הטכניון מכון טכנולוגי לישראל TECHNION Israel Institute of Technology

Faculty of Mechanical Engineering הפקולטה להנדסת מכונות

MECHANICAL ENGINEERING SEMINAR

Monday, May 29, 2023 at 14:30, D. Dan and Betty Kahn Building, Auditorium 1

Advances in mechanics and modeling of modern soft materials

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Hosted by: Prof. MB Rubin

In this talk we will first focus on rubber-like materials which exhibit many elastic and inelastic phenomena like for example the Mullins effect, induced anisotropy, permanent set and strain-induced crystallization. For example, the latter phenomenon is supposed to play an important role in the elastomer reinforcement and enhances the resistance to crack growth in natural rubbers. We will present a physically-based constitutive model coupled with infrared thermography based calorimetry to study strain-induced crystallization.

Further, special attention will be focused to modeling of mechanoluminescence, a phenomenon where broken chemical bonds emit visible light upon stress application. The model is based on a quantum mechanics motivated closed-form approximation of the exact non-Gaussian distribution function. Another important feature of the model is an analytical network averaging concept which enables scale transition without numerical integration. The network averaging takes into account an irreversible evolution in the spatial distribution of polymer molecules due to the inelastic effects. The network averaging concept serves to describe all other above mentioned inelastic effects of elastomers within a unique framework and can also be applied to double network hydrogels.

Aerogels are further interesting and very promising materials especially for aeronautical engineering due to their high porosity and as a result very low densities and thermal conductivities. In this case, the fractal morphology has a strong influence on mechanical properties. The geometric structure of silica aerogels can be described by diffusion-limited cluster-cluster aggregation models which allow us to describe silica aerogel networks and investigate the influence of different input parameters, as for example, varying particle sizes on their fractal properties.

Finally, we will discuss a new automatic procedure to generate interpretable material models. This approach is based on symbolic regression which represents an evolutionary algorithm searching for a mathematical model in form of an algebraic expression. As one of the machine learning approaches, symbolic regression was proposed rather long ago but has not so far been applied to material modeling. In the talk, we will see how symbolic regression can first be applied to create hyperelastic models and how additional parameters like for example temperature or strain rate can be incorporated there.

Seminars Coordinator: Assoc. Prof. Matthew Suss.