



Computational Multiscale Modeling of Biodegradation Behavior of Personalized Printed Implants

April 10

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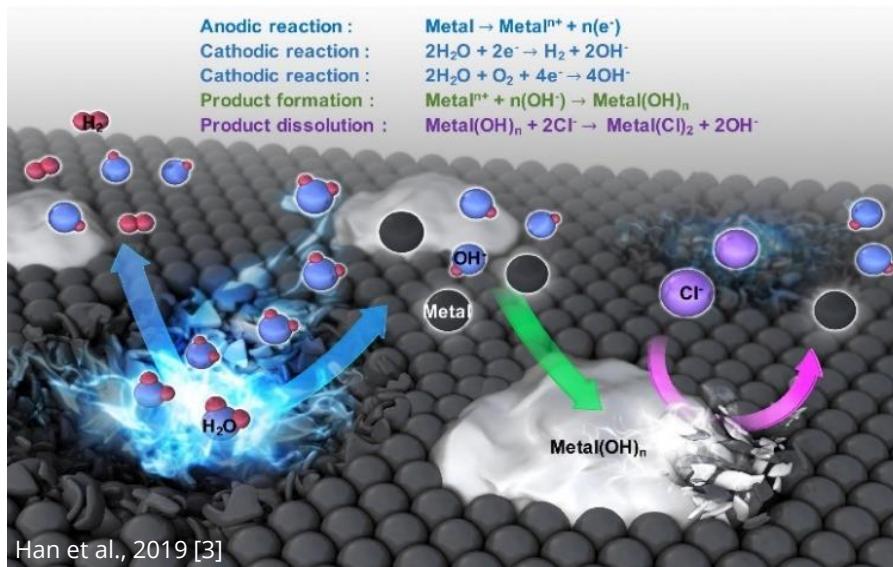
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Introduction

- In this project, we investigate the possibility to use biodegradable metals for part of the joint replacement implants, which means that the metal implant will disappear over time and be replaced by newly formed bone [1,2].
- We develop a quantitative mathematical model to assess the degradation of the implants in silico (in the computer) prior to conducting any in-vitro or in-vivo experiments.
- Once validated, the model will be an important tool to find the right design and properties of the degradable implants.

Method

This schematic figure shows the biodegradation process of metals [3]. We will study degradation for Mg, Ti, Zn, and Fe. We will also consider the interactions of the implant with the surrounding soft tissues and bone.

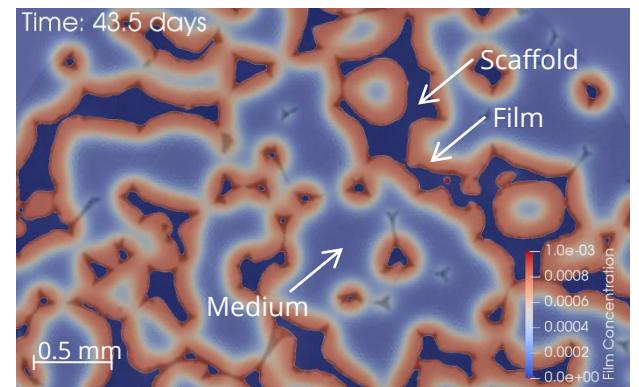


Results

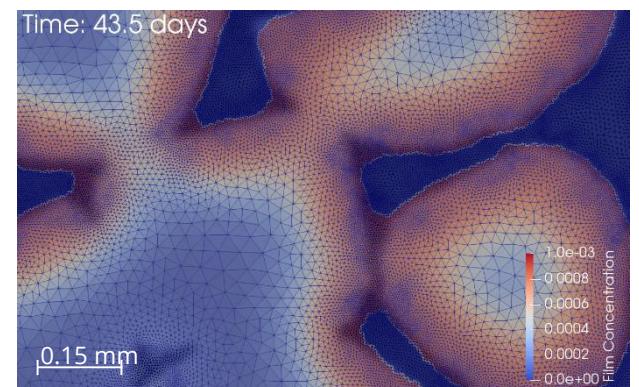
Initial results demonstration proof of concept of the model, applied to Mg implants (in the right column, numbered from top to bottom):

- Degradation of the scaffold and formation of a protection film during a dissolution experiment (timing is yet to be calibrated)
- A closer look at how we computed degradation
- Calibration of the model with experimental data: numerical reproduction of the initial shape of the tested Mg scaffold
- Degraded shape of the scaffold as well as the concentration of Mg released to the surrounding (timing is yet to be calibrated)

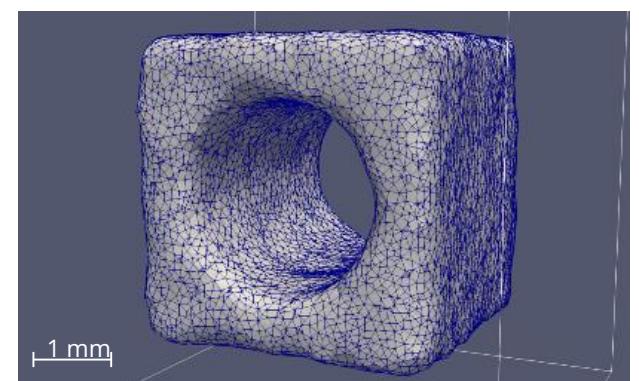
(1)



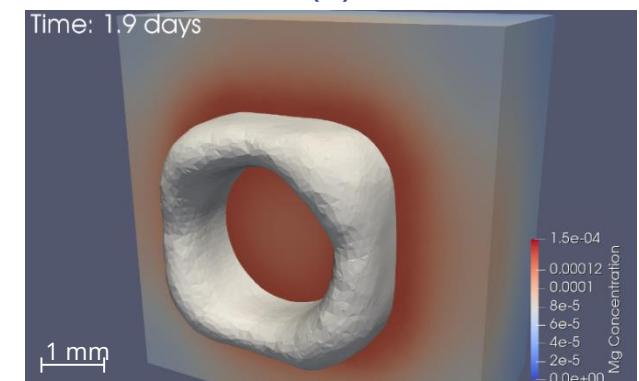
(2)



(3)



(4)



[1] Agarwal et al. (2016) Materials Science and Engineering C, 68: 948-963

[2] Bajger et al. (2017) Biomechanics and Modeling in Mechanobiology, 16(1): 227-238

[3] Han et al. (2019) Materials Today, 23: 57-71