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Editorial corner – a personal view

Hard challenge with soft materials: Understanding large deformation and fracture behavior

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Rubber has been recognized as an engineering material since the mid 1800s. It is well known that the mechanical behavior of rubber is complicated due to nonlinearity, hyperelasticity and its great sensitivity to the effects of temperature, environment and strain history. Nowadays there seems to be a renewing interest in many other materials that show a similar behavior, collectively known as soft materials. Soft matter is a field that encompasses an incredible spectrum of topics from living tissues to diverse engineered materials, from personal care products to energy-efficient electronic-paper displays. Biological tissues, foams, food, elastomeric polymers, membranes, biomaterials, gels, granular materials, and their composites have called the attention of basic and applied researchers belonging to a variety of disciplines (DOI: 10.1039/C3SM90100A). Soft materials display a mixture of fluid and solid properties, which deform themselves easily under mechanical loads. Hitherto, their mechanical testing has focused primarily on low level deformation rather than on ultimate properties. However, for novel engineering applications, mechanical integrity appears to be very important and mechanical failure should be considered as necessary as stiffness for design purposes. In this context, the improvement of the fundamental understanding of the mechanics of soft materials, and the development of new suitable methods appears as an stimulating scientific goal (DOI: 10.1039/C2SM90089K). In summary, it is clear that there are plenty of problems which are associated wiht the hyperelastic nature and its corresponding nonlinear character of soft matter deformation awaiting for solutions. Based on these drivers, the following experimental and theoretical research topics may be suggested for future research efforts: Characterization of fracture behavior. Comparison of different toughness measurement methods. Characterization of cohesive zone properties. Development of strong, tough, shock-absorbing structural hydrogels. Understanding cavitation and other instability phenomena in soft solids and structures. Characterization of microstructure and damage evolution in soft materials. Development of new soft material composites with superior strain stiffening capability. Understanding the effects of adhesion on contact mechanics when the size and stiffness of material decrease. Development of new methods to bridge the gap between mechanical testing of articular cartilage and hydrogels in cartilage regeneration. Derivation of nonlinear elastic stress–strain constitutive laws to describe the indentation of materials beyond the Hertzian regime.

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