Università degli Studi di Pavia
Computational Mechanics & Advanced Materials Group - DICAr

3D@UniPV
Virtual Modeling and Additive Manufacturing for Advanced Materials

SEMINAR

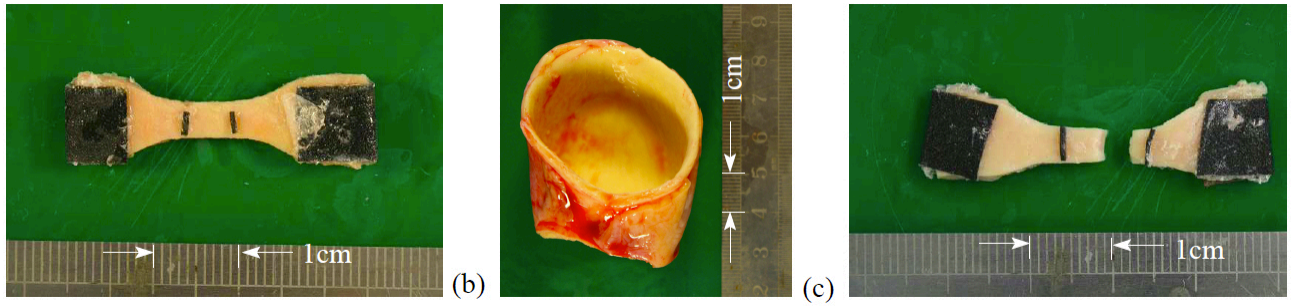
Modeling of Fiber-reinforced Solids with Application to Soft Tissues

Soft biological tissues such as artery walls can be viewed as fibrous composites assembled by a matrix material and embedded families of collagen fibers. In several soft tissues the collagen fiber orientations are distributed and their accommodation in a model is based on a von Mises distribution [1]. For artery walls in-plane (tangential plane of the artery) and out-of-plane dispersions are present, and it turns out that the dispersion depends on the state of disease. Modeling aspects and related finite element results are presented.

An arterial wall may rupture such as an atherosclerotic plaque or an aneurysm. In addition, a dissection may occur in the ascending or descending part of the aorta, which is a catastrophic clinical event – the underlying mechanism is tissue failure. Following the recently developed phase-field approach we model fracture of aortic tissues by considering an energy-based anisotropic failure criterion which captures the evolution of the crack phase-field [2]. We simulate fracture tests performed on specimens harvested from a human thoracic aorta. Model parameters are obtained by fitting the experimental data to the predicted model response; the finite element results agree favorably with the experimental findings.

References

[1] G.A. Holzapfel et al.: Modelling non-symmetric collagen fibre dispersion in arterial walls. J. R. Soc. Interface, 12:20150188, 2015.
[2] O. Gültekin et al.: A phase-field approach to model fracture of arterial walls: theory and finite element analysis. Comput. Meth. Appl. Mech. Eng., in press.



(a) Intact strip of the media prepared for a uniaxial extension test; (b) segment of a human aneurysmatic thoracic aorta from which the strip was cut out; (c) ruptured strip after the test

Prof. Gerhard A. Holzapfel
Institute of Biomechanics, Graz University of Technology, Austria
Faculty of Engineering Science and Technology, Norwegian University of Science and Technology, Trondheim, Norway

September 6th, 11:00am
DICAr – Hydraulic Meeting Room (ground floor)
Via Ferrata, 3 – Pavia