

Timothy Johnson: Chemical & Biological Engineering
Mentor: Jeffrey Heys -- Chemical & Biological Engineering
Gold nano rod hydrogel nanocomposite laser tissue welding

The original purpose of my research was to develop mathematical models of heat transfer and cell death and combine them into a model of Laser Tissue Welding (LTW) using collagen nanocomposite materials. LTW is an alternative to surgical sutures for repairing cuts and ruptures in tissues. Our LTW model uses collagen mixed with gold nanoparticles that convert light into heat. The application of laser light leads to a temporary phase change in the collagen from a gel to a viscous liquid and back into a gel that can seal a cut in the surrounding tissue. This topic interests me because as a student in Chemical Engineering, I will likely work with heat transfer and biological systems in many future projects. To develop the model, Dr. Jeff Heys and I utilized the Python programming language along with the FEniCS software library to solve the various partial differential equations and algebraic equations in the model. I combined two previously developed mathematical models: a bio-heat transfer model and a cell death model, and adapted them to work together in a single program so that individual variables can be optimized as efficiently as possible. Thus far, we have successfully integrated the two models into a single code that can predict the temperature of the nanocomposite and the surrounding tissue as well as predict the fraction of cells that are killed by elevated temperatures at different spatial locations. It is not yet possible to optimize system parameters, but is expected to be before May, 2017.