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Perspective

Smart Polymers: Swelling Mechanism and its Polymer Association Design

Roberto Cosma*

Department of Molecular Medicine, University of South Florida, Florida, USA

DESCRIPTION

Polymers are among the most widely utilized synthetic materials in contemporary applications their excellent mechanical characteristics light weight and low cost have facilitated their dissemination among the most varied application disciplines. High-performance polymers known as smart polymers adapt to their surroundings. Such materials can respond in a variety of ways such as changing color or transparency becoming conductive or permeable to water or changing shape (shape memory polymers) depending on a number of variables, including temperature, humidity, pH, chemical compounds the wavelength or intensity of light or an electrical or magnetic field. Typically, little environmental changes are enough to cause significant changes in the characteristics of the polymer. As far as smart polymers that are sensitive to chemical agents are concerned the requirement for a fluid carrier (solvent) to make the chemical agent enter the network must be taken into account. As a result, the supposed fluid-induced swelling caused by the solvent absorption and its interaction with the response offered by the activation of the smart molecules must be taken into account. The fluid uptake by a polymer results in the so-called gel a solid made of two components a three-dimensional network submerged in the medium of the other component (a liquid) in an equilibrium state maintained by the osmotic pressure and by the elastic deformation of the network itself. Peptides, nucleic acids, self-assembled aggregates, micelles, (bio) synthetic polymers, proteins and polysaccharides are among the polymers used for creating complex structures. These structures have a clear potential for biodegradability and biocompatibility due to the polymer choices made. Additionally, one of the key characteristics of these electrostatic interactions is their capacity to organize into a variety of structures, providing intriguing prospects for application in a number of industries, including biomedicine and catalysis.

In order to obtain a macroscopic responsiveness from the controlled deformation of materials ingested by a fluid, the swelling phenomena happening in a polymer having a good affinity with a solvent has been widely investigated and utilized in real applications. The capacity of hydrogels to experience significant elastic deformation and bifurcations makes it possible to construct objects with controlled modifying that take on a particular configuration or produce desired effects. Utilizing the bending mechanism is one of the simplest programming techniques that can be used in the context of actuation to design the desired modifying through out-of-plane bending deformation as well as instability-like mechanisms which are attainable by utilizing a differential swelling within the hydrogel etc. The competing effects of mechanical expansion caused by the fluid the polymer absorbs and chain relaxation caused by the responsive molecules expansion triggered by the mechanical and chemical stimuli are shown to cause a different macroscopic mechanical response of the polymer in the presence of the swelling mechanism. Furthermore the responsiveness of an active gel is examined in relation to the effects of the solid-fluid interaction parameters.

The transformation of a composite material into a Smart Composite Material (SPCM) which produces a feedback signal utilized in automation and monitoring the structure in which it is embedded is accomplished by the integration of a Long Period Grating Fiber Sensor (LPGFS) into the polymer matrix of the composite material. This signal can represent the LPGFS response to applied mechanical vibrations in various SPCM applications. The LPGFS response can be measured by looking at the spectral shifts, broadenings and splitting of the distinctive resonance absorption bands that show in the LPGFS transmission spectrum. The investigation which aims to advance SPCM fabrication engineering and the design of its applications in aviation, business, medical and defense is carried out with consideration for the LPGFS as a detector for ultrasound composite materials quality checks.

Correspondence to: Roberto Cosma, Department of Molecular Medicine, University of South Florida, Florida, USA, E-mail: roberto@cosma.edu

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