CASE STUDY

MSC Software: Case Study - BioSimulations, LLC

Stimulating Nerve Paths to the Brain

Simulation of a Molded Elastomeric Helical Anchor Nerve Clamp

Human Anatomy Nervous System

The human anatomy nervous system transmits signals to and from the brain for various voluntary and involuntary muscles. Nerve receptors also transmit data to the brain for heat, cold, pain and other sensations. The nerve fibers are protected by a covering or sheath.

The ability to control, modify or block the signals from the receptors to the brain may be accomplished through selective electrical stimulation of a specific nerve path.

A baseline concept to provide control assumes an external, battery operated, signal generating controller with electrical lead wires attached to the nerve sheath surface. The attachment design must allow installation, use and removal of the electrical lead wires without damaging the nerve sheath.

Design Objective

The objective of this study was to evaluate a proposed design concept for an electro-mechanical contact device which would provide the following characteristics:

- Suitable contact interface with the nerve sheath, allowing necessary electrical stimulation
- Device geometry and materials allows leads to be positioned on nerve sheath without damage to sheath
- Allow repositioning or removal, as required, without incurring nerve sheath damage.

Key Highlights:

Industry

Medical

Challenge

To evaluate a proposed design concept for an electro-mechanical device

MSC Software Solutions

Marc

Benefits

- Sucessfully check the model components and generate a final assembly of the model.
- Performed model pull-off loading using incrementally applied large displacements.
- Make results plotting easy using Marc post-processing features.

“The Marc post-processing features make results plotting easy”

Svenn Borgersen, BioSimulations, LLC

Design Material Selection

Biocompatible materials must be used for leads, contact device body and the electrical contact surface. Materials selected for evaluation were:

- Injection molded Silicon for lead and contact device body
- Stainless steel lead wires
- Platinum Iridium foil electrical contact surfaces

Analysis Software Selection

The analysis to be performed necessitated the following software capabilities:

- Complex geometry meshing
- Highly non-linear materials
- Complex 3-D contact surfaces
- Large displacement
- Sliding friction between contact bodies
- Calculation of contact forces and stresses
- Display analysis results

Based on these requirements, MSC Software’s Marc nonlinear simulation solution was selected to generate the model, perform the analysis and post-process the results.

FEA Model:

Materials

Molded Silicon was represented by the Mooney material library model available in the Marc materials library.

The very thin Platinum Iridium foil was represented by a non-linear, stress-strain curve generated by material tensile test data.

Geometry

An initial study was based on model geometry consisting of a rigid cylindrical contact surface simulating the nerve sheath; a molded Silicon central body containing the electrical leads; molded Silicon contact “fingers” wound helically around the rigid nerve sheath.

The inner surfaces of the helical “fingers” were bonded to the very thin Platinum Iridium foil which, in turn, was connected to the electrical leads within the central body. The FEA model consisted of approximately 1,300 nodes and 8,200 Hexahedral 8-node solid brick elements.

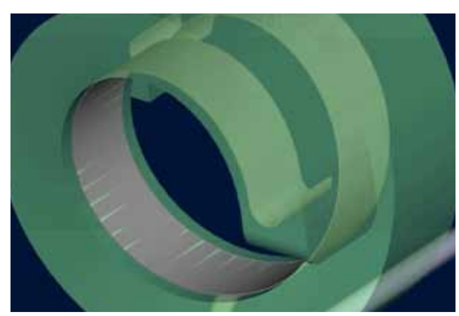
Modeling Procedure

The same model sub-assembly was also checked in tension using a distributed pressure loading incrementally applied to the inner foil surfaces.

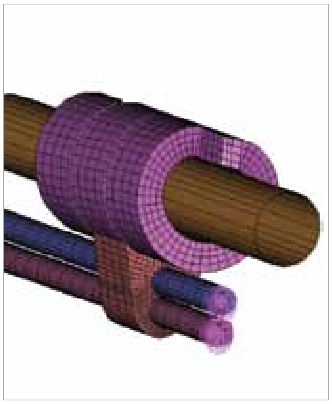
A final check used a single set of “fingers” and the simulated nerve sheath to verify functioning of the sliding friction contact mechanism between the 3-D contact sets and the simulated rigid nerve sheath.

After successfully checking the model components, a final assembly of the model was generated, consisting of: a set of three “fingers”; foil contact surfaces; central body; and simulated nerve sheath. The model was loaded by an incrementally applied large displacement of the simulated nerve sheath.

Model pull-off loading was performed using incrementally applied large displacements, moving the clamp assembly away from the simulated nerve sheath.The Marc software post-processing features make results plotting easy.

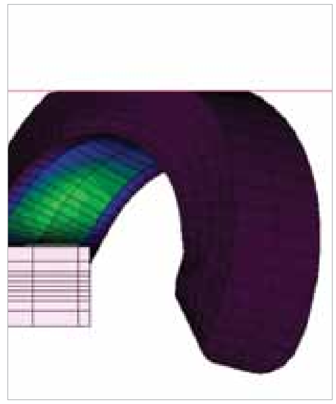


A segment of proposed concept is illustrated above and discussed here.

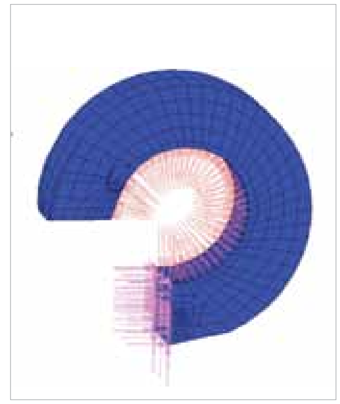


Model Total Assembly

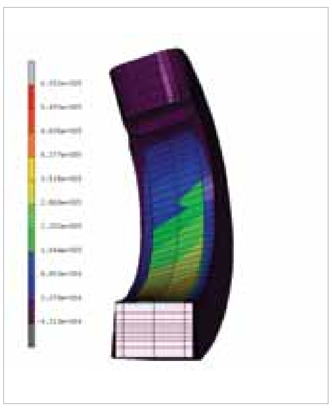
Finger sub-assembly Compression



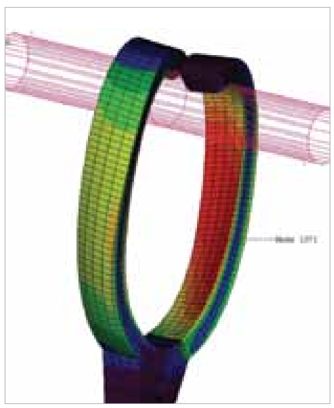
Finger sub-assembly in Compression Von Mises Stresses & Displacement



Finger sub-assembly Surface Pressure Load generating Tension & Bending

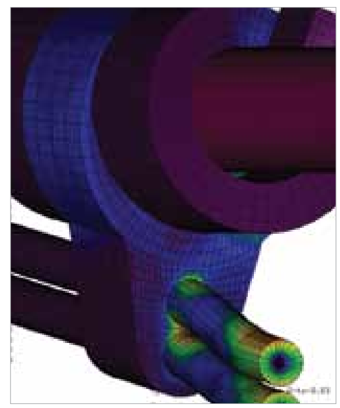


Finger sub-assembly Von Mises Stress & Tension & Bending Displacement



Finger Set Pull Off Contact with Simulated Nerve sheath

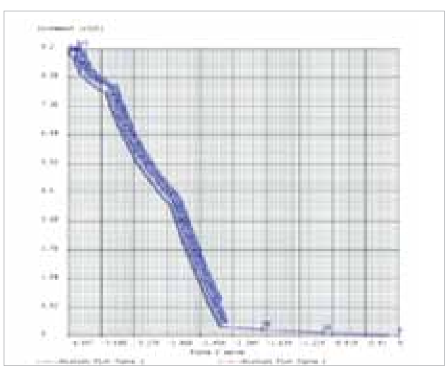
Full Model Assembly Pull Off Loading



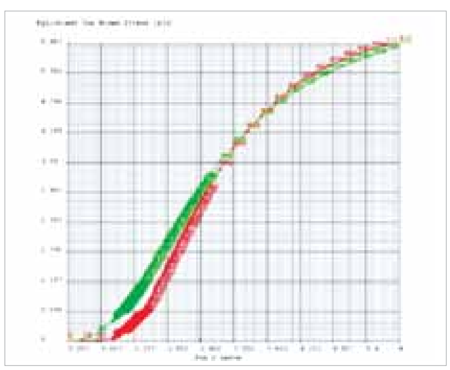
Displacement Increment 200

Clamp Pulling Away From Sheath

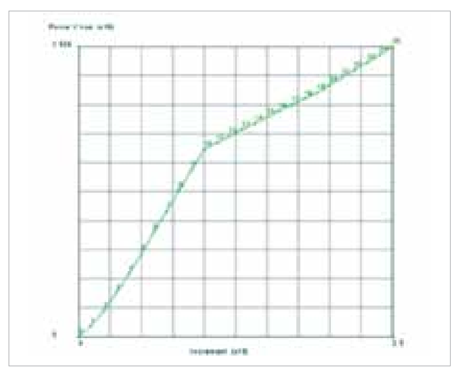
Finger Tip Sliding on Sheath Surface



Nodal Displacement v. Applied Displacement Increment



Nodal Stress v. Vertical Displacement



Pull-off Force v. Vertical Displacement

About MSC Software

MSC Software is one of the ten original software companies and the worldwide leader in multidiscipline simulation. As a trusted partner, MSC Software helps companies improve quality, save time and reduce costs associated with design and test of manufactured products. Academic institutions, researchers, and students employ MSC technology to expand individual knowledge as well as expand the horizon of simulation. MSC Software employs 1,000 professionals in 20 countries. For additional information about MSC Software's products and services, please visit www.mscsoftware.com.

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About Marc

Advanced Nonlinear & Multiphysics

Marc is a powerful, general-purpose, nonlinear finite element analysis solution to accurately simulate the response of your products under static, dynamic and multi-physics loading scenarios. Marc's versatility in modeling nonlinear material behaviors and transient environmental conditions makes it ideal to solve your complex design problems. With its innovative technologies and modeling methodologies, Marc enables you to simulate complex real world behavior of mechanical systems making it best suited to address your manufacturing and design problems in a single environment.

With the solution schemes that are smarter and designed to provide the performance that you need by taking full advantage of your hardware combined with an easy to use modeling solution, you can truly discover and explore nature's inherent nonlinearities. Whether your problems involve large deformation and strains, nonlinear materials, complex contact or interaction between multiple physics, you have reached the end of your search and with Marc, you can now focus on your improving your designs.

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