
Selected Challenges of Nonlinear Solid Mechanics

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Abstract

This lecture, presented as part of the EUROMECH Solid Mechanics Prize, addresses aspects of nonlinear solid mechanics with regard to experiments and the modeling of continuum mechanics. It highlights selected current challenges and identifies open problems and future directions.

In particular, the 3D micro- and nanostructure of connective tissue and its reconstruction possibilities, which can be used for corresponding modeling, are briefly discussed (1). The importance of quantifying experimental uncertainties will be highlighted and the need for a framework for their calculation is shown (2). Finally, the cross-linking of the (collagen) fibers will be analyzed. The higher the cross-linking density, the stiffer the mechanical response of the (arterial) tissue. A first attempt to characterize this effect on the elastic behavior is presented and the influence of the crosslink density on the mechanical behavior under uniaxial tensile loading is shown (3). A simple shear test focusing on the sign of the normal stress perpendicular to the shear planes (Poynting effect) is analyzed (4). Experimentally, it was observed that semi-flexible biopolymer gels, in contrast to rubber, tend to approach the top and bottom faces under simple shear (5). This so-called negative Poynting effect and its connection with cross-links as well as the fiber and cross-link dispersion is also investigated.

References

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