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Mechanism of the *in situ* silver nanoparticle synthesis in polymer/inorganic hybrids and biocide activity of the compositions

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Development of the regulated synthesis of metal nanoparticles with certain size, shape, sharp size distribution and high stability against aggregation is the key problem for their further application. Earlier we have shown that polymer/ inorganic hybrids are effective matrices for synthesis of silver nanoparticles (AgNPs) by borohydride reduction of Ag^+-ions in water medium. In this work, we have synthesized two polymer/inorganic hybrids based on silica sol (R=7.7 nm) and polyacrylamide (SiO_2-*g*-PAAm) with constant number but variable length of the grafted chains and have used them to study peculiarities and mechanism of *in situ* synthesis of AgNPs. It was found by the methods of static light scattering, FTIR spectroscopy and TEM that SiO_2-*g*-PAAm hybrids form in aqueous medium individual micelle-like structures with inorganic "core" and polymeric "corona", where PAAm chains are connected with silica surface by hydrogen bonds.

Using potentiometric investigations with silver-selective electrode, UV-Vis spectroscopy and TEM, we have shown that the reduction of Ag^+-ions in SiO_2-*g*-PAAm solutions occurs in polymeric "corona", develops in two stages with high rate and yield, and results in formation of stable crystalline AgNPs with the 3.5÷9 nm sizes and spherical morphology. The effect of concentrations of hybrid matrices and silver nitrate on the reaction parameters and long-term stability of AgNPs in aqueous solutions are considered. The AgNPs/hybrid compositions displayed significant antibacterial effect against fish pathogenic bacteria strains along with absence of their toxicity. Thus, the possibility of practical application of new biocide compositions in a fish farming was suggested.