Drug Delivery by PLGA Microspheres

Description –

This model is used to simulate drug delivery and also predict intraparticle pH and void fraction of the microsphere involved in the process.

Assumptions –

- The species are not well-mixed
- Reactions occur throughout the polymer microsphere volume.

Aspects –

- **Mathematical** model
- **Continuous-time model** – The chosen model functions based on kinetic equations, which enables us to simulate drug delivery at all times.
- **Deterministic model** – The predictions that the model make are based on initial conditions and parameter values, and not by random allotment.
- **Mechanical model** – This model analyses drug delivery mechanisms, the reaction-diffusion phenomena and not just direct observation.
- **Multi-scale model** - Microparticles also enable the encapsulation of drugs for delivery in a multi-stage pulsatile release and for the protection of proteins from being deactivated.

Salient features –

- A mechanistic reaction-diffusion model with quadratic autocatalytic hydrolysis kinetics.
- We can vary effective diffusivity to account for pore evolution.
- Size-dependent release profiles for microspheres, can be observed in simulations that couple reaction and diffusion but not by the pure-diffusion model.

Acknowledgement –

Ford, A. N., Pack, D. W., & Braatz, R. D. (2011). *Multi-Scale Modeling of PLGA Microparticle Drug Delivery Systems. 21st European Symposium on Computer Aided Process Engineering, 1475–1479.* doi:10.1016/b978-0-444-54298-4.50074-x

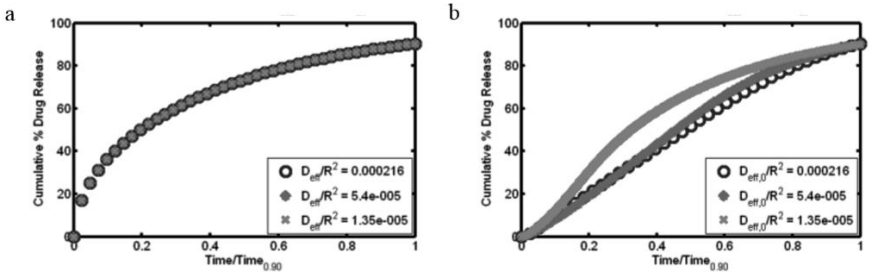

Fig. 1: Cumulative % drug release vs. time, scaled by the time required for 90% of the drug to be released, for (a) constant and (b) variable effective drug diffusivity arising from the coupling of autocatalytic polymer degradation reactions and diffusion.

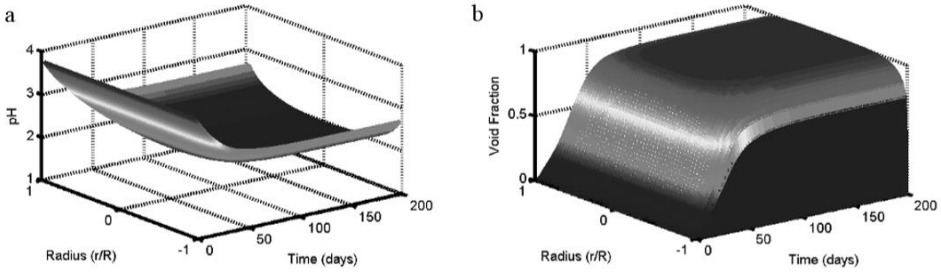

Fig. 2: Spatiotemporal profiles of (a) intraparticle pH and (b) void fraction for a multiscale model for a microsphere with initial effective drug diffusivity of $D_{eff,0}/R^2 = 5.4\times10^{-5}$.