Multiphysics Simulation Story: Simulating the Release Mechanism in Drug-Eluting Stents

Boston Scientific, MN, USA

Travis Schauer and Ismail Guler
The Challenge

- Stent insertion is a common treatment for arterial narrowing – or stenosis
  - Tissue regrowth around the inserted stent can cause arterial narrowing

- Drug-eluting stents help prevent restenosis
  - Drug release from stent coating into the surrounding tissues prevents regrowth

- A better understanding of the release mechanism is required for improving design
The Solution

- Used simulation and experiments to better understand drug release mechanism into surrounding tissues
- A pore-shell model of the stent coating was developed in COMSOL Multiphysics® to evaluate drug release for both in vivo and in vitro cases
  - Mass transport within and across the coating has been considered
- In vitro and in vivo experiments were performed and compared with simulation results

Idealized structure of a stent coating was modeled to learn more about the drug release mechanism.
The Simulation

- Pore-shell model of stent coating
  - Stiff-spring method was implemented to prevent discontinuity in diffusive flux at pore-shell interface
  - Optimization Module used to determine parameter values that could not be measured (e.g. polymer shell thickness and retardation coefficient of pores)

- Simulation results consist of release curves generated for in vivo and in vitro cases and drug released from coating as a function of time

- Simulation confirms fast release from pores and slow diffusion through shell
  - Excellent match with experimental data for the in vitro case

Top, simulation and experimental results for the in vitro case. Bottom, results in COMSOL Multiphysics® predicting drug concentration for the in vitro case at t = 2 hrs.