DREXEL UNIVERSITY
Materials Science and Engineering
College of Engineering

Department of Materials Science and Engineering,

Candidacy Exam

Tuesday, April 17th 2 pm
MEM Seminar Room, AEL 162

Molecular Bottlebrushes: From Nature to Synthetic and Back Again

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Abstract

Designing materials with independently tunable Young's modulus and elongation is synthetically challenging due to engineered materials generally following the trend $E \propto \lambda_{max}^{-2}$. Many natural materials, especially biological tissues, are exceptions to this trend where strain adaptive behavior is commonplace. The importance of developing synthetic materials to mimic these unique properties is seen in the design of biomaterials where mechanical properties are intimately related to function. A unique polymeric architecture inspired by biological tissue is the molecular bottlebrush where polymer side chains are densely grafted onto a polymer backbone. This architecture forces entropically unfavorable backbone extension and reduced entanglements compared to linear polymers, resulting in unique properties such as very low moduli while maintaining a solid nature. In this talk, the motivation for this architecture from biological tissue will be discussed and important advances in polymerizations enabling their fabrication will be briefly covered. A detailed physical description will be presented building from ideal single chain physics to the bulk properties of the bottlebrush. This description will be utilized to explain the use of bottlebrushes as super-soft elastomers. To conclude, it will be shown how independently tuning three structural parameters of this molecular architecture enables the design of synthetic materials that can mimic and even out-perform natural materials.