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Structural Characterization, Antibacterial Properties and Citotoxicity of γ-Irradiation Synthesized Ag-poly(N-isopropylacrylamide/itaconic acid) Hydrogel Nanocomposites

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Silver (Ag) impregnated dressings are intended to promote healing, prevent infection, to produce a sustained, steady supply of active Ag and to meet the challenges about safety. Hydrogels impregnated with nanocrystalline Ag (AgNPs) have the potential to meet most of these requirements.
Here hydrogel nanocomposite formulations are based on thermo- (NiPAAm) and pH-sensitive (IA) copolymer hydrogel matrix doped with AgNPs, (Ag-P(NiPAAm/IA), as a system for the controlled release of therapeutically active Ag ions with the aim to obtain the effective smart, antibacterial and nontoxic device. Synthesis of cross-linked polymer matrix (hydrogel) and in situ incorporation of AgNPs is made by biocompatible radiolytic products of water (using a ^{60}Co source) which provides a basis for the wide range of advanced or innovative applications in the biomedical field.
The aim of the work was to investigate structural characteristics of the AgNPs, the micromorphologycal and physicochemical characteristics of hydrogel, and biomedical potential of γ-irradiation synthesized nanosystems.

FTIR analysis confirms formation of 3D structure of copolymeric hydrogel with thermo- and pH responses. Swelling experiment was performed at different temperature (25°C and 37°C) and pH (2.2, 4.5 and 46.8) values. Internal morphology, examined by SEM and micro-CT analysis, showed the porous structure, dependent on the IA content, while AgNPs have no influence on the micro-structure. UV-Vis confirmed the synthesis of spherical AgNPs by the peak at around 400 nm. XRD studies confirmed the face centred cubic (fcc) crystal structure of AgNPs with the diffraction maxima at 2Θ angle values that correspond to the Bragg reflections from the crystal planes (111), (200), (220) and (311). The changes of lattice parameter, interplanar spacing, strain, stress, and dislocation density of crystalline AgNPs depend on the pore size and the diameter of AgNPs.

The controlled release of active substances was monitored by the release kinetics of Ag ions in a buffer solution (pH=7.4, $T = 37$°C). The content of Ag ions was determined by Argon arc plasma and obtained results are modelled by pharmacokinetic models (Korsmeyer-Peppas, Higuchi, Hixson-Crowel, Kopcha and Makoid-Banakar).

Antibacterial potential against the gram-negative (*Escherichia coli*) and gram-positive (*Staphylococcus aureus*) bacteria was investigated by the disc diffusion and optical density methods. Considering that the basic condition for the biomedical application of these types of materials is absence of toxicity in the surrounding tissue, cytotoxicity of synthesized nanocomposite device was examined by the effect on HaCaT cell line (healthy human keratinocytes). The results show that it is possible to achieve and fine-tune optimal antibacterial activity, below the cytotoxicity level, and without any harmful effects on the surrounding cells.

Country/Organization invited to participate

Serbia

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