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«Influence of polymer pseudomatrix on the formation of copper nanoparticles on the steel surface»

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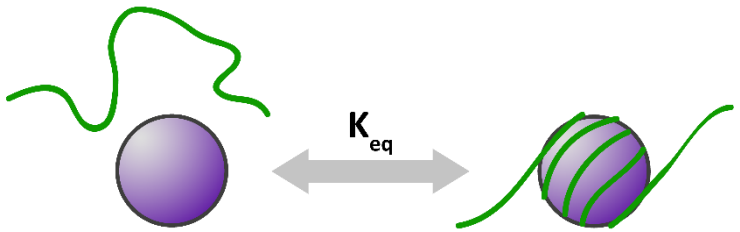


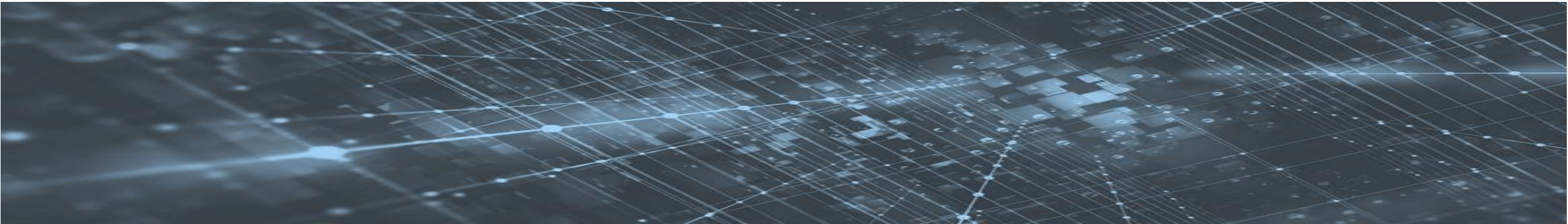
$K_{eq} = \exp(-\pi D^2 \Delta G/kT) = K^{D^2}$

$K = \exp(-\pi \Delta G/kT)$

It is widely known that the properties of nanoparticles are significantly influenced by their size characteristics and shape.

One of the approaches to control the size characteristics of nanoparticles is based on the use of polymer protectors pseudomatrix synthesis. The theory of pseudomatrix synthesis of metal sols is based on the idea of the cooperative nature of non-covalent interactions of macromolecules with the surface of nanoparticles, which makes it possible to effectively control the growth of nanoparticles during the synthesis of sols.

A similar method for controlling the size characteristics of nanoparticles can be used not only for the formation of sols, but also for the formation of nanoparticles on the surface of a more active metal.

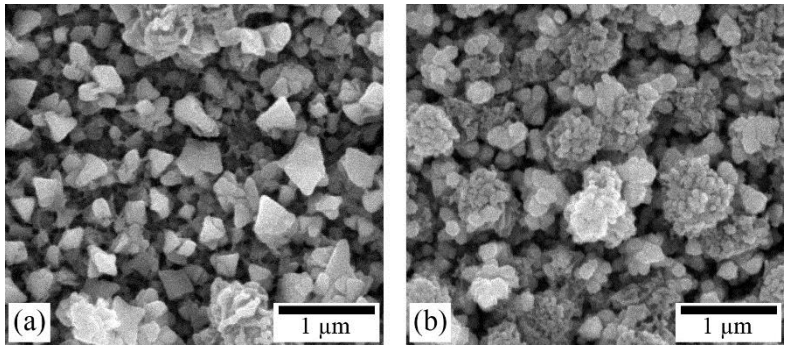


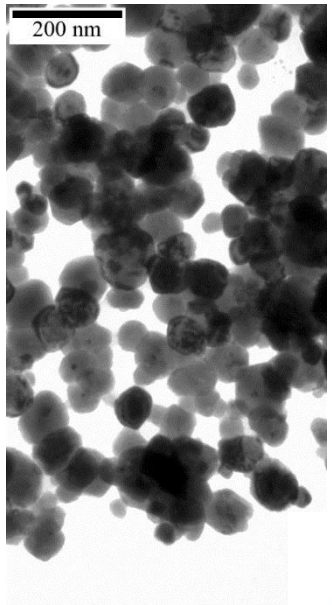
Methods

The processes of copper reduction on the steel surface in the presence of various polymer protectors [poly(N-vinylpyrrolidone), poly(ethylene glycol), poly(ethylene glycol-600-monolaurate)] were studied to determine the influence of the polymer pseudomatrix on the characteristics of the resulting nanoparticles.

Transmission electron microscopy, scanning electron microscopy, electron spectroscopy and thermogravimetric analysis were used to characterize the synthesis products.

Products obtained as a result of reduction of copper ions on the surface of steel: in the absence of PVP (a); in the presence of PVP 360000 (b).





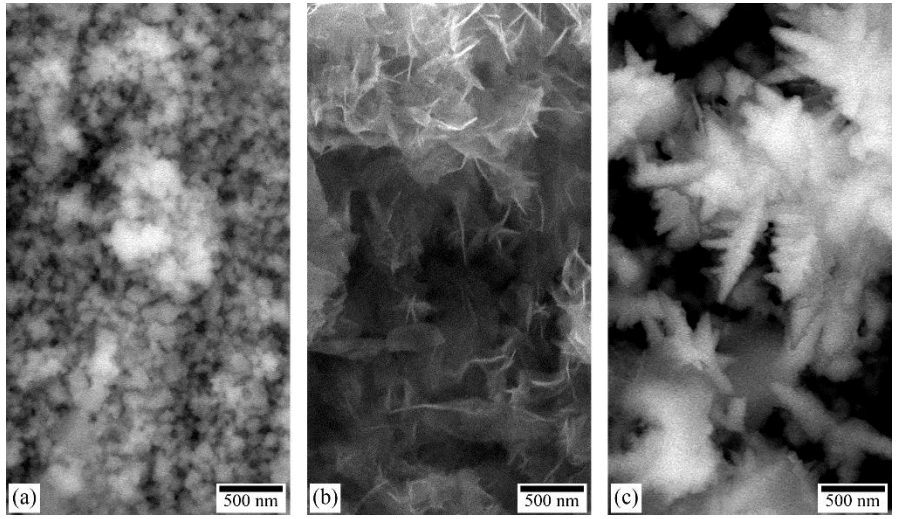
Sol particles formed as a result of ultrasonic treatment of the reaction system during the formation of samples in the presence of PVP 360000. It was noted that sols were not formed in the absence of PVP.

Conclusions

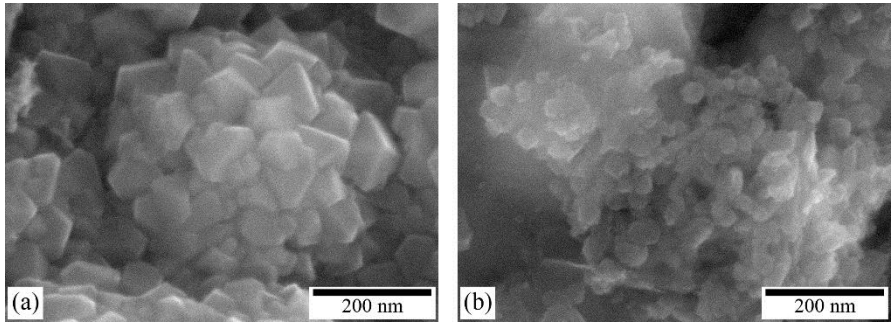
1. The processes of interaction of macromolecules with growing on the surface of a more active metal particles are similar to the known processes for the chemical reduction of copper (II) ions in aqueous solutions of polymer protectors.

2. The molecular mass of the applied polymer protector affects the characteristics of the resulting nanoparticles.

3. The effect of different polymer protectors on the formation of nanoparticles varies. Dendritic structures are formed when using PEG, in the presence of PVP – spherical aggregates of copper crystallites, in the presence of PEGML – needle-shaped structures. It was noted that in the presence of PEGML and PVP, nanoparticles of the same shape and composition are formed directly on the steel surface, and then they are combined into more complex structures. In the presence of PEG, smaller particles are not observed on the steel surface.



SEM-images of samples obtained in the presence of PVP (a), PEGML (b), PEG (c).



Samples of nanocomposites on the steel surface obtained in the presence of PVP (a) and PEGML (b).

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