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Reconfigurable Nanooptics and Smart Chromogenic Sensors Enabled by Multi-Stimuli-Responsive Shape Memory Polymers

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Abstract

Shape memory polymers (SMPs) are stimuli-responsive materials that can change their shapes upon application of an external stimulus (e.g., heat and light). They have been extensively exploited for a wide spectrum of technological applications ranging from smart biomedical devices to aerospace morphing structures. Unfortunately, most of the currently available SMPs are thermoresponsive and they suffer from heat-demanding shape memory programming and recovery processes. Additionally, the intriguing nanoscopic shape memory effects, which could significantly enhance the response speed and greatly expand the application scopes of SMPs, are largely unexplored. In this presentation, I will discuss unconventional nanoscopic shape memory effects exhibited by a new series of multi-stimuli-responsive SMPs. When combined with a unique macroporous photonic crystal structure templated from self-assembled colloidal crystals, these smart SMPs enable nontraditional "cold" programming and instantaneous shape recovery at ambient conditions triggered by multiple nontraditional stimuli, such as static pressure, lateral shear stress, a large variety of liquids and vapors, ultrasonic waves, and laser illumination. Additionally, striking chromogenic responses associated with a full all-room-temperature shape memory cycle could render a new and sensitive optical technology for investigating the intriguing nanoscopic deformation and recovery of SMPs. Moreover, the stepwise recovery of collapsed macropores leads to easily perceived color changes that can be correlated with concentrations of various analytes in gas, liquid, and solid phases, promising for developing novel chromogenic sensors. These smart polymers provide vast opportunities for a plethora of applications ranging from reconfigurable nanooptical devices to chromogenic pressure and chemical sensors to novel biometric and anti-counterfeiting materials.

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