TECHNION
Israel Institute of Technology
הטכניון מכון טכנולוגי לישראל

Faculty of Mechanical Engineering
הפקולטה להנדסת מכונות

MECHANICAL ENGINEERING STUDENT SEMINAR

Thursday, June 6th 2024 at 13:00, D. Dan and Betty Kahn Building, Room 217.

Constitutive Modeling of Methyl Cellulose Hydrogel under Static and Dynamic Loadings

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Methyl cellulose (MC) is a unique material that displays a liquid-solid phase transition when heated. Methyl cellulose is a biocompatible material and it is FDA approved. The manufacturing process of the gel is cheap and it is widely used in the bio-engineering field as well as a structural material for 3D bioprinting, drug delivery system etc.

In this work, the static mechanical behavior of solid MC was first characterized and modeled. Compression tests of MC, with different compositions and temperatures were performed. Various hyperelastic models, with different levels of complexity were examined. Since tension experiments of MC are challenging, the predicted behavior of each model was compared qualitatively to other hydrogels tension curves.

Previous researches found that the solidification energy can be supplied as a mechanical impact, and not only as heat. When a shock wave propagates through MC gel, some of the energy is utilized for the phase transition process. This phenomenon makes MC gel a candidate for impact absorbing applications.

For this purpose, shock waves propagation tests were performed in order to characterize and model the attenuation of MC. According to the experimental results, a phenomenological 1D model was suggested. The model predicts the impulse and the shape of the transmitted shock wave, according to the incident pulse and the gel characteristics. The model was validated against measured experimental transmitted signals.

Finally, a new methodology for integrating the previous 1D wave attenuation model into FE routine was suggested. The new methodology allows to simulate 3D wave propagation in the time domain, with a frequency-dependent drag coefficient. The new methodology overcomes the limitations of the commercial FE software as it performs time-domain frequency-dependent FE simulations. The new method was used to simulate the attenuation of the gel for complex 3D cases, such as an armor plate or a helmet.

Note: the seminar will be given in English

Seminars Coordinator: Assoc. Prof. Matthew Suss.