



TRAD eleven

BOOK OF ABSTRACTS

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Gamma irradiation-induced synthesis and characterization of bi-layered Au-(PNiPAAm/PVA) hydrogel nanocomposites

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The development of polymer-based smart materials has significantly expanded in the recent years. These materials can change physical or chemical properties in response to external stimuli, making them suitable for a variety of applications. One kind of these materials - photoactuators, that can produce a reversible mechanical deformation under light exposure, have received considerable attention due to their broad range of possible applications, such as soft robotics, artificial muscles, and smart devices. Multi-layered hydrogel systems have proven to be promising materials for this purpose.

The current study investigates a new bi-layered material made of thermosensitive poly(N-isopropyl acrylamide) (PNiPAAm) as the active layer and poly(vinyl alcohol) (PVA) as the passive layer. To make photoactuators, different-shaped gold nanoparticles (spheres - AuNPs, and rods - AuNRs) were incorporated into the active layer. These functional NPs have unique photo-thermal capabilities to convert the absorbed light into thermal energy, causing local shrinkage of the active layer, and thus enabling the wireless control of the device (bending and curling motions). The presence of NPs within the active layer was confirmed by characteristic SPR bands at around 540 nm for AuNPs and at around 530 nm and 700 nm for transversal and longitudinal oscillation, respectively, for AuNRs. For any practical implementation of hydrogel-based materials, their highly porous structure is required. The SEM analysis revealed that the polymer chains formed a honeycomb-like structure with a high number of micro- and macropores. The impact of various NPs shapes on the physicochemical properties, such as swelling and deswelling, and volume phase transition temperature (VPTT), was investigated. Understanding the swelling capacity of hydrogels as well as the kinetics of the process is essential to their application in systems for the release of active chemicals. The incorporation of AuNRs into the active layer of the photoactuators leads to an increase in both, the swelling capacity and VPTT. Knowing the values of the kinetic parameters and diffusion coefficient can help predict the rate and efficiency of the release process and optimize the design of the hydrogel for a specific use. The mechanical properties of hydrogels (strength, rigidity, and deformation) are crucial to understanding how they will behave in different applications, such as tissue engineering, drug delivery, or soft robotics. The results obtained from compression measurements show that the mechanical response of investigated systems depends on the shape and concentration of incorporated gold NPs.

In summary, bi-layered Au-(PNiPAAm/PVA) hydrogel nanocomposites were successfully synthesized using a combination of freeze-thaw and radiolytic methods. The incorporation of different shapes of gold NPs has an influence on the investigated properties of the photoactuators. The Au-PNiPAAm/PVA hydrogel nanocomposites showed an improvement in swelling capacity, a faster rate of swelling and deswelling, and a higher VPTT in comparison with the neat PNiPAAm/PVA hydrogel matrix. Moreover, the study of the diffusion transport mechanism revealed that the effects of diffusion and polymer chains relaxation are comparable.

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