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Nanocomposites of metallic silver in a matrix of 1-vinyl-1,2,4-triazole and N-vinylcaprolactam copolymer

Abstract: A current trend in materials science is the creation of new materials used in technology and science. The production of new functional copolymer nanocomposites with metal nanoparticles, in particular silver, based on non-toxic hydrophilic polymers can expand the range of polymeric substances used in the medical industry. Polymers and copolymers of 1-vinyl-1,2,4-triazole (VT) can be used as a polymer matrix, since they have film-forming ability, solubility, biocompatibility and non-toxicity(LD_{50}>3000 $mg \cdot kg^{-1}$). The areas of possible practical use of the types of thermosensitive polymers under consideration are constantly expanding. They are used as flocculants in synthetic latexes and components of extraction systems. Polymers isolated from solution as a separate phase can be used in the creation of nanomaterials. As a polymer matrix for stabilizing silver nanoparticles, we used a copolymer of VT with N-vinylcaprolactam (VC), obtained by electrochemical synthesis. Experiments have shown that electrolysis of aqueous or aqueous-ethanol solutions of VT and VC or their mixtures in various ratios in the presence of $AgNO_3$ and chitosan leads to the formation of nanocomposites and nanocomposite coatings with a silver content of 1–9 wt. % only in the presence of a peroxide-type initiator 4-tred-butylperoxy-4-oxobutanoic acid (TBOBA), the electroreduction potential of which is close to the potentials of cathodic deposition of metals - 0.6–1.2 V (s.ch.e.). Thus, we have established the ability of the VT-VC copolymer to the effectively stabilize metallic silver nanoparticles. The effect of the polymer matrix on the size of nanoparticles during their stabilization with different silver contents is the shown. Water-soluble nanocomposites are promising for the production of effective medical products with a wide range of antimicrobial activity. Silver nanocomposites were that formed from VT-VC monomer systems by a single-stage electropolymerization method. The composition and architectonics of the created nanocomposites and coatings were studied by various physicochemical methods. The synthesized metallic nanocomposites are recommended for use in medicine, in the creation of thromboresistant, antimicrobial polymeric materials, as well as in electronics and catalysis.

Keywords: electropolymer, nanoparticles, 1-vinyl-1.2.4-triazole, silver, electrocopolymerization, N-vinylcaprolactam.

Biography: Serzhik Hakob Sargsyan was born in 1953 in the Nagorno-Karabakh Republic. 1970-1975 studied at the Chemistry Department of the Yerevan State University. 1976-1978 worked at the A.L. Mndzhoyan Institute of Fine Organic Chemistry (Academy of Sciences of the Armenian SSR). 1978-1981 entered and completed postgraduate studies at the Frumkin Institute of Electrochemistry and defended his PhD thesis in the specialty "Electrochemistry". Since 1982, he worked at the Institute of Organic Chemistry of the Academy of Sciences of the Armenian SSR.

He studied the processes of electrochemical polymerization of nitrogen-containing heterocyclic monomers. Sargsyan developed a unique electrochemical method for the synthesis of coordination polymers. In this case, he was the first to show that azoles undergo electrochemical reduction on transition metals in absolute organic solvents in the presence of quaternary ammonium salts. Sargsyan also developed a new method for producing spatially structured polymer coatings based on the same monomers. He found out the mechanism of the deposition process. Summing up these studies, Sargsyan defended his doctoral dissertation in 1996. Currently, he is engaged in the synthesis and study of the properties of polymer nanocomposites. Since 2004, he has been working at the Department of TE and ZOS of the Armenian State Polytechnical University. In 2008, he received the academic title of professor. In 2012, he was appointed acting head of the Department of “Thermal energy and environmental protection”, and then elected head of the department. He was the executor of the project A-948 of the Institute of Scientific Research of the National Academy of Sciences of the Republic of Armenia, the scientific director of the projects A-1358, A-1841. He is a member of the specialized council 010 of the National Academy of Sciences of the Republic of Armenia, as well as a member of the specialized councils 057 and 055 of the National Polytechnical University of Armenia. He is the author of 178 scientific works, including 12 original and 14 scientific-methodical manuals, including 2 textbooks. He participated in numerous international conferences, where he made reports.