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

SEMINAR

On Electro-Active Anisotropic Material Models for the Behavior of the Large Intestine

Active soft biological materials manifest sensitivity to mechanical forces and electric fields and often exhibit rate dependent behaviors at different scales. In spite of the large literature on viscous and electroactive behaviors, the coupling of viscosity and active mechanics still lacks of accurate and significant numerical investigations.
Aim of this work is the presentation of a general theoretical framework for active visco-electro-elasticity in fiber reinforced tissues, with application to muscle behaviors. Our formulation is based on the additive decomposition of the Helmholtz free energy density in elastic, viscous and active parts, accompanied to a multiplicative decomposition of the deformation gradient in elastic, viscous and active parts. Viscosity is introduced by means of an ideal standard solid analog. A particular viscous doubly fibrous electromechanical model derived from the general framework has been implemented in a finite element code.
The code is employed in the numerical simulation of the complex peristalsis motion in a portion of the human colon. Using a vmtk level set toolkit on three-dimensional colonoscopy data, we reconstructed a solid model and conducted comparative quasistatic analyses considering purely electric, electro mechanical and visco-electro-mechanical behaviors. Calculations show the relevance of viscosity in the description of the intestine behavior. Rate dependency reduces the overall level of stress and maintains for longer times the muscle contraction induced by the electric signal, promoting and allowing the peristaltic activity.
The study has been developed in collaboration with Alessio Gizzi and Maria Giuseppina C. Nestola, from the Campus Bio-Medico of Roma, and Marcello Vasta, from the University of Chieti-Pescara.

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