Bachelor and Master theses at the Institute of Biomechanics

Presented by: Clarissa S. Holzer-Stock

Head of the Institute: Prof. Gerhard A. Holzapfel

Open topics: https://www.biomech.tugraz.at/teaching

Scan for more topics and the latest updates!

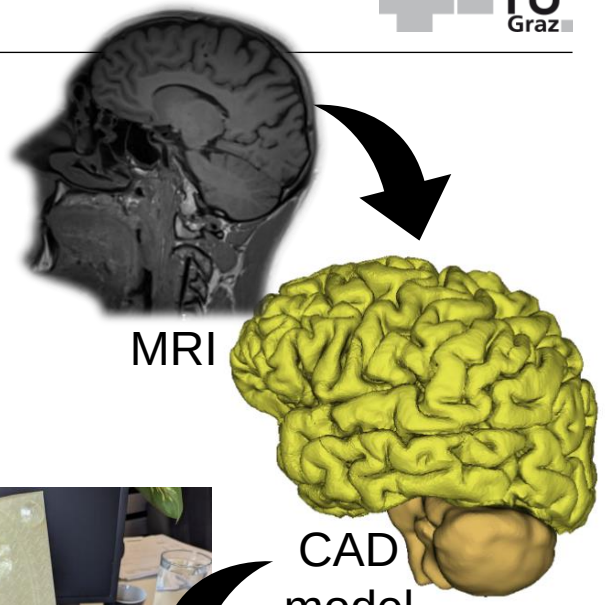
March 18, 2025

Bachelor project(s)

- **Topic**
  - Fabrication of patient-specific, full-scale hydrogel brain phantoms

- **Requirements**
  - Hands-on lab experience with soft (bio)materials
  - Technical experience in CAD design
  - Experience with design/fabrication of 3D prints

- **Responsibilities and tasks**
  - Independent preparation of tissue-mimicking hydrogels
  - Preparation of 3D-printed molds
  - Fabrication process documentation, analysis and optimization

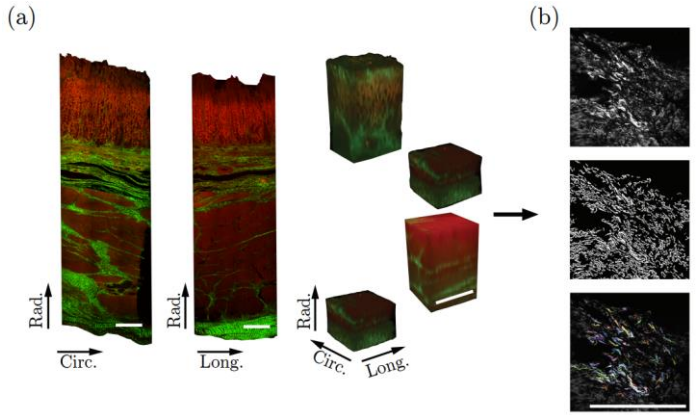



Mold


Hydrogel phantom

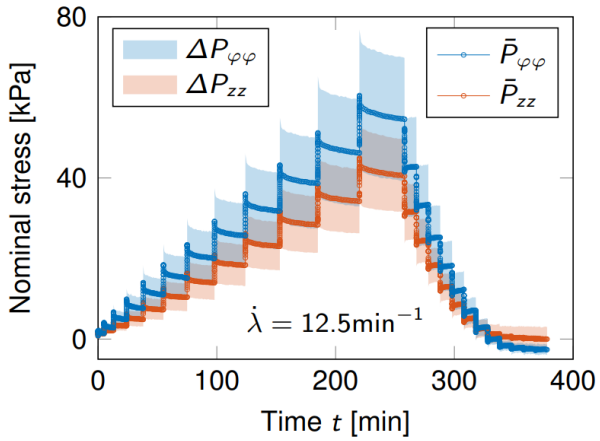
Bachelor/master projects

- **Bachelor thesis**
  - ‘Estimation of collagen and elastic fiber characteristics in (human) blood vessels’
- **Requirements**
  - Interest in biomechanics and microstructure of blood vessels
- **Responsibilities and tasks**
  - Post-processing of and estimation of fiber characteristics with Fiji and Matlab in microscopy scans



Obtained MPM scans and exemplary fiber tracking procedure using single MPM scan.

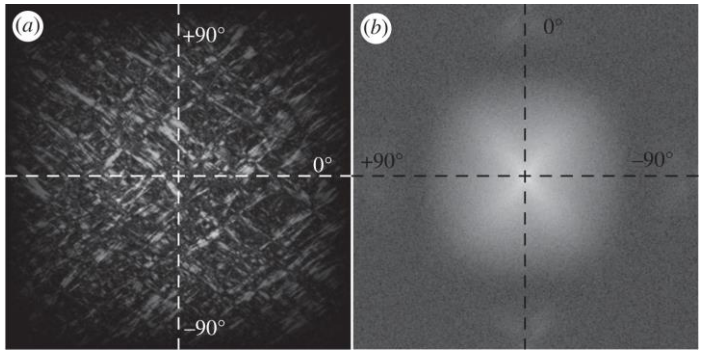
- **Master thesis**
  - ‘Biomechanical investigation of human gastric tissue: On the separation of the equilibrium relations & inelasticity of the stomach wall’
- **Requirements**
  - Interest in (bio)mechanics, lab work and basic statistics
- **Responsibilities and tasks**
  - Mechanical testing, data processing and statistical evaluation



Exemplary stepwise equibiaxial tensile test.

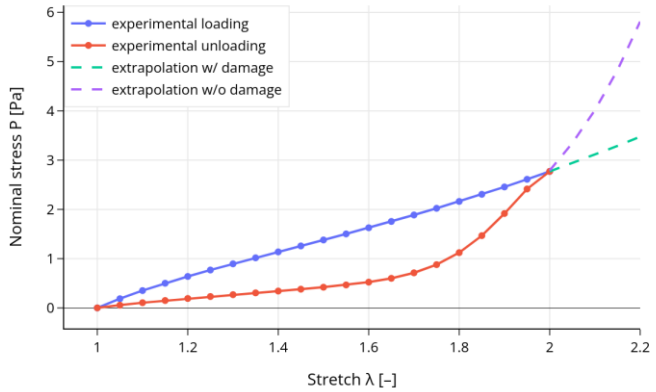
Bachelor/master projects

- **Bachelor thesis**
  - ‘Inference accuracy of fiber distributions from the power spectrum of 2D images’
- **Requirements**
  - Interest in numerical modeling and implementation
- **Responsibilities and tasks**
  - Benchmarking of the power spectrum algorithm



The windowed grayscale image of the intima and its power spectrum.

- **Master thesis**
  - ‘The effect of omitted damage modeling on the predictive power of mechanical simulations’
- **Requirements**
  - Interest in continuum mechanics and constitutive modeling
- **Responsibilities and tasks**
  - Calibration of an isotropic hyperelastic material model including and excluding damage to real experimental data



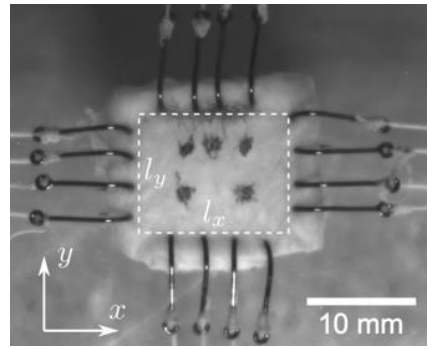
Model extrapolates differently depending on accounted damage.

Master project

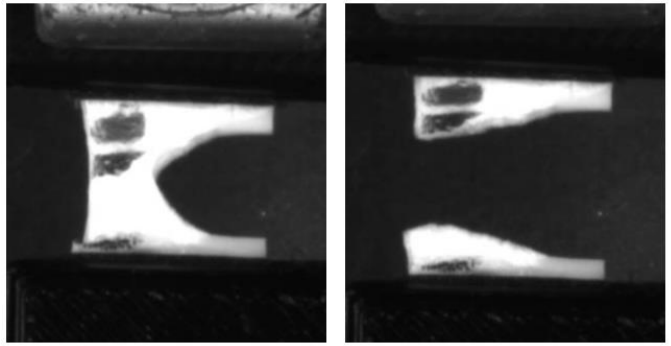
- **Topic 1**
  - ‘On the assumption of homogenous deformation in planar biaxial testing of anisotropic materials’
- **Responsibilities and tasks**
  - Develop a finite element model that reproduces a real experimental setup

- **Topic 2**
  - ‘Modeling the fracture mechanics of polymeric scaffolds for tissue engineering’
- **Responsibilities and tasks**
  - Develop a finite element model of crack propagation

- **Requirements**
  - Interest in solid mechanics
  - Good knowledge of finite element analysis



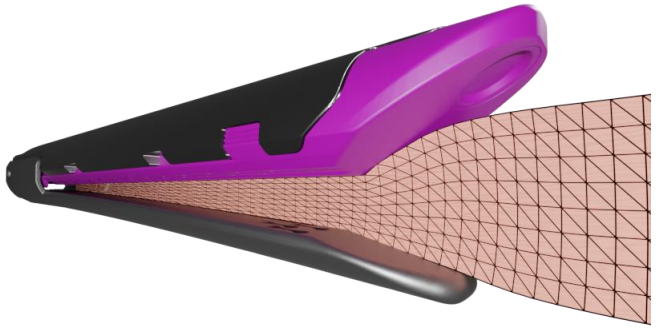
Representative biaxial test sample of human abdominal skin (Alberini et al., 2024).



Experiment of crack propagation in a polymeric scaffold.

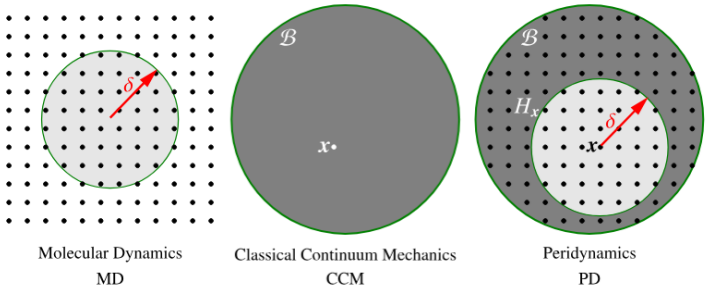
Bachelor projects

- **Topic 1**
  - Soft tissue contact in finite element simulations with LS-Dyna
- **Requirements**
  - Interest in finite element modeling
- **Responsibilities and tasks**
  - Investigate different contact types in combination with a range of material models suitable for soft tissues



Finite element simulation of a surgical stapler.

- **Topic 2**
  - Review on meshfree modeling of fracture in soft tissues
- **Requirements**
  - Interest in numerical simulation techniques and soft tissue (fracture) mechanics
- **Responsibilities and tasks**
  - Literature review of recent approaches in meshfree methods

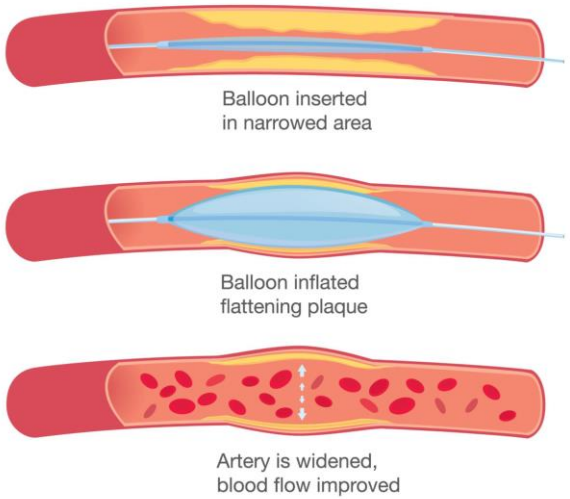


Continuum and particle methods (Adapted from [1]).

[1] Javili, A., Morasata, R., Oterkus, E., & Oterkus, S. (2019). Peridynamics review. Mathematics and Mechanics of Solids, 24(11), 3714-3739.

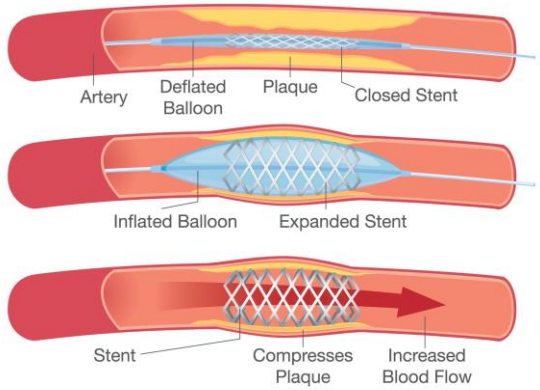
Bachelor projects

- **Topic 1**
  - ‘Simulation methods for balloons in the treatment of atherosclerosis.’
- **Responsibilities and tasks**
  - Review on balloon angioplasty used in finite element simulations



Implementation of balloon angioplasty in an atherosclerotic artery [1].

- **Topic 2**
  - ‘The influence of mechanical loading, i.e., oversizing, during balloon angioplasty and stenting on the success of surgery, e.g., restenosis.’
- **Responsibilities and task**
  - Review on the success of surgery during balloon angioplasty and stenting.



Implementation of balloon and stent in atherosclerotic artery [1].

[1] premierheartandvascular.com

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