

Viscoelastic biodegradable materials: modelling, mathematical analysis and medical applications

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Viscoelastic properties of materials represent a compromise between viscous and elastic responses, under mechanical stress. Biodegradation is the erosion of materials by the action of biological processes that cause a progressive breakdown of the material. The degradation and the unique viscoelastic properties of polymers give them a central role in controlled drug delivery to provide sustained release of therapeutic agents while avoiding removal surgery.

The release of drug is governed by an instantaneous swelling, a nonlinear diffusion, a stress driven convection and a decrease of the polymer molecular weight. The interaction of these phenomena is represented by a system of partial integro-differential equations, coupled with initial and boundary conditions. The qualitative properties of the solution are studied and the stability of the system is analyzed.

Medical applications are addressed. The evolution of the concentration of drug, released from a biodegradable viscoelastic implant inserted into an unhealthy eye, is presented. Numerical simulations illustrate how to tune polymeric material properties that give rise to predefined release profiles.

The talk is based on joint work with E. Azhdari, J. Ferreira and P. Silva.