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## Statistical Mechanics of Light- and Field- Responsive Soft Materials

Dr. Kaushik Dayal

Walter J. Blenko, Sr. Professor

Department of Civil and Environmental Engineering  
Carnegie Mellon University, Pittsburgh, Pennsylvania

**Abstract:** Light- and electric field- responsive polymeric materials are important for emerging technologies in fields ranging from soft robotics to biomedical devices. However, engineering models of these materials are largely phenomenological, which inhibits systematic materials design. I will present our recent work on formulating statistical mechanical models that account for the coupling between light and electric fields to entropic polymer elasticity. First, we study polymers with photo-responsive mesogens that show spontaneous deformation when illuminated, due to a trans-cis bending of the mesogens. A statistical mechanical model that exploits a separation of energy scales between entropic elasticity and photoswitching is developed and shows the emergence of a broken symmetry in the coupling between light and deformation, which agrees with our experimental measurements of photoswitching and shape evolution. Second, we study the role of nonlocal electrical interactions in polymer chains. We develop a consistent non-perturbative model of electrical fields interacting with polymer chains, and show that the nonlocal nature of the dipolar self-interactions drives the collapse of a polymer chain above a critical field, providing a pathway to understand instabilities and failure mechanisms in polymer chains subjected to large electric fields.

**Biographical Sketch:** Kaushik Dayal is a professor in the Department of Civil and Environmental Engineering at Carnegie Mellon University. Dayal's research interests are in the area of theoretical and computational multiscale methods applied to problems in materials science, with particular focus on bridging from atomic to continuum scales in the context of functional behavior, non-equilibrium response, and electromagnetic effects.

Dayal received his B.Tech. degree from the Indian Institute of Technology Madras (Chennai) in 2000. He earned his M.S. and Ph.D. in Mechanical Engineering at the California Institute of Technology in 2007.

For additional information, please contact Prof. Farhad Imani at [farhad.imani@uconn.edu](mailto:farhad.imani@uconn.edu) or Victoria Neel at [victoria.neel@uconn.edu](mailto:victoria.neel@uconn.edu)