A multiscale/multiphysics platform for analysis and design of photo-responsive polymer

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As light-sensitive molecules are included in it, photo-responsive polymer (PRP) undergoes macro-scale shape change under light irradiation, which renders PRP a promising material for long-range actuation such as circuit-less actuator and self-morphing structures. In order to understand photo-deformation of the photo-responsive polymer, the underlying physics scaled from subatomic quantum interaction to macroscopic deformation would be required. Herein, we suggest a sequential multiscale framework which describes an opto-mechanical behaviour of PRP. This model covers a broad range of physics from quantum-level photo reaction of the molecule to conformation effect imposed on nearby elastomer chain. For each scale, unique analysis models are provided and model solution techniques are proposed. The information obtained from each scale are transferred from one scale to another based on scale-bridging method. Through this multiscale computation framework, we describe comprehensive phenomena of PRP deformation induced by light. In addition, the proposed multiscale photo-mechanics computational framework is expected to work as efficient PRP material design tool for potential applications.

Keywords: Multiscale, Multiphysics, Photo-responsive polymer, Photo-mechanical behavior

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