MECHANICAL ENGINEERING SEMINAR

Monday, May 22, 2023 at 14:30, D. Dan and Betty Kahn Building, Auditorium 1

Modeling Glass Transition in Polymers – New Thoughts about an Old Mystery

Valeriy V. Ginzburg, Ph.D.

Visiting Professor, Chemical Engineering and Materials Science,
Michigan State University (USA)
Email: ginzbur7@msu.edu ; Website: https://www.egr.msu.edu/people/profile/ginzbur7

Hosted by: Prof. Oleg Gendelman

Philip W. Anderson, a Nobel Prize-winning theoretical physicist, wrote in 1995: "The deepest and most interesting unsolved problem in solid state theory is probably the theory of the nature of glass and the glass transition." This challenge is especially intriguing and practically important for polymers. Many processes (mechanical recycling, lithography, application of paints to surfaces, extrusion of amorphous plastics, etc.) are designed based on our ability to understand the glassy dynamics, where the material viscosity can increase by several orders of magnitude as the material is cooled by only a few degrees.

In my talk, I will describe a new mean-field model aimed at capturing this behavior. The model – labeled "two states, two (time)scales" or TS2 – has been shown to successfully describe dielectric α- and β-relaxation in several amorphous polymers, such as PS and PMMA; it can also be extended to miscible polymer blends and random copolymers. By combining TS2 with the Sanchez-Lacombe lattice theory and adding the Tool-Narayanaswamy-Moynihan (TNM) relaxation equations, we are able to also describe the pressure-volume-temperature (PVT) data both above and below the glass transition. The theory can also capture the thickness dependence of the glass transition temperature (Tg) of thin films. I will conclude by discussing future steps in theory development, including its practical applications.

Valeriy Ginzburg was born in Kharkiv (USSR, now Ukraine) in 1966. He has earned his Ph. D. (Polymer Physics) in 1992 at the Moscow Institute of Physics and Technology ("FizTech") in Russia. After postdoctoral fellowships at the University of Colorado (1993-97) and the University of Pittsburgh (1998-2000), he worked at The Dow Chemical Company (2001-2020). Today, he is a visiting professor at Michigan State University. Dr. Ginzburg is a co-inventor on 15 US patents and author or co-author of about 100 journal publications. He is a co-editor of a book, "Theory and modeling of nanocomposites" (published by Springer Nature in 2020). He has been elected Fellow of the American Physical Society (2014) and awarded the Dow Core R&D Excellence in Science award (2015). His mail research interests are polymer glass transition and polymer statistical physics.

Seminars Coordinator: Assoc. Prof. Matthew Suss.