Physicochemical characterization of Au/PNiPAAm hydrogel nanocomposites: influence of nanoparticle shape

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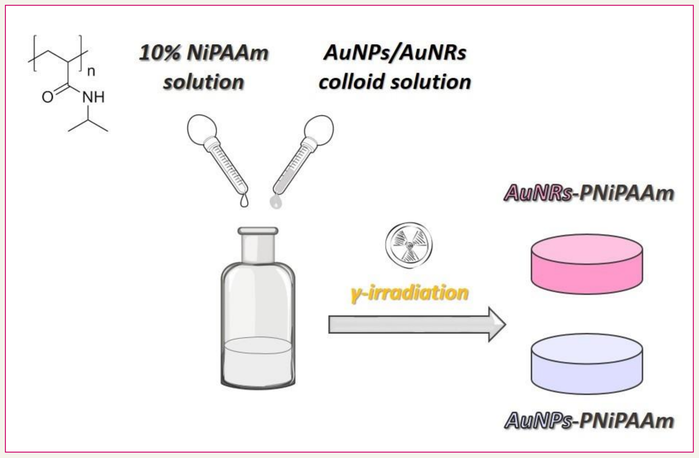
INTRODUCTION

Hydrogels are a class of polymeric materials with easily adjustable characteristics, and a wide range of applications, especially in medicine and biotechnology. Because of their great fluid absorption and retention capacity as well as their stable cross-linked three-dimensional structure, hydrogels provide an excellent platform for the stabilization of nanoparticles (NPs). Recently, hydrogels that exhibit environmentally responsive behavior and reversibly switch from hydrophilic to hydrophobic state in response to temperature changes represent a special class of intelligent materials.

Poly(N-isopropylacrylamide) (PNiPAAm) is the most investigated thermosensitive polymer with a well-defined volume phase transition temperature (VPTT) around 32°C. On the other hand, noble metal NPs are very attractive due to their unique physicochemical, optical, catalytic, structural, and electronic properties. A hydrogel nanocomposite with the appropriate and preferred characteristics can be created by combining the benefits of metal nanoparticles and selected polymer material.

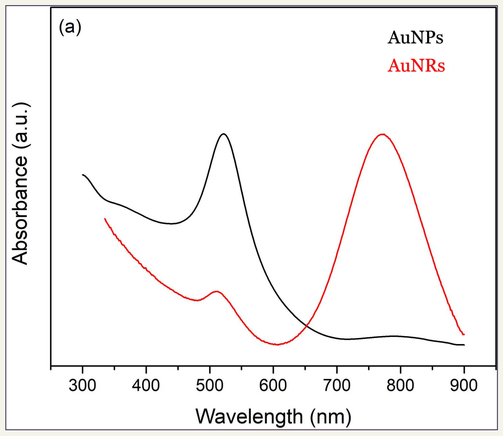
EXPERIMENTAL SECTION

We present a simple, straightforward two-step synthesis of nano Au/PNiPAAm hydrogel nanocomposites that includes the chemical formation of nanospheres (NPs) and nanorods (NRs), followed by gamma irradiation induced PNiPAAm crosslinking in the presence of NPs and NRs.



RESULTS

Optical properties



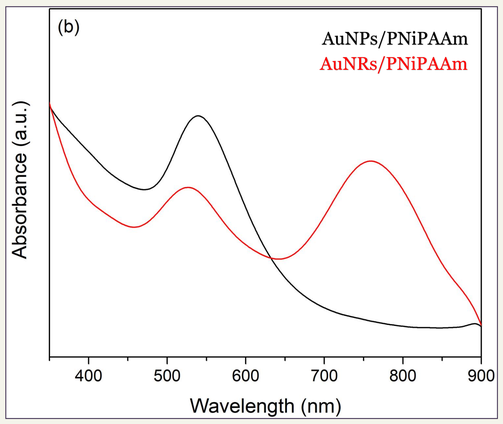


Figure 1. UV-Vis absorption spectra of colloidal AuNPs and AuNRs (a), and AuNPs/PNiPAAm and AuNRs/PNiPAAm hydrogel nanocomposites (b)

Physicochemical characterization

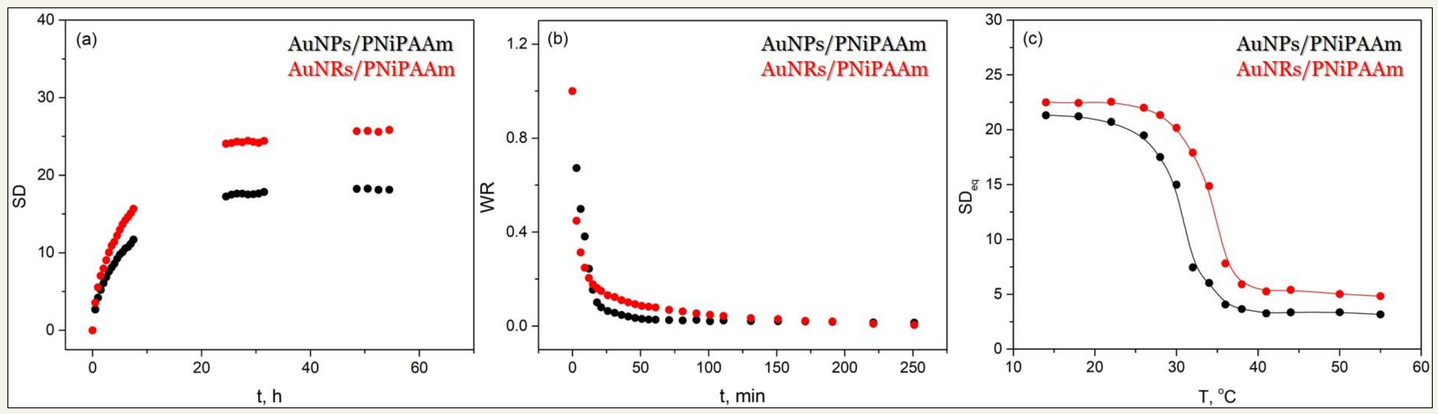


Figure 2. Swelling (a) and deswelling (b) curves and temperature dependence (c) of AuNPs/PNiPAAm and AuNRs/PNiPAAm hydrogel nanocomposites.

Microscopy

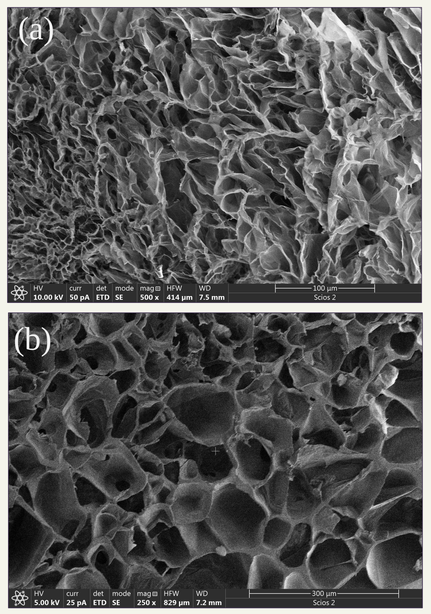


Figure 3. SEM micrographs of AuNPs/PNiPAAm (a) and AuNRs/PNiPAAm (b) hydrogel nanocomposites.

CONCLUSION

In summary, the AuNPs/PNiPAAm and AuNRs/PNiPAAm hydrogels nanocomposites were successfully synthesized by γ-irradiation method. Evidence of the AuNPs and AuNRs in the polymer matrix has been shown through the presence of characteristic SPR band with the maximum around 540 nm, and 530 nm (transversal oscillation) and 760 nm (longitudinal oscillation), respectively. According to SEM analysis it is evident that PNiPAAm chains formed a honeycombed morphology with a large number of micro-pores The AuNRs/PNiPAAm nanocomposite hydrogel, compared to AuNPs/PNiPAAm, indicates not only higher swelling capacity, deswelling rate constant and increased diffusion coefficient, but also the VPTT is shifted to the higher values.

Table 1. Parameters obtained from physicochemical characterization: equilibrium swelling degree (SD_{eq}), diffusion exponent (n), diffusion coefficient (D), deswelling rate constant (K_d), and volume phase transition temperature ($VPTT$).

	SD_{eq}	n	$Dx10^7$, cm^2/s	K_dx10^3, $1/min$	$VPTT$, °C
AuNPs/PNiPAAm	18.5	0.61	5.81	10.7	31.1
AuNRs/PNiPAAm	25.8	0.69	8.44	12.3	32.6

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