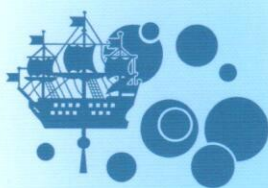




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SYNTHESIS AND CATALYTIC PROPERTIES OF GOLD NANOPARTICLES FORMED IN THE PRESENCE OF DNA

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Gold nanoparticles (Au NPs) are widely used in biology and biomedicine as optical sensors and in catalysis [1]. Their physical and chemical properties are strongly size-dependent [2]. There are many approaches to synthesize Au NPs via reduction of HAuCl_4 by glucose, sodium citrate, ascorbic acid, sodium boron hydride, and other reducing agents [3]. Recently it has been shown that guanine can reduce HAuCl_4 with the formation of particles with mean size about 6 nm [4]. It was to investigate the ability of DNA macromolecules to reduce Au(III) in the solution and analyze the size distribution as well as catalytic properties of thus formed Au NPs. Reduction of 4-nitrophenol by sodium boron hydride was chosen as the model catalytic reaction.

The interaction of HAuCl_4 with DNA was studied with different ratios of DNA and HAuCl_4 in the solution. Upon addition of HAuCl_4 into DNA solution, the DNA-Au complex was formed. The nanoparticles were found only after 48 hours and if ratio of DNA/Au in the solution below 1.0. TEM image of Au NPs and their size distribution are shown in Fig. 1. It was found that the mean size of Au NPs was 0.9 nm, is smaller than of those obtained in presence of glucose (16 nm), ascorbic acid (16 nm), NaBH_4 (4 nm), or ascorbic acid (16 nm) [3]. Based on this result, we can conclude that it is possible to obtain Au NPs in presence of DNA. Reduction of 4-nitrophenol catalyzed by Au NPs was monitored by measuring the mixture absorbance at λ 400 nm (the electronic absorption spectra are shown in Fig. 2.) It is clearly seen that without AuNPs no changes in the spectrum were observed, indicating no reaction even at 1000-fold excess NaBH_4 . However, the addition of AuNPs induced rapid color change. The plot of the natural log of the absorbance at 400 nm versus time is shown in Fig. 3. Thus, mixing DNA solutions with HAuCl_4 resulted in the Au-DNA complex. In the presence of Au NPs formation, the reduction of 4-nitrophenol to 4-aminophenol by sodium boron hydride catalyzed by Au nanoparticles obtained in the presence of DNA. The rate constant of 4-nitrophenol reduction catalyzed by Au NPs prepared in the presence of DNA ($9.62 \cdot 10^{-2} \text{ s}^{-1}$) was an order of magnitude higher in comparison with those formed in the presence of ascorbic acid ($7.0 \cdot 10^{-3} \text{ s}^{-1}$) or glucose ($6.54 \cdot 10^{-3} \text{ s}^{-1}$). The difference in the catalytic properties was likely due to the difference in the particles size.

Acknowledgements The financial support of Russian Foundation for Basic Research (project No. 17-08-01087).

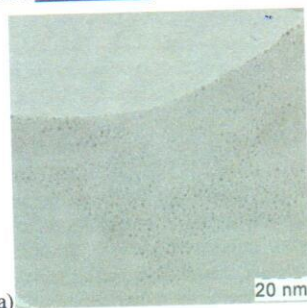


Fig. 1. a) TEM image of gold nanoparticles synthesized by reduction of HAuCl_4 with DNA.
b) Size distribution of the formed nanoparticles (200 particles).

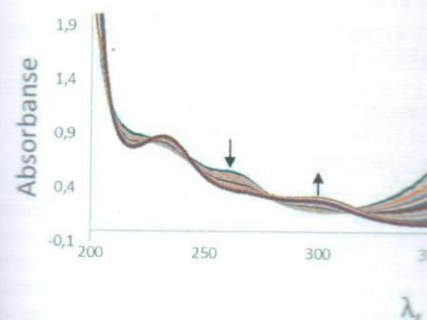


Fig. 2. The electronic absorption spectra of 4-nitrophenol.

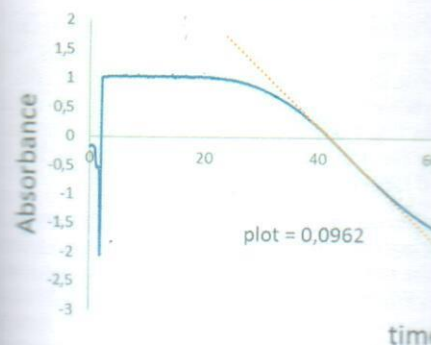


Fig. 3. Natural log of the absorbance at 400 nm versus time.

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