD project involves the development and analysis of new mathematical models to investigate the role of the biodegraded implant products (mainly magnesium ions) in the bone healing process and the potential impact on the rest of the body. We will first model magnesium accumulation in the body resulting from the long term release of magnesium from a corroding implant or implants. Secondly we will examine the role of the released magnesium ions in enhancing the bone healing process, thereby providing an additional benefit over more conventional implant materials. The project will provide quantitative tools to assess the optimum properties of magnesium implant materials in the promotion of bone healing.

The student must have a first or 2-1 in a degree with a strong mathematical background. In undertaking the PhD project, the student will be developing their skills in mathematical modelling, analysis of differential equations and computational methods as well as gaining valuable experience in multi-disciplinary research.

References
Ahmed, SK, Ward, J, Liu, Y (2017) Numerical modelling of effects of biphasic layers of corrosion products to the degradation of magnesium metal in vitro, Materials, DOI: 10.3390/ma11010001.
Ward, J, Ahmed, SK, Liu, Y (2021) Physiologically based pharmacokinetic model of magnesium implant absorption and distribution in tissue and organs, Submitted.
Han, HS et al., (2019) Current status and outlook on the clinical translation of biodegradable metals, Materials Today, DOI: 10.1016/j.mattod.2018.05.018