Nanocomposites and nanomaterials

Kinetic scheme of silver nanoparticles growth in aqueous medium

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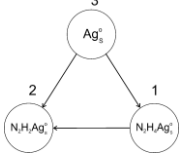
The reaction of silver ions reduction by hydrazine in alkaline medium in a wide range of the reactants concentrations has been investigated by the direct potentiometry. Using the methods of UV/Vis–spectroscopy, TEM and XRD–analysis it was determined that the spherical silver nanoparticles (AgNP) with an average diameter from 15 to 40 nm are formed. The form of the kinetic curves indicates on the avtocatalitical character of the process, in which the surface of AgNP plays a role of the catalyst. The generalization of data concerning to the kinetic studies allowed to suggest a scheme of the nanoparticles growth process, which can be represented by the following graph.



At the first stage of the process the hydrazine is adsorbed on the surface of the silver nucleus (or AgNP) (Ag_s^0) with the formation of the intermediate complex $N_2H_4Ag_s^0$ (see transition 3–1). This complex interacts with two Ag^+ and OH^- ions and forms the next intermediate complex $N_2H_2Ag_s^0$ and two silver atoms which are remained on the AgNP surface. In turn, $N_2H_2Ag_s^0$ complex also interacts with two Ag^+ and OH^- ions and completes the kinetic scheme. Such transformations can be described by the kinetic equation:

$$w_{grow} = -\frac{d[Ag^+]}{dt} = \frac{k_1 k_2 k_3 [N_2H_4][Ag^+]^2[OH^-]^2}{(k_1 k_2 + k_1 k_3)\cdot[N_2H_4] + k_2 k_3 \cdot [Ag^+]^2[OH^-]^2)} \cdot S$$

Here S is the total surface area of nanoparticles, which is the function of silver ions current concentration and the nuclei number; k_1, k_2, and k_3 are the rate constants of the corresponding process.