Controlling Biomimetic Soft Robots

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Abstract

Materials designed with sensory mechanisms and shape-morphing capabilities allow the fabrication of devices with biomimetic capabilities. One such class of materials is hydrogels functionalized with active components such as spiropyran hydrogels with embedded magnetic nanowires which interact with both light and magnetic fields. Our continuum models quantitatively study these interactions and allow us to create controllable soft robots capable of walking and swimming. Furthermore, we design autonomous devices by utilizing materials that convert chemical into mechanical energy and vice versa. Our models describe systems where the chemical reaction, the hydrogel mechanics, and the solvent diffusion inside the material are integrated and provide guidelines to develop multisensory, synthetic materials.

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Short Biography

Monica Olvera de la Cruz obtained her Ph.D. in Physics from Cambridge University, UK, in 1985. She joined Northwestern University in 1986, where she is the Lawyer Taylor Professor of Materials Science & Engineering, Professor of Chemistry, and by courtesy, Professor of Physics and Astronomy and Chemical & Biological Engineering. She is the Director of the Center for Computation and Theory of Soft Materials. From 1995-97 she was a Staff Scientist in the Commissariat a l'Energie Atomique, Saclay, France, where she also held visiting scientist positions in 1993 and 2003. She has developed theoretical models to determine the thermodynamics, statistics, and dynamics of soft materials. She is a member of the American Philosophical Society, the National Academy of Sciences (NAS), the American Academy of Arts and Sciences, and a Fellow of the American Physical Society (APS). She has been awarded the David and Lucile Packard Fellowship, the NSF Presidential Young Investigator award, the Vannevar Bush Faculty Fellowship, the PNAS Cozzarelli Prize, and the APS Polymer Physics prize. She has served in the Advisory Committees of the Department of Energy Basic Energy Science Program (2012-21) and the NSF Mathematical and Physical Science Directorate (2005-09), and the National Research Council (NRC). She serves in the scientific advisory committee of the Max Planck Institute for Polymer Research, and ESPCI (École supérieure de physique et de chimie industrielles de la Ville de Paris). She is a member of the PNAS editorial board, and the Board of Trustees of the Gordon Research Conferences (2019-27).