QUANTIFYING CROSSLINKING OF ELASTOMERIC PROTEIN FILMS USING NANOINDENTATION

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ABSTRACT

Protein-based composites in nature often exhibit great deformability and long range elasticity due to the presence of a large amount of the elastomeric proteins. Their organization and cross-linking are associated with their function and the structure-function relationship is of great importance for the design of high-efficiency synthetic composites. Inspired by biological counterparts, a synthetic composite was made of the elastomeric protein elastin in which polycaprolactone fibers were embedded. Nanoindentation testing was used to investigate the differences in the mechanical properties of the synthetic rubber-like composite between materials crosslinked for different time periods (2, 4, and 6 hours). Furthermore, the characterization of the viscoelastic properties of the synthetic composite by nanoindentation reveals the composite crosslinked for 4 hours as an optimized strain energy storage material when employed at low frequency load cycles. Also, investigating the microstructure of the synthetic composite shows the presence of pores which, under deformation, are responsible for the generation of a simultaneous mechanical response of poroelasticity. Thus in this presentation a methodology is discussed to decouple the viscoelastic and the poroelastic behavior by combining the nanoindentation technique with finite element simulations. With this approach, it is possible to quantify measurements of the poroviscoelastic properties of these protein-based composites. Such techniques are expected to find broader applications for quantifying the influence of crosslinking density and environmental factors on the nanoscale mechanical properties of many other similar composites [supported by NSF].