IX International Conference on Computational Bioengineering
ICCB 2022
P. R. Fernandes and J. Folgado (Editors)

Abstract ID 42

NUMERICAL IMPLEMENTATION OF THE POLYLACTIC ACID (PLA) BEHAVIOUR DURING IMPLANT DEGRADATION

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Keywords: Polylactic acid (PLA), Degradation, Constitutive model, Hyper-elastic material, Finite Element Analysis

Summary: Polymers are widely employed in biomedical applications, like scaffolds for tissue engineering, stents, implants or in drug delivery systems, among others [1,2]. Polymers undergo an erosion or degradation process due to scission of their long molecular chains caused by hydrolytic reactions [3,4]. In particular, polylactic acid (PLA), is a biopolymer with good biocompatibility, biodegradability, good mechanical strength and process ability, being its biodegradation products the lactic acid (LA), which is biologically inert to growing cells [2,4,5]. In some cases, the degradation products can accumulate inside the polymer, mainly due to diffusion difficulties, leading to a process that accelerates the hydrolysis of the polymer, what is called autocatalysis. Diffusion has a major role in polymers degradation process. When it can be considered that diffusion occurs instantaneously all over the entire specimen, it is said that hydrolysis occurs throughout the material and it is called homogeneous or bulk erosion and when diffusion is very slow compared to hydrolysis, it occurs at the surface of the specimen and it is called heterogeneous or surface erosion. Factors such as crystallinity, crystal morphology or even the microstructure can influence the degradation rate of polymers [2,5].The degradation experienced by PLA is considered a stochastic process, drive mainly by hydrolysis, although some authors include autocatalysis and mechanical stimulation in their degradation models [3,6]. In this way, degradation of PLA accounts for the dependency of its properties over time. Apart some experimental work has been carried out and measurements of mechanical properties have been done [5,7], for each degradation stage, and models of the mechanical behaviour have been deduced, still lacks a clear and well-established understanding about the evolution of mechanical properties over time, during degradation [8]. In this work, a hyper elastic constitutive model and time-dependent model, from literature, were implemented in a simple model (50mmx50mmx10mm) made of PLA. The numerical approach, regarding the material properties and time-dependent models, were implemented in Ansys® Parametric Design Language (APDL). It was observed the predicted non-linear behaviour of PLA, during degradation and the decay of mechanical properties, according to [5,8].