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COLLOQUIUM SERIES

Mapping Nonlinear Deformation Field in Soft Materials with a Particle Tracking Method



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Refreshments at 3:30 pm | 116 Upson Hall

ABSTRACT: Soft elastomers and gels are widely applied in many emerging technologies such as soft robotics, biomedical implants and stretchable electronics. Understanding their mechanical behaviors, especially when cohesive or adhesive failure occurs, is critical for evaluating the mechanical reliability of their applications. However, experimental characterization of the large deformation field in soft materials has been challenging due to its highly nonlinear nature. This is especially true in fracture problems where cracks introduce discontinuities in the displacement field and severely concentrated strain fields. Although existing methods such as digital image correlation have been used to measure strain fields in soft materials, the nonlinear crack tip deformation field has not been systematically measured. Here we present a new approach to map the large deformation field by optically tracking the displacements of randomly distributed tracer particles. The tracer particles serve to provide displacement data at discrete spatial locations without affecting the mechanical property of the underlying soft material sample. The discrete displacement data are further converted to continuous displacement and strain fields through an interpolation scheme. Using a soft silicone elastomer as a model system, we demonstrate that the particle tracking method is capable of resolving the highly concentrated nonlinear deformation field at the crack tip. The measured crack tip deformation field enables local evaluation of energy release rate through the J-integral, which can remove the requirement of specific experimental geometries to measure the fracture toughness. Finally, we extend the particle tracking method to three-dimension (3D) for mapping the 3D strain field within the volume of a soft gel substrate indented and sheared by a micro-pillar.

BIOGRAPHICAL SKETCH: *Rong Long* is currently an Assistant Professor and Lyall Faculty Fellow in the Department of Mechanical Engineering at University of Colorado Boulder. Prior to that he was an Assistant Professor at University of Alberta in 2013-2014, a Research Associate at University of Colorado in 2012, and a Postdoctoral Associate at Cornell University in 2011. He received his Ph.D. degree in Theoretical and Applied Mechanics from Cornell University in 2011 and his B.S. degree in the same field from University of Science and Technology of China in 2006. He received the Young Adhesion Scientist Award in 2014, the Ralph E. Powe Junior Faculty Enhancement Award in 2015, the 3M non-Tenured Faculty Award in 2017, the ESPCI-Michelin Visiting Professorship in 2016 and 2018, and the NSF CAREER Award in 2018. His research interests include: continuum mechanics of soft materials, fracture mechanics, contact mechanics, adhesion and biomechanics.