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ORIGINAL RESEARCH

Synthesis, fabrication and characterization of polymer microgel/photochromic dye-based sandwiched sensors

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Abstract

Stimuli-responsive biosensors are empirically measurable signatures for the detection of physiological status of environment and thus can act as clinical diagnosis devices. Poly(*N*-isopropylacrylamide) (PNIPAM) polymeric gels are widely explored as in vivo and in vitro thermoresponsive gels by changing their lower critical solution temperature (LCST). In this perspective, multi-responsive thin film sensors having polymer part composed of poly(*N*-isopropylacrylamide) (PNIPAM) integrated with photochromic dye (malachite green, MG) were prepared, which changed their behavior upon exposure to light and with the adjustment of the pH and temperature of their environment. The sensing materials were characterized by different techniques such as scanning electron microscopy (SEM), thermal analysis (TGA/DTA), UV–Vis spectroscopy, and reflectance spectroscopy to confirm their synthesis and integration of MG with PNIPAM. These sensors changed their color in the pH-responsive fields to yield patterns that change the reflectance spectra upon exposure to UV–visible light. By using thin films of low price, commonly available metals as coverslips, the reflectance response with light of these polymeric gels was measured. The response of these sensors was proved to be completely reversible and could be triggered multiple times. The Cr/Ag coverslips were found to be the best against environments with high or low pH values. In this investigation, we proved that a class of portable pH-sensing materials can be synthesized which can be implemented in specific drug delivery and display technologies in future.

Keywords Microgels · Photochromic dye · Biosensors · Reflectance · Reversibility

Introduction

Stimuli-responsive microgels have taken the place of the most important colloidal building blocks and are increasingly being used as stabilizing agents due to their amazing properties, e.g., surface activity, deformability, reverse swelling capacity, and stimulus responsiveness.

The term "polymer gel" is defined as the substance having cross-linked polymer network, which is formed within a solvent phase. The polymeric chains trap the solvent molecules within the matrix [1]. A vital category of gels is of polymeric nature, because they have the ability to compose a system with controlled and precise properties. Stimulus-responsive hydrogels respond to the small changes occurring in the environment; therefore, these hydrogels are also called smart or intelligent materials [2]. They may be thermoresponsive [3, 4], pH responsive [5, 6], gas triggering, pressure simulative, photoresponsive, and ionic strength or electricity-sensitive hydrogels.

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